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Department of
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Forest
Service

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Draft Environmental Impact Statement

Two Bit Vegetation Management

Happy Camp Ranger District, Klamath National Forest
Siskiyou County, California

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Two Bit Vegetation Management
Draft Environmental Impact Statement
Siskiyou County, California

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Abstract

Land managers for the Klamath National Forest propose the Two Bit Vegetation Management Project to sustain diverse, fire resilient ecosystems more in keeping with historic conditions, and to provide a programmed flow of timber products north and west of Happy Camp, California. This Draft Environmental Impact Statement (DEIS) considers the environmental effects of thinning and burning on about 9,530 acres of National Forest System land (see the vicinity map and proposed action map below).

The proposed action was developed with the input of local citizens and representatives from various organizations and government agencies and is designed to address the laws, policies and plans that guide vegetation management on National Forest System lands within the project area. The thinning and burning is intended to sustain diverse, fire-resilient ecosystems and a functioning forest and watershed by 1) reducing stand densities; 2) improving structural diversity within stands, where applicable; 3) maintaining natural meadows and wetlands or restoring meadows and wetlands where encroachment has occurred; 4) maintaining existing hardwood diversity or restoring hardwood diversity where loss has occurred or recruitment is low; 5) protecting mid- and early-seral forest from loss due to wildfire; 6) developing heavily stocked early seral stands into later seral conditions and reducing the risk of losing northern spotted owl habitat due to wildfire; and 7) maintaining or improving watershed conditions and the quality of the Indian Creek water source. The thinning and burning is intended to provide a programmed flow of timber products by: 1) improving and maintaining good growth rates; 2) minimizing

insect and disease damage through stocking control; and 3) continuing maintenance treatments in existing plantations.

Comments on this DEIS are due 45 days following the publishing of the Notice of Availability in the Federal Register. Reviewers should provide the Forest Service with their comments during the review period of the DEIS. This will enable the Forest Service to analyze and respond to the comments at one time and to use the information acquired in the preparation of the Final EIS, thus avoiding undue delay in the decision-making process. Reviewers have an obligation to structure their participation in the National Environmental Policy Act (NEPA) process so that it is meaningful and alerts the agency to the reviewer's concerns and contentions (Vermont Yankee Nuclear Power Corp. v. NRDC, 435 U.S. 519, 553 (1978). Environmental objections that could have been raised at the draft stage may be waived if not raised until after completion of the final environmental impact statement. City of Angoon v. Hodel (9th Circuit, l986) and Wisconsin Heritages, Inc. v. Harris, 490 F. Supp. 1334, 1338 (E.D. Wis. 1980). Comments on the draft environmental impact statement should be specific and should address the adequacy of the statement and the merits of the alternatives discussed (40 CFR 1503.3).

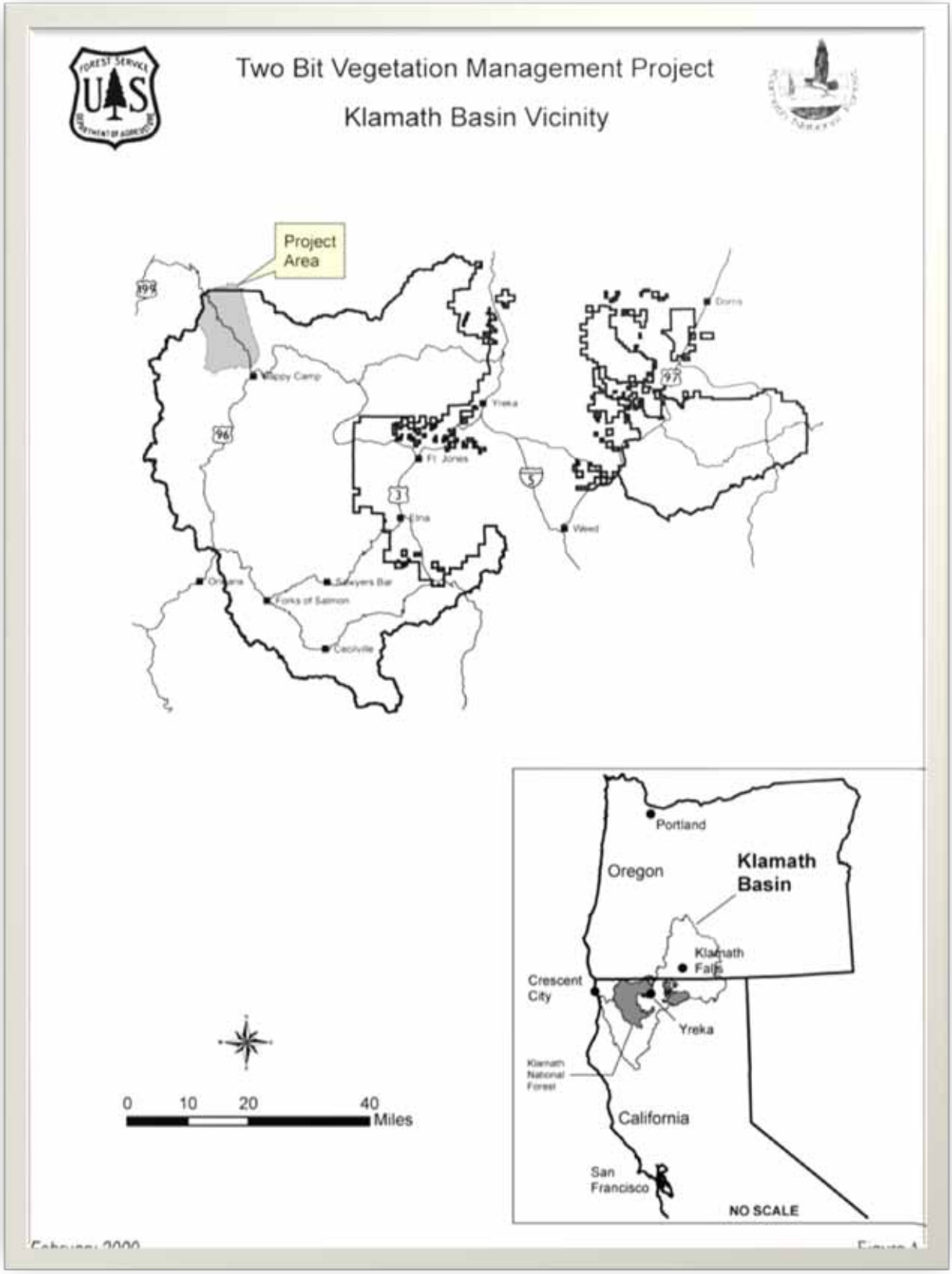


Figure 1. Vicinity Map

Figure 2. Activities proposed for alternative 2 – proposed action *note: stream layers shown on this map have not been field verified; for field-verified stream locations, see Two Bit Hydrology Specialist Report (Bousfield 2010)*

Summary

Land managers for the Klamath National Forest propose the Two Bit Vegetation Management Project to sustain diverse, fire resilient ecosystems more in keeping with historic conditions, and to provide a programmed flow of timber products north and west of Happy Camp, California. This Draft Environmental Impact Statement (DEIS) considers the environmental effects of thinning and burning on about 9,530 acres of National Forest System land (see figure 1, vicinity map and figure 2, proposed action map). The project is designed to sustain diverse, fire-resilient ecosystems and a functioning forest and watershed by:

- Reducing stand densities
- Improving structural diversity within stands, where applicable
- Maintaining natural meadows and wetlands or restoring meadows and wetlands where encroachment has occurred
- Maintaining existing hardwood diversity or restoring hardwood diversity where loss has occurred or recruitment is low
- Protecting mid- and early-seral forest from loss due to wildfire
- Developing late-successional conditions, increasing patch size of late-successional areas and reducing the risk of losing northern spotted owl habitat due to wildfire
- Maintaining or improving watershed conditions and the quality of the Indian Creek water source

Provide a programmed flow of timber products by:

- Improving and maintaining good growth rates
- Minimizing insect and disease damage through stocking control
- Continuing maintenance treatments in existing plantations

The proposed action would authorize approximately 9,530 acres of thinning and burning across approximately 68,000 acres of National Forest System land. Commercial thinning and other silvicultural treatments make up approximately 2,280 acres, and the remainder (about 7,250 acres) is proposed for prescribed burning. The majority of the treatment units proposed for commercial thinning are existing plantations. Approximately 315 acres proposed for treatment are natural stands.

The Klamath National Forest published a Notice of Intent to prepare an Environmental Impact Statement for the Two Bit Vegetation Management Project on February 20, 2009 in the Federal Register, initiating the public scoping period for this project. A scoping letter was distributed for public input and comment on February 18, 2009. The letter was mailed to approximately 90 individuals, groups, agencies and tribal governments and posted on the Klamath National Forest website. The Forest Service held a public meeting in Happy Camp, CA on March 4 to discuss the project and a public field trip was held on June 22, 2009 to show interested individuals the project area, discuss proposed treatments and answer questions. Ten

letters were received in response to the scoping effort and were used in conjunction with internal scoping with agency specialists to develop a list of significant issues. These issues led the agency to develop alternatives to the proposed action including:

- **Alternative 1 – No Action**
- **Alternative 2 – Proposed Action –** The proposed action includes a total of 2,280 acres of silvicultural treatments, 142 treatment units, approximately 4.1 miles of road decommissioning and approximately 7,250 acres of underburning outside of treatment units. Approximately 2.9 miles of temporary roads would need to be constructed and about 4.3 miles of existing temporary roads would be reconstructed to effectively access and treat thinning units.
- **Alternative 3 – No New Temporary Roads -** No new temporary roads would be constructed under Alternative 3. Approximately 3.5 miles of existing temporary roads would be reconstructed to effectively access and treat thinning units. Skid trails and existing temporary roads would be used and then hydrologically restored following treatment. Units that would require excessive adverse skidding distances would not be treated. Alternative 3 includes a total of 2,010 acres of silvicultural treatments, 125 treatment units, approximately 4.1 miles of road decommissioning, and a total of 7,320 acres of underburning outside of treatment units.
- **Alternative 4 – Minimized Underburning -** Alternative 4 includes silvicultural treatments (2,280 acres in 142 units) and road decommissioning (4.1 miles) as described in alternative 2. Fuels treatments would focus on thinned units, consisting of jack pot burning, pile burning and some limited underburning outside of thinned units, for approximately 570 acres outside of treatment units. Mastication to treat slash following thinning would be used instead of or in combination with underburning/hand pile burning in 93 units, to total approximately 1,490 acres of mastication.

Alternative components are summarized in table 1.

The Klamath National Forest Supervisor is the Responsible Official for this project. In the decision, the Forest Supervisor will answer the following questions based on the environmental analysis:

- Will the proposed action or one of the additional alternatives to the proposed action proceed as proposed or not at all? If one of these alternatives proceeds:
- What mitigation measures and monitoring requirements will the Forest Service apply to the project?
- Will the project require a Forest Plan amendment?

Table 1. Summary of alternative components

Component / Objective	Alternative 1 No Action	Alternative 2 Proposed Action	Alternative 3 No Temporary Roads	Alternative 4 Minimized Underburn
Total treatment acres (all treatments combined)	0	9,530	9,330	2,850
Total underburning acres	0	7,250	7,320	570
Total thinning acres	0	1,980	1,710	1,980
Total specialized treatment acres	0	140	140	140
Total meadow enhancement acres	0	160	160	160
Total acres of natural stands commercially thinned (% of thinning treatment)	0	315 (16%)	180 (11%)	315 (16%)
Total acres of plantations commercially thinned (% of thinning treatment)	0	1,665 (84%)	1,525 (89%)	1,665 (89%)
Total miles of road decommissioning	0	4.1	4.1	4.1
Total acres of mastication	0	0	0	1,490
Miles of temporary roads constructed	0	2.9	0	2.9
Potential sawlog volume produced from thinning (CCF, hundred cubic feet)	0	46,240	39,785	46,240

Table of Contents

Abstract i

Summary vii

Chapter 1. Purpose and Need for Action *1*

1.1 Document Structure 1

1.2 Management Direction 1
1.2.1 Additional Guidance 4

1.3 Purpose and Need for Action 6
1.3.1 Regulated Lands 8
1.3.2 LSR 8
1.3.3 Riparian Reserves 9
1.3.4 Summary of Purpose and Need 10

1.4 Proposed Action 10

1.5 Decision Framework 11

1.6 Public Involvement 11

1.7 Issues 11
1.7.1 Water Quality, Fisheries and Cumulative Watershed Effects 12
1.7.2 Economics 12
1.7.3 Air Quality and Prescribed Burning Implementation 13

Chapter 2. Alternatives, Including the Proposed Action *15*

2.1 Introduction 15

2.2 Alternatives Considered in Detail 15
2.2.1 Alternative 1 - No Action 15
2.2.2 Alternative 2 - The Proposed Action 15
2.2.3 Alternative 3 - No New Temporary Roads 27
2.2.4 Alternative 4 - Minimal Underburning 33

2.3 Summary of Best Management Practices (BMPs) and Project Design Features Common to All Alternatives 37
2.3.1 Best Management Practices 37
2.3.2 Project Design Features 39

2.4 Monitoring Common to All Alternatives 48

2.5 Alternatives Considered but Eliminated from Detailed Analysis 48
2.5.1 Maximize Harvest 49
2.5.2 Citizens Alternative 49
2.5.3 Initial Proposed Action 51

2.6 Alternatives Compared 53

Chapter 3. Affected Environment and Environmental Consequences *69*

3.1 Methodology 69

3.2 Past, Present and Reasonably Foreseeable Actions 69

3.3 Forest Vegetation 76
3.3.1 Methodology 76

3.3.2 Affected Environment 78
3.3.3 Environmental Consequences 91

3.4 Fire and Fuels 110
3.4.1 Methodology 110
3.4.2 Affected Environment 113
3.4.3 Environmental Consequences 116

3.5 Air Quality 123
3.5.1 Methodology 123
3.5.2 Affected Environment 124
3.5.3 Environmental Consequences 126

3.6 Water 129
3.6.1 Methodology 129
3.6.2 Affected Environment 131
3.6.3 Environmental Consequences 137

3.7 Geology 153
3.7.1 Methodology 153
3.7.2 Affected Environment 155
3.7.3 Environmental Consequences 157

3.8 Soils 167
3.8.1 Methodology 167
3.8.2 Affected Environment 168
3.8.3 Environmental Consequences 171

3.9 Fisheries 179
3.9.1 Methodology 179
3.9.2 Affected Environment 181
3.9.3 Environmental Consequences 188

3.10 Botany and Noxious Weeds 198
3.10.1 Methodology 198
3.10.2 Affected Environment 200
3.10.3 Environmental Consequences 202

3.11 Terrestrial Wildlife 207
3.11.1 Methodology 207
3.11.2 Affected Environment 208
3.11.3 Environmental Consequences 214

3.12 Social and Economic Resources 244
3.12.1 Methodology 244
3.12.2 Affected Environment 245
3.12.3 Environmental Consequences 249

3.13 Scenery and Recreation Resources 257
3.13.1Methodology 257
3.13.2 Affected Environment 259
3.13.3 Environmental Consequences 261

3.14 Cultural Resources 267
3.14.1 Methodology 267
3.14.2 Affected Environment 268
3.14.3 Environmental Consequences 270

3.15 Climate Change 275
3.15.1 Methodology 275

3.15.2 Affected Environment 276
3.15.3 Environmental Consequences 277
3.16 Short-term Uses and Long-term Productivity 278
3.17 Unavoidable Adverse Effects 279
3.18 Irreversible and Irretrievable Commitments of Resources 279
3.19 Energy Requirements 279
3.20 Legal and Regulatory Compliance 280
Chapter 4. Consultation and Coordination 281
4.1 Preparers and Contributors 281
4.2 Federal, State, and Local Agencies: 282
4.3 References 284
4.4 Glossary 293
4.5 Index 305
Appendix A – Public Scoping Comments and Responses 307
Appendix B – Treatment Objectives by Thinning Unit 331
Appendix C – Proposed Logging Systems Descriptions 367
Logging Systems 367
Appendix D – Aquatic Conservation Strategy Compliance 371
No-action Alternative 372
Alternatives 2, 3 and 4 373
Appendix E – Implementation of Best Management Practices for the Two Bit Vegetation Management Project 377
Introduction 377
Best Management Practices 377
Appendix F – Cumulative Watershed Effects Modeling Summary 393
Introduction 393
Summary of Findings 394
Existing conditions, with past and present/current actions 394
Alternatives 394

Table of Tables

Table 1. Summary of alternative components ix
Table 2. Klamath National Forest Plan Management Areas in the Two Bit project area 2
Table 3. Acres of proposed treatments for alternative 2 16
Table 4. Acres of logging systems for commercial thinning in alternative 2 19
Table 5. Acres of treatments proposed under alternative 2 by Forest Plan Management Area 22
Table 6. Acres of treatments proposed for alternative 3 27

Table 7. Acres of logging systems proposed for commercial thinning in alternative 3 29
Table 8. Acres of proposed treatment activities for alternative 3 by Forest Plan Management Areas 30
Table 9. Acres of treatments proposed for alternative 4 33
Table 10. Acres of proposed treatments by Forest Plan Management Area for alternative 4 34
Table 11. Best Management Practices selected for the Two Bit Project 38
Table 12. Project Design Features by resource area and where they apply 39
Table 13. Summary of alternative components and how well alternatives achieve project objectives 53
Table 14. Summary of environmental effects by alternative 58
Table 15. In-progress or planned activities within the Indian Creek Watershed 75
Table 16. Acres of completed, in progress or planned activities within the Indian Creek 5th Code Watershed, since 1953 76
Table 17. Existing condition, acres by vegetation cover (canopy closure) 79
Table 18. Existing condition, acres of forest type regenerated to plantation within the Two Bit Project Area 80
Table 19. Representative units: existing conditions 90
Table 20. No Action Alternative, Comparison of SDI for Existing Condition and 30 Years Out91
Table 21. No Action Alternative for years 2009 and 2039, TPA and QMD 94
Table 22. Alternative 2, comparison of SDI for Existing Condition, Post Treatment (CT and UB), and 30 Years Out 98
Table 23. Alternative 2 comparison of TPA and QMD for existing condition, post treatment in 2014, and post treatment in 2039 101
Table 24. Comparison of no action alternative and Alt 2, SDI and increase in QMD for Sample Stands 109
Table 25. Current conditions based on modeling results from FVS-FFE 115
Table 26. Descriptions of Historic Natural Fire Regimes 115
Table 27. Historic Fire Return Intervals in the Project Area 116
Table 28. Fire behavior measurement indicator results for the no action alternative 117
Table 29. Structure, composition and size measurement indicators for no action 117
Table 30. Fire behavior and effects measurement indicators for proposed action alternative - Note that the underburn is not modeled until 2014 118
Table 31. Stand structure, composition and size measurement indicators for proposed action. Note that the underburn is not modeled until 2014. 119
Table 32. Fire behavior and effects measurement indicator results for alternative 4. 120
Table 33. Stand structure, composition and size measurement indicator results for alternative 4. Note that underburn is not modeled until 2014. 121
Table 34. Comparison of alternatives by acres treated and average 90th percentile flame length for year 2014 (modeled underburn) and 2029 (15 years post-treatment) 123
Table 35. State and federal ambient air quality standards 125
Table 36. Estimated Emissions by Particulate Type (tons/acre and total tons) 127
Table 37. Total miles of unpaved log truck travel. Estimated PM10 fugitive dust emissions from log haul and return trips by alternative 128
Table 38. Beneficial uses with the Two-Bit Vegetation Management project area and existing watershed conditions 132
Table 39. Existing Pool conditions for surveyed stream reaches 134
Table 40. Previously clear-cut stream course Riparian Reserves 135
Table 41. Proposed action comparison of miles of reconstructed temporary roads to decommissioned roads located in stream course RRs by 7th –field watershed (percent change in parentheses) 140

Table 42. Proposed action acres of reconstructed landings located in stream course RRs by 7th–field watershed 141
Table 43. Proposed action commercial treatment acreage located in stream course RRs by 7th field watershed[1] 142
Table 44. Proposed action prescribed burning acreage located in stream course RRs by 7th field watershed 143
Table 45. Cumulative watershed effects risk ratios for the existing condition (alternative 1) and the proposed action (alternative 2) 144
Table 46. Alternative 3 comparison of miles (percent) of reopened/reconstructed temporary roads to decommissioned roads located in stream course RRs by 7th field watershed 147
Table 47. Alternative 3 commercial treatment acreage located in stream course RRs by 7th field watershed[1] 147
Table 48. Alternative 3 influence of cumulative watershed effects risk ratios (change in parentheses) 148
Table 49. Alternative 4 proposed mastication acreage located in stream course RRs in 7th field watersheds 150
Table 50. Alternative 4 influence of cumulative watershed effects risk ratios (change from existing condition in parentheses) 151
Table 51. Summary of how alternatives address geologic measurement indicators 166
Table 52. Existing soil conditions in proposed treatment areas 171
Table 53. Acreage of Detrimental Disturbance across the treatment units for alternative 2 176
Table 54. Acreage of Detrimental Disturbance across the treatment units for alternative 3 178
Table 55. Salmonid habitat indicators, primary environmental factors determining condition of salmonid habitat indicators, and appropriate measures for determining effects of proposed action on salmonid habitat indicators 189
Table 56. Alternative 2 - Effects on salmonid habitat condition measures 192
Table 57. Sensitive Species in the Two Bit Project Area, based on known occurrences or presence of suitable habitat 200
Table 58. Direct, indirect and cumulative effects to Sensitive Plants from implementation of alternative 2 203
Table 59. Sensitive Species in the Two Bit Project Area, based on known occurrences or presence of suitable habitat 209
Table 60. Management Indicator Species relevant to the Two Bit Project 211
Table 61. Northern spotted owl habitat in the Two Bit project area 219
Table 62. Treatment types in northern spotted owl habitat, all action alternatives 220
Table 63. Proposed thinning in NSO foraging habitat 223
Table 64. Proposed Treatments in LSR 242
Table 65. County Employment (Number of Jobs) by Economic Sectors 248
Table 66. Timber Volume and Values for alternative 2, proposed action 250
Table 67. Timber Volume and Values for alternative 3, No Temporary Roads 252
Table 68. Summary of effects to socioeconomic indicators from all alternatives 255
Table 69. Employment Impacts across Alternatives (number of jobs) 256
Table 70. High and Moderate Sensitivity Level Viewpoints 261
Table 71. Proposed Thinning Treatments within Visual Quality Objective Categories 262
Table 72. Scoping Comment Disposition 307
Table 73. Treatment objectives by thinning unit by alternative 331
Table 74. Modeled sediment delivery and equivalent roaded acres for the existing condition (Alternative 1) and Alternatives 2, 3 and 4 395
Table 75. Cumulative watershed effects risk ratios for the existing condition and Alternatives 2, 3 and 4 396

Table of Figures

Figure 1. Vicinity Map iii
Figure 2. Activities proposed for alternative 2 – proposed action *note: stream layers shown on this map have not been field verified; for field-verified stream locations, see Two Bit Hydrology Specialist Report (Bousfield 2010)* v
Figure 3. Decision process for Riparian Reserve prescriptions 21
Figure 4. Proposed activities for alternative 2 – proposed action) 25
Figure 5. Proposed activities for alternative 3 – No temporary roads*)* 31
Figure 6. Proposed activities for alternative 4 –minimized underburning 35
Figure 7. Indian Creek 5th field watershed and relationship to Two Bit Project Area and 7th field watershed boundaries 73
Figure 8. Vicinity of the Two Bit project area large fire history 114
Figure 9. Fire Regime Condition Class based on Fire Return Intervals 116
Figure 10. Employment Levels by County, 2001-2007 247
Figure 11. Mechanical felling using a feller buncher 367
Figure 12. Skidder operations 367
Figure 13. Yarder operations 368
Figure 14. Mastication equipment 369

Chapter 1. Purpose and Need for Action

1.1 Document Structure

The Forest Service has prepared this Draft Environmental Impact Statement in compliance with the National Environmental Policy Act (NEPA) and other relevant Federal and State laws and regulations. This Environmental Impact Statement discloses the direct, indirect, and cumulative environmental impacts that would result from the proposed action and alternatives. The document is organized into four chapters:

Chapter 1. Purpose and Need for Action: This chapter includes information on the history of the project proposal, the purpose of and need for the project, and the agency's proposal for achieving that purpose and need. This section also details how the Forest Service informed the public of the proposal and how the public responded.

Chapter 2. Alternatives, including the Proposed Action: This chapter provides a more detailed description of the agency's proposed action as well as alternative methods for achieving the stated purpose. These alternatives were developed based on significant issues raised by the public and other agencies. This discussion also includes mitigation measures. Finally, this section provides a summary table of the environmental consequences associated with each alternative.

Chapter 3. Affected Environment and Environmental Consequences: This chapter describes the environmental effects of implementing the proposed action and other alternatives. This analysis is organized by resource area.

Chapter 4. Consultation and Coordination: This chapter provides a list of preparers and agencies consulted during development of the environmental impact statement.

Appendices: The appendices provide more detailed information to support the analyses presented in the environmental impact statement.

Index: The index provides page numbers by document topic.

Additional documentation, including more detailed analyses of project area resources, may be found in the project planning record located at the Happy Camp Ranger District Office in Happy Camp, California.

1.2 Management Direction

The alternatives are guided by the 1995 Klamath National Forest Land and Resource Management Plan (Forest Plan), which subdivides the forest into Management Areas with established desired conditions and associated management direction (Standards and Guidelines – S&Gs). The project is designed to be consistent with the goals, objectives and standards and guidelines of all affected Management Areas. The table below shows Management Areas and the standards and guidelines that comprise relevant Forest Plan direction for the project and summarizes acreage for the 'most restrictive' Management Area that applies to any piece of the

forest, as indicated by the Forest Plan Management Area number (the most restrictive Management Areas have the lowest numbers in their titles). Multiple Management Areas may apply to a given area. Riparian Reserve standards and guidelines apply to lands that meet the description of Riparian Reserves, regardless of the Management Area they are within.

Matrix is a term from the Northwest Forest Plan applied to the portion of the Forest where timber harvest is programmed and is categorized in Regulation Classes 1, 2, and 3. These Regulated Lands are designated as such in the Forest Plan to provide sustained yield of timber with harvest volumes contributing to the Potential Sale Quantity (PSQ). For purposes of this document, the term 'Regulated Lands' is used instead of Matrix to refer to Management Areas where scheduled timber harvest is expected to occur, and harvest volumes contribute to the PSQ. Regulated Lands are noted in the table below.

Table 2. Klamath National Forest Plan Management Areas in the Two Bit project area

Land Designation	Approximate Acreage Within Project Area	Approximate Percentage of Project Area	Forest Plan Goals	Regulated Lands
Non-Forest Service System Lands or No Data	2347	3	Not under Forest Service jurisdiction	N/A
Off-Forest (Siskiyou National Forest Lands	2236	3	Not under Klamath NF direction	N/A
Klamath Forest Plan Management Areas				
MA 2 – Wilderness	1230	2	Manage for wilderness characteristics, natural conditions, ecological processes, air quality and primitive or semi-primitive non-motorized recreation opportunity; no timber harvest allowed; prescribed fire allowed when consistent with goals	No
MA 5 – Special Habitat – Late-Successional Reserves	14119	21	Provide habitat that contributes to the recovery of federally listed threatened, endangered and sensitive species; silvicultural and prescribed fire treatments allowed when consistent with goals	No
MA 5- Special Habitat - Threatened and Endangered Species	248	<1	Provide habitat that contributes to the recovery of federally listed threatened, endangered and sensitive species; silvicultural and prescribed fire treatments allowed when consistent with goals	No

Land Designation	Approximate Acreage Within Project Area	Approximate Percentage of Project Area	Forest Plan Goals	Regulated Lands
MA 6 – Managed Wildlife Area	2714	4	Manage for late successional habitat and habitat conditions as defined in the Fisher Habitat Capability Model; marginal timber yield and prescribed fire provided consistent with areas goals	Yes
MA 1, 7, 8 – Special Management (Research Natural Area, Special Interest Area, Cultural)	330	<1	Manage for ecological processes and unique features for which the area was designated; promote public use and enjoyment when compatible with area values; limited silvicultural and fuels treatments allowed when consistent with goals	No
MA 10 – Riparian Reserves	12457	18	Maintain and restore riparian-dependent structures and functions of intermittent streams; provide benefits to riparian-dependent and associated species; be consistent with Aquatic Conservation Strategy goals; silvicultural and fuels treatments allowed when needed to reach area goals	No
MA 11 – Retention – Visual Quality Objective	834	1	Provide attractive, forested scenery by maintaining areas in their natural or natural-appearing condition; manage for programmed, sustainable harvest in capable areas; maintain stand health and resilience to fire, insects, and disease	Yes
MA 15 – Partial Retention – Visual Quality	9851	15	Provide attractive, forested landscape where management activities are visually subordinate to landscape character; manage for sustained yield of wood products in capable areas; maintain stand health and resilience to fire, insects and disease	Yes

Land Designation	Approximate Acreage Within Project Area	Approximate Percentage of Project Area	Forest Plan Goals	Regulated Lands
MA 17 – General Forest	21267	32	Provide a programmed, non-declining flow of timber products, sustainable through time; maintain stand health; emulate ecological processes; provide for snags and hardwood habitat to maintain viable wildlife populations; meet visual quality objectives	Yes
Totals for Project Area	**67, 633 acres**	**100%**		**52%**

1.2.1 Additional Guidance

Several plans, policies and regulations provide management direction for this project, including but not limited to:

- Section 7(a)(1) of the Endangered Species Act
- Clean Air Act
- Clean Water Act
- The Roadless Rule of 2001

Endangered Species Act

Consultation for this project is occurring with federal regulatory agencies including the National Marine Fisheries Service (NMFS) and the US Fish and Wildlife Service (USFWS) as required by the Endangered Species Act. Representatives from these agencies have been involved in the project design and analysis for this DEIS. More information is in the Fisheries and Terrestrial Wildlife sections of Chapter 3.

Clean Water Act

Water quality standards have been developed by the State of California, as authorized by the Federal Environmental Protection Agency and the Clean Water Act of 1972. The Porter-Cologne Act, California's corresponding state law, assigns responsibility for protection of water quality within North Coast watersheds to the North Coast Regional Water Quality Control Board (NCRWQCB). The NCRWQCB implements and enforces the Porter-Cologne Act, and the Water Quality Control Plan for the North Coast Basin (Basin Plan). Water quality objectives are outlined in the Basin Plan.

The primary purpose for maintaining water quality is to assure that the beneficial uses of water are not adversely affected. When water quality objectives are met, and beneficial uses protected, the State then considers that a project meets water quality standards. Best management practices and project design features have been developed for this project to comply with the provisions and requirements of Sections 208 and 319 of the Federal Clean Water Act and to

otherwise ensure protection of water quality consistent with the Basin Plan. More information is in Section 3.8-Water in Chapter 3.

Clean Air Act

Air quality is managed through a complex series of federal, state, and local laws and regulations designed to assure compliance with the Clean Air Act. Regulations that apply to the Two Bit Vegetation Management Project are detailed in the Air Quality Report. Air quality and smoke management plans have been developed for the airshed surrounding the project area. The project is designed to be consistent with these plans.

A Smoke Management Plan (contained in all prescribed fire plans) would be submitted and approved by the Siskiyou County Air Pollution Control District prior to using prescribed fire on federal lands. As part of the Smoke Management Plan the Forest Service must provide a detailed meteorological prescription that must be met prior to igniting a prescribed burn. At a minimum, the prescription must include acceptable wind direction. Other considerations include wind speed, temperature profile, winds aloft, humidity, temperature, actual and predicted inversions, burn day status and forecast, precipitation forecast, and any other meteorological conditions that may affect smoke dispersion and/or fire behavior.

The Smoke Management Plan would also contain actions the Forest Service would take if smoke from burning unexpectedly impacts smoke sensitive areas; including the ability to extinguish the fire with equipment on hand. Smoke sensitive areas include any towns and or major roads within a 5-mile radius that could be impacted by smoke from the burn project.

One objective of the project is to prevent the occurrence of damaging wildland fires. Wildland fires are known to result in high levels of emissions and associated air quality problems. Vegetation management treatments provide the opportunity on a long-term basis to reduce the magnitude of wildfire air quality problems. Forest thinning is needed to reduce risk of catastrophic wildland fires that are likely to exceed air quality standards and result in greater releases of greenhouse gasses. More information is in the Air Quality section of Chapter 3.

Inventoried Roadless Areas

Approximately 36 acres of meadow restoration treatment is proposed for a small portion of the Siskiyou Roadless Area. Of this 15 acres are proposed for non-commercial thinning to remove small encroaching conifers and the remaining 21 acres are proposed for prescribed burning. All alternatives are consistent with roadless area management direction contained in the Regional Forester’s letter of November 28, 2007(USDA Forest Service 2007b), which directs that the 2001 Roadless Rule be applied to projects that propose cutting and removal of trees (including thinning). Consultation with the State of California has occurred consistent with this letter.

The Secretary of Agriculture issued a Memorandum (1042-154) on May 28, 2009, stating that his office has the authority to approve or disapprove road construction or reconstruction and the cutting, sale, or removal of timber in those areas identified in the set of

inventoried roadless area maps contained in Forest Service Roadless Area Conservation, Final Environmental Impact Statement, Volume 2, dated November 2000 (USDA Forest Service 2000a). Since then, the Forest Service has received two re-delegations of decision authority; one on August 3, 2009 and one on October 16, 2009. These letters provide re-delegations to allow many decisions on roadless area projects to be made by Forest Service officials without going through the Secretary of Agriculture. The Two Bit project was submitted to the Regional Office for review on December 3, 2009, as directed in a November 5, 2009 letter from the Regional Forester.

1.3 Purpose and Need for Action

The overall purpose of the project is to provide a programmed flow of timber products and to sustain diverse, fire resilient ecosystems more in keeping with historic conditions, as described below:

1. Sustain diverse, fire-resilient ecosystems and a functioning forest and watershed more in keeping with historic conditions – Actions proposed in the Two Bit project area are designed to do this by reducing stand density; improving structural diversity within stands; maintaining natural meadows and wetlands or restoring meadows and wetlands where encroachment has occurred; maintaining hardwood diversity or restoring hardwood diversity where loss has occurred or recruitment is low; protecting mid- and early-seral forest from loss due to wildfire; developing heavily stocked early-seral stands into later seral conditions, reducing the risk of losing northern spotted owl habitat due to wildfire; and maintaining or restoring watershed condition and the quality of the Indian Creek water source.

2. Provide a programmed flow of timber products – Actions proposed in the Two Bit project area are designed to do this by improving and maintaining good growth rates; minimizing insect and disease damage through stocking control; and continuing maintenance treatments in existing plantations.

Approximately 76 percent of the proposed thinning treatments are within Forest Plan Management Areas available for scheduled timber harvest (General Forest, Partial Retention Visual Quality Objective, and Managed Wildlife Habitat). The remaining areas are within Riparian Reserves, Special Management Areas, and Late-Successional Reserves; thinning activities within these management areas are in existing plantations.

Historical large fire history as well as fire exclusion have played a substantial role in vegetation successional patterns throughout the area. Historic conditions within the project area as seen in 1944 aerial photos indicate that large fires were a common occurrence in the area and vegetation was more open. According to Klamath National Forest Geographic Information System maps, there were 17 fires greater than 5 acres in size within the project area between 1944 and 2004. Historical vegetation classes were primarily Klamath Mixed Conifer and Douglas-fir as they are today, but seral stage distribution has changed over time. Historically, approximately 95 percent of the project area supported vegetation at or below a fire return

interval of 35 years, or fire regime condition class I (moderate to low fire intensity with frequent intervals). Currently, 89 percent of the project area is in fire regime condition class III (moderate intensity with an infrequent interval), indicating that most of the project area has shifted greatly from the natural historic fire regime (Isbell 2010).

Historically, there was variation in the landscape with areas of continuous cover broken up by openings of various sizes in the canopy. The lower severity fires of the past maintained open understory and kept levels of woody debris low; although this varied as it does today depending on weather, local topography and fuels conditions. More recent aerial photo interpretation indicates a more continuous cover of forest of various age classes and fewer openings. This change has contributed to increased fuel hazard (and the potential for high severity wildland fire), decreased habitat quality for some species and increased susceptibility to insect and disease impacts and loss of big trees.

Desired conditions for the Two Bit project area include:

- A sustainable flow of wood fiber
- Stand conditions that do not promote high severity wildfires
- Stand conditions that are more resilient to high intensity wildfires and drought
- Stand conditions that include a diversity of vegetation conditions including areas of continuous cover, more open stands especially on drier sites, and lower fuel levels similar to historic vegetation patterns.

These desired conditions are consistent with desired conditions and objectives described in the 1997 Indian Creek Watershed Analysis (USDA Forest Service 1997, pages IV-1 through IV-4 and table 4-1). Selected desired conditions and objectives from the Watershed Analysis underscore the need for treatment throughout the project area:

- Maintenance of late-seral conditions for extended periods with light fuel loadings (use fire to manage understory and reduce fuel loading; some removal of intermediate and suppressed trees may be beneficial)
- Fuel loadings that pose low risk to resources and investments (use fire to manage understory and reduce fuel loading; some removal of intermediate and suppressed trees may be beneficial)
- Riparian Reserves with vegetative cover with low risk of wildfire loss (manage conditions and densities commensurate with site capacities using tools such as thinning and fire)
- Stable road system that does not produce chronic sediment load to creek system (Implement road stabilization projects)
- Progression to late mature condition with light fuel loadings. Vegetation densities commensurate with site capacities (commercially thin and apply light underburn)
- Watershed contributes to sustainable programmed harvest on regulated lands (prioritize programmed harvest on regulated lands upon long-term growth and yield sustainability considerations)

The purpose of thinning and burning is to move toward desired conditions that more closely resemble the landscape of the past. These conditions would reduce potential for damaging wildfire and help sustain older forest habitat through time.

1.3.1 Regulated Lands

Approximately 52 percent of National Forest System land in the Two Bit area is allocated to Regulated Lands, which are lands open and available for commercial timber harvest. The management direction for Regulated Lands depends on the Forest Plan Management Area (see table 2). Much of the Regulated Lands portion of the project area is General Forest, which influences the type and extent of treatments that may occur on these lands.

Forest stands within regulated lands include areas that are overstocked to levels where competition for available resources (e.g., sunlight and water) makes them less able to withstand periodic drought. This condition also weakens trees' defense mechanisms and puts them at greater risk of damage from insects and disease, which further reduces tree vigor. Thinning is needed in these areas to reduce tree density and improve forest health and vigor in order to move toward the desired condition of healthy vigorous stands with less risk of loss from fire, insects or disease. Approximately 76 percent of the thinning treatments proposed are within Management Areas containing Regulated Lands.

1.3.2 LSR

Approximately 21 percent of National Forest System land in the Two Bit area is allocated to Late- Successional Reserve (LSR). *The Klamath National Forest, Forest-wide Late-Successional Reserve Assessment* (USDA Forest Service 1999a) presents a management strategy for attainment of LSR goals and objectives. Since the completion of this assessment, biologists from the USFWS-Yreka Field Office and the Klamath National Forest have emphasized the need to enhance late-successional desired conditions within LSRs. Important elements of the desired conditions typically include multiple canopy layers, small understory trees and canopy gaps.

Only a small percentage of proposed thinning (6 percent) would occur within LSR and approximately 18 percent of proposed underburning would occur within LSR. The majority of proposed thinning would be within existing plantations. These portions of LSR are not at the desired condition. Stands are mostly even-aged and generally too dense to grow large diameter trees. Trees would have to die to develop gaps where growing space is available for the understory to develop, increasing surface fuels and putting stands at risk to fire damage. Action is needed to reduce stocking levels to a point where late-successional characteristics could develop.

The desired condition within LSRs is detailed in the 1999 Late-Successional Reserve Assessment (USDA Forest Service 1999a, page 3-2) as:

> *"The desired condition within LSRs is to provide late-successional and old-growth forest in which structure and composition is consistent with site conditions and ecological processes. Important structural attributes include live old growth trees, standing dead trees, fallen trees or logs on the forest floor, and logs in streams. Additional important elements typically include multiple canopy layers, smaller understory trees, canopy gaps, and patchy understory."*

The use of prescribed fire is specifically mentioned in the 1999 LSR Assessment (USDA Forest Service 1999c, page 3-2) as follows:

> *"The introduction of prescribed fire to the LSRs will help encourage the processes and attributes that define late-successional and old-growth ecosystems. It is expected and even desirable to have low to moderate intensity fires burn in LSRs. Low intensity fires will reduce fine fuels and ladder fuels, create a seedbed for a diversity of herbaceous plants, and create a patchy understory open enough for spotted owl movements."*

Action is needed in LSR to reduce continuity of surface and ladder fuels and competition between trees and is consistent with the desired conditions for plantations as also mentioned in the 1999 LSR Assessment (USDA Forest Service 1999c, page 3-2) as follows:

> *"It is anticipated that plantations are capable of supporting mature and late-successional forest, and therefore, the desired condition is to manage them as such. Residual snags, hardwoods, and down logs from the previous stand will be desired components to maintain within these plantations. Hardwoods should be carried through the life of the stand. In the interim, the stands should be healthy and fast growing with stocking levels and fuel accumulations that reduce the likelihood of loss to catastrophic fire."*

1.3.3 Riparian Reserves

Riparian Reserves are vital for the protection of aquatic dependent species and to provide forest connectivity. Riparian areas are essential in maintaining stream temperature, dissolved oxygen levels, and other elements of water quality. They also ensure large wood recruitment, stabilize the channel, provide for filtration of sediment, and increase habitat diversity. Forested riparian ecosystems provide habitat for a diversity of plant communities. Riparian Reserves cover approximately 18 percent of the area.

They are to be managed to maintain mid- to late-seral stands over the long term, connectivity for late-seral wildlife and sufficient habitat for sustainable populations of indigenous aquatic species. Some Riparian Reserves in the proposed treatment areas are not at this desired condition and action is needed to restore desired conditions.

Desired conditions for Riparian Reserves are described in the Forest Plan on pages 4-106 through 4-107 and include:

> *"Vegetative communities contain native and desirable non-native species that are in good ecological condition. A multi-layered vegetative canopy is present…An overstory of conifers provide shade and thermal cover to streams and lakes…An intermediate layer provides thermal buffering, nutrient cycling and bank stability…The riparian community includes all age classes and sizes…."*

The purpose for treatment within Riparian Reserves includes maintaining or restoring watershed condition and water quality in Indian Creek and contributing to meeting Aquatic Conservation Strategy Objectives, particularly related to the influence of vegetation conditions on watershed processes. Riparian Reserve treatments in plantations would promote large woody

debris recruitment and stream shade; Riparian Reserve treatments in both plantations and natural stands would contribute to reduce wildfire risk.

1.3.4 Summary of Purpose and Need

The purpose of taking management action at this time in the Two Bit project area is to achieve two primary goals: to sustain diverse, fire-resilient ecosystems by restoring forest health and reducing fuel hazard and to provide forest products. The purpose and need for action is driven by the difference between the current and desired conditions of forest vegetation in the Two Bit area.

Action is needed within all land designations, including General Forest, LSR, and Riparian Reserves, although the emphasis for treatment varies. The project is intended to influence forest vegetation toward the desired conditions across the Two Bit area while remaining consistent with current management direction.

1.4 Proposed Action

The initial proposed action (as described during the February 2009 scoping period) and alternative 2 – the proposed action described in this document are quite similar; however, several refinements have been made since the scoping period. These refinements were based on additional field review by the IDT and other internal scoping efforts and resulted in the need to make some modifications to the initial proposed action. These modifications were mentioned in a flyer sent to the project mailing list in June 2009, posted to the project website, and discussed during the public field trip on June 22, 2009. No additional comments or concerns were received in response to this notification. Alternative 2 – the proposed action described in this document better addresses the purpose and need for action and the public input received to date, and more accurately reflects on-the-ground conditions; therefore, the initial proposed action was dismissed from further detailed analysis.

The action proposed by the Forest Service to meet the purpose and need is to commercially thin and conduct prescribed burning on a total of 9,530 acres within the project area. Commercial thinning treatments make up 1,980 acres of this; specialized treatments (pole harvest, sanitation thinning, and hardwood release) comprise 140 acres; and meadow enhancement treatments make up 160 acres. Prescribed burning (underburning) is proposed for 7,250 acres outside of thinning units. The majority of the treatment units proposed for commercial thinning are existing plantations. Approximately 4.1 miles of existing system roads would be decommissioned as part of this project. These roads were identified in 2004 through the Indian Creek Watershed Road Sediment Source Inventory process as requiring excessive maintenance, having little value to future management projects, and contributing to unfavorable watershed conditions. In order to facilitate tractor and cable logging, 2.9 miles of temporary roads would be created and 4.3 miles of existing temporary roads would be reconstructed to support this project. All temporary roads and pre-existing reconstructed roads would be

hydrologically restored to minimize erosion and sediment production upon completion of the project. Approximately 315 acres proposed for treatment are natural stands. The project is scheduled for implementation beginning in 2010 and lasting 10 years or more.

1.5 Decision Framework

Given the purpose and need, the deciding official reviews the proposed action, the other alternatives, and the environmental consequences in order to make the following decisions:

- Will the proposed action or one of the alternatives to the proposed action proceed as proposed or not at all?

  If one of the alternatives proceeds:

- What mitigation measures and monitoring requirements will apply to the project?
- Will the project require a Forest Plan amendment?

1.6 Public Involvement

The Klamath National Forest published a Notice of Intent to prepare an Environmental Impact Statement for the Two Bit Vegetation Management Project on February 20, 2009 in the Federal Register, initiating the public scoping period for this project. A scoping letter was distributed asking for public input and comment on February 18, 2009. The letter was mailed to approximately 90 individuals, groups, agencies and tribal governments and posted on the Klamath National Forest website. The Forest Service held a public meeting in Happy Camp, CA on March 4 to discuss the project and a public field trip was held on June 22, 2009 to show interested individuals the project area, discuss proposed treatments and answer questions. Ten letters were received in response to the scoping effort and were used in conjunction with internal scoping comments from agency specialists to develop a list of significant issues. In addition, as part of the public involvement process, the agency participated in coordination meetings and discussions with the Karuk Tribe, the US Fish and Wildlife Service, the North Coast Regional Water Quality Control Board, the National Marine Fisheries Service and the American Forests Resource Council. Meeting notes from these agency coordination efforts are available in the project record. Appendix A includes a table that displays the consolidation of all comments received during scoping and how these comments have been addressed.

Using the comments from the public, other agencies, and tribes, the interdisciplinary team developed a list of issues to consider.

1.7 Issues

The Forest Service separated the issues into two groups: significant and non-significant issues. Significant issues were defined as unresolved conflicts concerning alternative uses of available resources that is within the scope of the proposed action, relevant to the Decision to be made, supported by scientific evidence and has not already been decided by law, regulation or policy. Non-significant issues were identified as those: 1) outside the scope of the proposed action; 2)

already decided by law, regulation, Forest Plan, or other higher level decision; 3) irrelevant to the decision to be made; or 4) conjectural and not supported by scientific or factual evidence. The Council on Environmental Quality (CEQ) NEPA regulations explain this delineation in Sec. 1501.7, "…identify and eliminate from detailed study the issues which are not significant or which have been covered by prior environmental review (Sec. 1506.3)…" A list of non-significant issues and reasons regarding their categorization as non-significant may be found in the project record. Appendix A contains a table that lists scoping comments received and how they were categorized.

The Forest Service identified the following significant issues during scoping

1.7.1 Water Quality, Fisheries and Cumulative Watershed Effects

Temporary road construction will increase road density and may result in increased sediment production and peak flow that could impact water quality and aquatic habitat, especially when combined with the existing high density of roads in the Indian Creek Watershed. Riparian Reserve function may be adversely affected by commercial thinning; particularly disturbance from tractor logging, and stream water temperature could be adversely impacted. The key indicators used to analyze this issue are: 1) Cumulative Watershed Effects model outputs; 2) Temporary road length and landings within stream course Riparian Reserves, location within sensitive subunit watersheds (as mentioned in the watershed analysis), trend in relation to baseline watershed condition; 3) Project effects to anadromous fish habitat, specifically sedimentation, channel geomorphology and stream temperature; 4) Compliance with Aquatic Conservation Strategy and adherence to Riparian Reserve standards and guidelines (see appendix D); and 5) Percent canopy cover retention along perennial streams

An alternative that eliminates new temporary road construction (alternative 3, see Chapter 2) has been created to respond to this issue.

1.7.2 Economics

Logging costs may be higher than the thinning log value. Lumber prices are currently low and there is concern that the timber value and volume projected from the Two Bit project may not be enough to provide a financially viable timber sale. In addition, the costs associated with creation of roads and road maintenance may be cost prohibitive, considering the revenue created by timber harvest. The key indicators used to analyze this issue are: 1) Economic modeling; and 2) Log value, logging costs, other project costs, and present net value

An alternative that maximizes the number of treatment units while reducing the associated road costs was preliminarily considered to respond to this issue, although was not developed further for analysis (titled Maximize Harvest, see Chapter 2). One aspect of the maximize harvest prescription development—treatments to increase the thinning interval, which would increase economic viability— has been added to all action alternatives.

1.7.3 Air Quality and Prescribed Burning Implementation

The amount and location of proposed underburning may result in short-term but adverse impacts to local air quality due to the level of smoke produced, exacerbated by the tendency for smoke in these areas to settle in the basin. This can result in inconvenience and discomfort for residents that live along Indian Creek and in the town of Happy Camp, particularly those with allergies or breathing conditions. The amount of prescribed burning outside of treatment units may be difficult to feasibly implement, considering time and funding, other District work and the sensitivity of the area. The key indicators used to analyze this issue are: 1) Amount of particulates released; 2) Acres of burning and proximity to residential neighborhoods; and 3) Adherence to state air quality standards.

An alternative that reduces the amount of underburning and increases the non-burning slash treatments has been created to respond to this issue (alternative 4, Minimized Underburning, see Chapter 2).

Chapter 2. Alternatives, Including the Proposed Action

2.1 Introduction

This chapter describes and compares the alternatives considered for the Two Bit Vegetation Management Project. It includes a description of each alternative considered in detail, as well as those alternatives that were initially considered but not developed for further analysis. Alternatives considered in detail are compared based on alternative components and how well they achieve project objectives. A summary of the environmental effects of each alternative is included at the end of this chapter.

2.2 Alternatives Considered in Detail

Alternative 1, the no action alternative, is a baseline for comparison of the action alternatives. Alternative 2, the proposed action was developed by the interdisciplinary team to respond to the purpose and need for action and the project objectives. Alternatives 3 and 4 were then developed to address issues raised by the public during scoping of the proposed action. This section discusses the no action alternative, the proposed action alternative and the additional two action alternatives.

2.2.1 Alternative 1 - No Action

Under the no action alternative, no ground disturbing activities would be planned in the Two Bit project area. Commercial thinning, specialized treatments (e.g. sanitation thinning or hardwood release), prescribed burning and road decommissioning would not be implemented to accomplish project goals. On-going routine management activities would continue in the project area under Alternative 1, guided by the Forest Plan.

2.2.2 Alternative 2 - The Proposed Action

Alternative 2 would authorize approximately 9,530 acres of treatment across the 68,000 acre project area (Figure 4[1]). Of this, underburning is prescribed across approximately 7,250 acres of National Forest System lands outside of thinning units (11percent of the project area, see figure 4). Thinning is proposed for approximately 1,980 acres. Most commercial thinning is proposed for plantations; 315 acres (16 percent of proposed thinning) is proposed for natural stands.

The proposed action also includes specialized thinning treatments totaling 140 acres, including roadside sanitation thinning, roadside pole harvest and hardwood release treatments. In addition, approximately 160 acres of conifer-encroachment thinning would be conducted to enhance natural meadows.

[1] Note: stream layers shown on the map (figure 4) have not been field verified; for field-verified stream locations, see Two Bit Hydrology Specialist Report (Bousfield 2010)

These activities would occur in a variety of Forest Plan Management Areas including General Forest, Late Successional Reserves, and Riparian Reserves (see Table 2). Implementation of alternative 2 is expected to last 10 years or more from the time the decision is made to completion of the project. This landscape-scale project is intended to provide forest products, maintain or improve forest health and reduce fuel hazard over a large area.

Elements of alternative 2 are summarized in the table below. Appendix B displays treatment objectives for individual units.

Table 3. Acres of proposed treatments for alternative 2

Total Acres that would be treated	9,530 acres
Underburning	7,250 acres
Commercial thinning	1,980 acres
Specialized Treatments	140 acres
Meadow Enhancement	160 acres
Road Decommissioning	4.1 miles in 6 segments
Temporary Road Construction	2.9 miles in 26 segments
Re-Opening/Reconstruction of Existing Temporary Roads	4.3 miles
Landing Sites	250 landings needed (128 are existing); 122 new landings constructed totaling 60 acres
Mastication	0

Tree Thinning and Specialized Treatments

Proposed treatments include thinning of plantations and natural stands with subsequent fuels treatment. Specialized treatments are thinning pole-sized trees along roads in two locations, sanitation thinning to remove trees badly infected with dwarf mistletoe, and thinning to restore hardwoods. Timber products or other forest products would be produced from the thinning treatments.

Thinning would generally be from below where smaller trees with poor crowns would be removed to favor trees that are higher in the canopy with well developed crowns. There are several exceptions for groups of trees or for individual trees. At times, smaller trees would be left rather than larger trees in order to maintain species diversity, to remove some damaged or diseased trees from the stand, to remove off-site planted ponderosa pine, or where trees are too small to be thinned for timber products in this entry. In plantations there is less variation in the size of trees, and thinning would tend to be across all diameter classes. Trees of the same size within stands are often grouped together because of localized site conditions. In these cases, certain sized trees that are large compared to the other trees in one patch, might be the smallest-sized trees to remove within a different patch.

Thinning would focus on trees larger than 10 inches in diameter, but many of the trees smaller than that would be removed or felled during thinning operations or during post harvest fuel treatment (see Underburning and Fuels Treatments below), or other stand improvement

activities. Treatments would vary in the extent of thinning leaving some stands more open than others. See appendix B for more details regarding treatment objectives by unit.

Prescriptions for some stands would include a modified version of variable density thinning. This type of thinning creates a fine scale mosaic pattern by thinning to different densities, creating openings, and leaving areas unthinned in small patches within a stand. Most stands would have free thinning prescribed to maintain desired species that are not shade tolerant such as sugar pine, California black oak and Pacific madrone. Free thinning removes competing trees from around the desired tree. For both the latter types of thinning, individual larger trees could be removed to meet the objectives.

The Forest Service identified approximately 1,980 acres of stands that are of a size, condition, and location suitable for thinning and producing commercial quality timber. Thinning is proposed primarily for plantations, making up 84 percent of all acres proposed for this treatment. Commercial thinning is proposed for LSR, Managed Wildlife Areas, Special Management Areas, Riparian Reserves, Partial Retention and General Forest (table 5). Thinning proposed in LSR would occur only in plantations, which contain small inclusions or individual trees left from the original stand. Within LSR there are few trees over 20 inches in diameter and these trees would not be cut except in a few cases where it is necessary to facilitate the thinning operations. Alternatives have been designed to comply with all applicable Management Area standards and guidelines.

Thinning treatments would be designed to maintain or improve the health and vigor of the stand. Diseased trees (e.g. dwarf mistletoe, heart and butt rots, etc.) would be targeted for removal, as long as overall resource objectives are met. However, snags and a portion of trees with decadent characteristics would remain where practicable, particularly in LSR. Firewood and other special forest products would be offered where feasible to help meet the thinning or fuels treatment prescriptions.

Whole tree yarding would result in creation of slash piles at landing sites. Piles would be burned at the landing, after piled material is made available for personal use fuel wood gathering. Heavy equipment may be used to pile the slash or slash would be hand piled where needed, particularly in areas where trees are limbed on site. The timing of underburning through thinned and adjacent stands would be coordinated with slash treatments after thinning.

Specialized treatments, including roadside sanitation thinning, roadside pole thinning, and thinning to restore hardwood stands, are proposed for 140 acres. These acres combined with commercial thinning totals 2,120 acres proposed for thinning. These specialized treatments make up a small percentage of the project area.

Pole harvest is proposed for 84 acres along roadsides that are heavily stocked with small diameter (less than 10 inch) trees. These areas are proposed for thinning to meet fuels objectives and would be made available to the local community through personal use pole permits.

Sanitation harvest is proposed for 36 acres along a roadside that has dwarf mistletoe infestation. Thinning in these areas is proposed to remove a portion of trees with dwarf mistletoe to slow the spread to nearby healthy stands.

Thinning to restore hardwood stands is proposed for approximately 18 acres to reduce conifer competition with medium- to large-sized oak trees and other hardwoods.

Roads, Landings and Skid Trails

Approximately 2.9 miles of temporary roads in 26 segments located throughout the project area would be constructed to more efficiently remove thinned logs. All of the proposed road segments have been reviewed by IDT members and found to meet standards. Existing roads, skid trails and landings would be used whenever possible and practical to avoid new disturbance. Approximately 4.3 miles of pre-existing temporary roads would be re-opened/reconstructed.

Timber hauling would mainly occur on existing Forest System roads or on re-opened temporary roads, although some new temporary roads would be constructed to facilitate commercial thinning, as described in more detail below. Many Forest System roads in the project area are in good condition; however, some would require programmatic maintenance before proposed operations would begin in order to bring them up to current standards. Programmatic maintenance on Forest System roads is a routine action that is on-going and has been evaluated in a separate environmental analysis. Programmatic maintenance includes bringing roads up to safe condition for use and to ensure that impacts from road use would not leave the running surface (e.g. dip, ditch and culvert cleaning, dust abatement and grading). Earth scientists and/or road engineers would determine appropriate treatments if watershed health problems such as streams crossings with diversion potential are encountered on re-opened maintenance level 1 road.

Gravel would be necessary for programmatic road maintenance and in some instances, for use of re-opened temporary roads or new temporary roads. There is an existing rock source (gravel pit) in the project area that would be used. Project design features for geology and noxious weeds include measures for minimizing the potential impacts of rock sources.

Existing skid trails and landings would be used whenever possible and practical to avoid new disturbance; however, new skid trails and landings would be required to facilitate thinning treatments under alternative 2. As shown in table 3, 250 landings would be required, and 122 of these would be new construction. Exact location and total acres of skid trails is not feasible to determine at this project planning stage; however it is estimated that fewer skid trails (less need for new skid trails and less frequent use of existing skid trails) would be necessary under alternative 2 than under alternative 3 due to the use of new temporary roads.

New skid trails with substantial cut and fills would generally not be developed, though safety and operational conditions may require a skid trail to cross short, steeper sections within tractor units. Some cut and fill may be necessary to safely cross these areas. Any skid trails with

substantial cut and fills would be reviewed by a geologist prior to construction to ensure slope stability.

New temporary roads and landings would not be constructed in Riparian Reserves. New temporary roads would be built, used, and then hydrologically restored in the same season of use (prior to winter). Some reconstructed pre-existing roads and landings would occur in Riparian Reserves. New disturbance would be avoided in locations where sediment may directly enter streams. Rock would come from existing quarries located outside Riparian Reserves. Berms would be removed, and conditions which concentrate surface runoff would be eliminated on all temporary roads and re-opened existing roads. After use, reconstructed pre-existing roads would be hydrologically restored, and rock pits and quarries would be water-barred and shaped for drainage.

Timber sale operators would be required to apply site-specific measures to road work to protect water quality. Any new temporary road alignments or skid trails with substantial cut and fills added during the implementation phase of the project would be reviewed by a hydrologist and geologist to ensure BMPs are properly applied.

Logging Systems

The majority of the commercial thinning and specialized treatment units are proposed to be harvested using ground-based operations (mechanized harvest or conventional tractor skidding using feller bunchers and rubber-tired skidders). A small percentage would be cable-logged (including skyline and mobile yarders). No helicopter logging is proposed. Logging systems are summarized in the table below and described in appendix C.

Table 4. Acres of logging systems for commercial thinning in alternative 2

Commercial Thinning Logging Systems	Acres
Mechanical harvesting	719
Mechanical harvesting with Tractor Endlining	773
Handwork with Conventional Log Skidding and Tractor Endlining	35
Conventional Log Skidding with Tractor Endlining	339
Handwork Only	87
Cable Yarding	167
Total Thinning	**2120**
Meadow enhancement (no logging)	160
Total Silvicultural Treatments	**2,280**

Commercial Harvesting in Riparian Reserves

Riparian Reserves (RR) occur throughout about 18 percent of the project area within 170 feet of an intermittent or perennial stream, and extend to 340 feet from fish bearing stream reaches. Riparian Reserves are also established for inner gorges, unstable areas, and small wetlands.

Forests within RR in the project area, and in general, have a wide range of fuel loadings and vegetation conditions; past flood damage has left some riparian areas with sparse cover (USDA Forest Service1997).

Approximately 300 acres within Riparian Reserves are proposed for commercial thinning under alternative 2 (table 4) to achieve the objectives of late-successional stand structure and diversity over time, as well as fuel reduction of surface, ladder and crown fuels.

Standards and guidelines apply to silvicultural prescriptions in Riparian Reserve (see MA 10 Goals in Chapter 1). Appendix B includes a table outlining the commercial thinning units' generalized prescriptions, and identifies where Riparian Reserve thinning is proposed. Appendix C includes descriptions of how each alternative complies with the Aquatic Conservation Strategy. Riparian Reserve thinning would be conducted according to design criteria that ensure woody material is properly maintained, soil compaction and disturbance is minimized or eliminated, and important elements of the riparian environment are not degraded, as described in Table 13 at the end of this chapter.

Ephemeral streams that do not meet the Riparian Reserve definition ("...having a definable channel and evidence of annual scour or deposition"; page C-31; USDA Forest Service 2005) are not subject to the decision process outlined in figure 3 and will not be included in the acreage calculations in table 5. However, even ephemeral streams lacking annual scour are capable of transporting sediment and large wood to intermittent or perennial streams during upcoming flood events. Therefore, the project design features for water (table 12) will apply for all ephemeral streams regardless of whether they meet the Forest Plan definition of Riparian Reserve or not.

Yarding corridors are designed to avoid crossing streams, however should a crossing be necessary, logs would be fully suspended. Tractor skid trails would not cross streams except by agreement in rare cases during implementation. Remedial shaping and/or subsoiling of skid trails may be prescribed at that time. The decision process below outlines the course of action used to determine the Riparian Reserve prescription. Trees larger than prescription felled for operations or safety in Riparian Reserves would be retained on the ground unless to do so would pose an operational, safety or fuels hazard.

Riparian Reserve Decision Process

1. Would thinning trees greater than 10 inches within this Riparian Reserve promote stand conditions needed to meet Aquatic Conservation Strategy Objectives over time/space?

If no, do not commercially thin this Riparian Reserve. Non-commercial thinning and/or underburning may still be prescribed depending on existing condition.

If yes, continue to 2.

2. Is this Riparian Reserve located within a plantation?

If no, continue to 3.

If yes, consider commercial thinning throughout the plantation. Apply Best Management Practices and Soil Design Features including keeping tractors on slopes less than 35percent. Maintain buffer on Riparian Reserves as described in project design features in table 12.

3. The outer portion of the Riparian Reserve (as described in project design features in table 12) may be commercially thinned according to a site-specific prescription that maintains large trees and older forest connectivity. No commercial thinning would occur within wetlands, inner gorges and unstable areas.

Figure 3. Decision process for Riparian Reserve prescriptions

Meadow Enhancement

Meadow enhancement/restoration is proposed for 160 acres in order to maintain or enhance meadow conditions. Treatments would include cutting generally small diameter encroaching conifers, handpiling and burning, and limited use of prescribed fire. Cut trees would be left on site. No commercial products would be removed.

Underburning and Fuels Treatment

Proposed prescribed burning activities include hand piling, burning small concentrations of debris and slash (jackpot), and low intensity burning under a forest canopy. These activities are designed to treat fuel accumulations created during proposed thinning treatments in thinned stands, and to reduce fuel loading and buildup of forest debris both within thinned units and outside of thinned units (Figure 4). Fuels treatment within thinned stands includes a combination of landing pile burning, underburning, hand pile burning and jackpot burning to burn debris. Approximately 2,000 acres of underburning in combination with landing pile burning is proposed within thinning units and 120 acres is proposed for hand pile burning. Meadow enhancement units (160 acres) would also be hand piled and pile burned.

Outside of thinning units, approximately 7,250 acres of underburning is proposed over approximately a ten-year period. Non-commercial thinning of small trees and brush may occur within these large underburn areas as needed to promote effective fuel consumption.

Underburning outside of thinning units would occur within several Forest Plan Management Areas, including LSR, RR General Forest and other areas, as shown in the table below.

Table 5. Acres and percent of treatment area for treatments proposed under alternative 2 by Forest Plan Management Area

Management Area	Underburning Acres and Percentage of Treatment Area	Silvicultural Treatment Acres *(does not include meadow enhancement)* and Percentage of Treatment Area
Non National Forest	87 (1%)	0
MA-2 Wilderness	4 (<1%)	0
MA-5 Late Successional Reserve	1299 (18%)	125 (6%)
MA-6 Managed Wildlife Area	447 (6%)	1 (<1%)
MA-1,7,8 Special Management	13 (<1%)	23 (1%)
MA-10 Riparian Area *(see hydrology specialist report (Bousfield 2009) for field-verified stream course RR and percentages of proposed treatment area)*	1601 (22%)	353 (17%)
MA-15 Partial Retention VQO	757 (10%)	363 (17%)
MA-17 General Forest	3042 (42%)	1255 (59%)
Total	**7,250**	**2120**

Burning operations would be accomplished according to burning and smoke management plans intended to meet management objectives and minimize the effects of smoke on adjacent communities and the public. Burning would usually be accomplished during times of high fuel and duff moisture levels, which limits the burning of large stumps and coarse wood and maximizes consumption of smaller-sized fuel.

Burning would occur during favorable weather conditions when smoke is transported away from sensitive locations. Slash piles would be constructed to burn with minimal smoke. Techniques include covering piles to keep them dry and limiting the amount of soil in the piles. For example, ignitions would be slowed or stopped if changing meteorological conditions cause smoke to intrude into sensitive areas, or burning may be undertaken on low visitor use days in the spring and avoided on high use weekends.

Smoke management plans would be submitted to the Siskiyou County Air Pollution Control District for each burn plan. Contingency actions would be undertaken if smoke impacts occur or meteorological conditions go out of prescription. Spot weather forecasts would be used to ensure favorable “within prescription” weather conditions for the burn itself and for smoke transport.

Underburning is recommended in the Watershed Analysis, LSR Assessment, and various Fire Plans. Underburning is also prescribed in Riparian Reserves to meet Aquatic Conservation Strategy (ACS) objectives (NWFP S&G FM-4, page C-36).

The goal of management within Riparian Reserves includes maintaining and restoring riparian-dependent structures and functions, providing benefits to riparian-dependent and associated species, and maintaining consistency with Aquatic Conservation Strategy goals.

Underburn prescriptions would be designed to result in low severity burns in Riparian Reserves so that these processes are maintained over time. Techniques such as allowing fire to back into Riparian Reserves and hand piling fuels on potentially unstable areas are methods for reducing underburn severity and impacts to other resources.

Specific problem spots, such as high concentrations of fuel located on unstable areas (particularly granitic areas), would be field reviewed by fuels and earth science personnel during development of the burn plan to implement appropriate burning prescriptions. Effective shade would be maintained in riparian areas.

Cumulative watershed effects would be considered in the amount of burning in any 7th field watershed during a three-year period (i.e., not all burning would occur at the same time and would be staggered across years to meet cumulative watershed objectives).

Road Decommissioning

Approximately 4.1 miles of existing Forest System roads are proposed for decommissioning. These roads were identified in 2004 through the roads analysis process as requiring excessive maintenance, having little value to future management projects, and contributing to unfavorable watershed conditions. Road density reduction was also a component of the recommendations made as part of the 1997 Indian Creek Watershed Analysis.

The Watershed Analysis did not provide an actual road density reduction figure; but made recommendations on road management in the Indian Creek Watershed. Since the Watershed Analysis was written, several projects have been undertaken or are planned to reduce road densities in this watershed through decommissioning, storm-proofing and hydrological stabilization including the Happy Camp Road Decommissioning Project (USDA Forest Service 1999a), the East Fork Road Project (USDA Forest Service 1999ab) and the 2005 Mill Luther Watershed Restoration Project (USDA Forest Service 2005b).

The proposed road decommissioning as part of this project would continue to implement the recommendations from both the watershed analysis and the roads analysis. In addition, road decommissioning is also a recommendation made in the 1999 Forest-Wide LSR Assessment (USDA Forest Service 1999c).

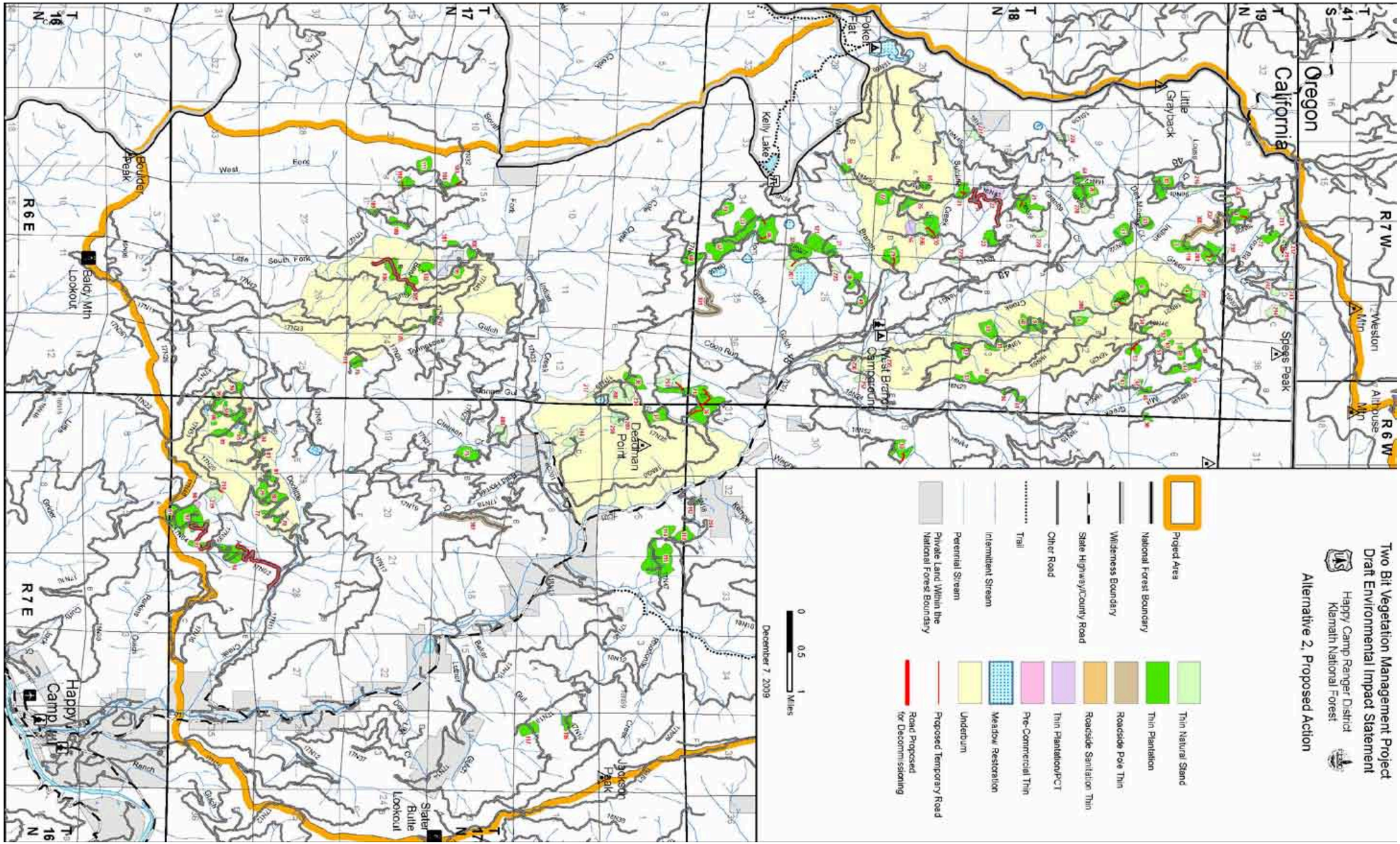


Figure 4. Proposed activities for alternative 2 – proposed action

2.2.3 Alternative 3 - No New Temporary Roads

Alternative 3 would authorize approximately 9,330 acres of treatment across the 68,000 acre project area (Figure 5[2]). Of this, underburning is prescribed across approximately 7,320 acres of National Forest System land outside of treatment units (11% of the project area, see Figure 5). Thinning is proposed for approximately 1,710 acres. Most commercial thinning is proposed for plantations; only 180 acres (11% of proposed thinning acres) is proposed for natural stands.

Alternative 3 also includes specialized thinning treatments, totaling 140 acres, including roadside sanitation thinning, roadside pole harvest and thinning to restore a hardwood stand. In addition, approximately 160 acres of conifer-encroachment thinning would be conducted to enhance natural meadows.

No new temporary roads would be constructed under alternative 3; however, 3.5 miles of pre-existing temporary road reopening/reconstruction would occur under (0.8 miles less than alternative 2). Skid trails and reopened roads would be used and then hydrologically restored following treatment.

These activities (see table 6) would occur in a variety of Forest Plan Management Areas, including General Forest, Late-Successional Reserves, and Riparian Reserves.

Implementation of alternative 3 would last approximately 10 years or more from the time the decision is made to full implementation. This landscape-scale project is intended to provide forest products, restore forest health and reduce fuel hazard over a large area.

Elements of alternative 3 are summarized in the table below.

Table 6. Acres of treatments proposed for alternative 3

Total Acres that would be treated	9,330 acres
Underburning outside of thinning units	7,320 acres
Commercial thinning	1,710 acres
Specialized Treatments	140 acres
Meadow Enhancement	160 acres
Road Decommissioning	4.1 miles in 6 segments
Temporary Road Construction	0
Re-Opening/Reconstruction of Existing Temporary Roads	3.5 miles
Landing Sites	222 landings needed (126 are existing); 96 new landings constructing totaling 48 acres
Mastication	0

The primary differences between alternative 2 and 3 are the total acres treated with commercial thinning, temporary road construction, and underburning. All other aspects of alternative 3 (thinning and specialized treatment; meadow enhancement; and road

[2] Note: stream layers shown on the following map have not been field verified; for field-verified stream locations, see Two Bit Hydrology Specialist Report (Bousfield 2010)

decommissioning) are the same as those previously described for alternative 2. Where there are differences between these alternatives, these differences are described below.

Thinning and Specialized Treatments

Thinning on approximately 1,710 acres within Late-Successional Reserves, Riparian Reserves and regulated lands that are of a size, condition, and location suitable for thinning from below are identified for alternative 3. Commercial thinning is proposed primarily for plantations, making up 89 percent of all acres proposed for this treatment. This alternative has been designed to comply with all applicable Management Area standards and guidelines (see table 2).

Specialized treatments, including roadside sanitation thinning, roadside pole thinning and thinning to restore a hardwood stand are proposed for 140 acres, and are the same as described for alternative 2.

As shown in the table above, approximately 222 landings would be required, and 96 of these would be new construction. The total amount of skid trails needed, both in segments and total miles would be more under alternative 3 than alternative 2. Although exact location and total acres of skid trails is not feasible to determine at this project planning stage, it is estimated that more skid trails would be necessary under alternative 3 than under alternative 2 since no new temporary roads would be constructed under this alternative; skid trails can sometimes result in more short-term soil disturbance than temporary roads, as discussed in more detail in the soils section of Chapter 3.

Timber hauling would occur only on existing Forest System roads or on existing temporary roads that are reopened or reconstructed and no new temporary roads would be constructed to facilitate commercial thinning. Haul routes on existing roads would receive maintenance where needed, such as dip, ditch and culvert cleaning, dust abatement and grading.

New skid trails with substantial cut and fills would generally not be developed; however safety and operational conditions may require a skid trail to cross short, steeper sections within tractor units. Some cut and fill may be necessary to safely cross these areas. Any skid trails with substantial cut and fills would be reviewed by a soil scientist, geologist, hydrologist or other earth science specialist prior to construction to ensure slope stability.

New landings would not be constructed in Riparian Reserves. New disturbance would be avoided in locations where sediment may directly enter streams. Landings would be placed along the existing road system and new disturbance for landings would be minimized. Landing areas outside of existing roadbeds would be rehabilitated for proper runoff drainage, improved infiltration, and effective soil cover as prescribed by an engineer and/or earth scientist. This can include shaping the slope for better drainage, sub-soiling to 18 inches to break up compaction, and mulching/revegetation to provide short- and long-term cover.

Approximately 270 fewer acres of commercial thinning and 5 percent fewer natural stand treatments would occur under alternative 3 when compared to alternative 2 due to the deletion of

several units that would require excessive skidding or had difficult access without creation of temporary roads.

Logging Systems

As in alternative 2, the majority of the commercial thinning units under alternative 3 are proposed to be harvested using ground-based operations (mechanized harvest or conventional tractor skidding using bulldozers, feller bunchers and rubber-tired skidders). A small percentage would be cable-logged (including skyline and mobile yarders). No helicopter logging is proposed. Logging systems are summarized in the table below and described in appendix C.

Table 7. Acres of logging systems proposed for commercial thinning in alternative 3

Commercial Thinning Logging Systems	Acres
Mechanical harvesting	683
Mechanical harvesting with Tractor Endlining	672
Handwork with Conventional Log Skidding and Tractor Endlining	35
Conventional Log Skidding with Tractor Endlining	265
Handwork Only	87
Cable Yarding	108
Total Thinning	**1,850**
Meadow Enhancement (no logging)	160
Total Silvicultural Treatments	**2,010**

Commercial Harvesting in Riparian Reserves

Commercial thinning is proposed in terrestrial-influence zones within RR to achieve the objectives of late-successional stand structure and diversity over time, as well as fuel reduction of surface, ladder and crown fuels.

Like alternative 2, standards and guidelines apply to silvicultural prescriptions in Riparian Reserves (see MA 10 S&Gs in Chapter 1). Appendix B includes a table outlining the commercial thinning units' generalized prescriptions, and identifies where Riparian Reserve thinning is proposed (maps are available on the Website). Riparian Reserve thinning would be conducted according to design criteria that ensure woody material is properly maintained, soil compaction and disturbance is minimized or eliminated, and important elements of the riparian environment are not degraded, as described in Table 13 at the end of this chapter.

Other components of implementation of treatments within RR are the same as those described for alternative 2, including the use of the Riparian Reserve Decision Process (Figure 3).

Underburning and Fuels Treatment

Proposed prescribed burning activities under alternative 3 are the same as those proposed for alternative 2; although there are differences in the amount of acres treated due to the differences in thinning units treated. Approximately 1,730 acres of underburning in combination with

landing pile burning is proposed within thinning units, and 120 acres is proposed for hand pile burning. Meadow enhancement units (160 acres) would also be hand piled and pile burned.

Outside of thinning units, approximately 7,320 acres of underburning is proposed over a ten-year period. Noncommercial thinning of small trees and brush may occur within these large underburn areas as needed to promote effective fuel consumption. Underburning outside of thinning units would occur within several Forest Plan Management Areas, including LSR, RR and General Forest, as shown in the table below.

Table 8. Acres and percent of treatment area for proposed treatment activities by Forest Plan Management Areas for alternative 3

Management Area	Underburning Acres	Silvicultural Treatment Acres (does not include meadow enhancement)
Non National Forest	87 (1%)	0
MA-2 Wilderness	4 (<1%)	0
MA-5 Late Successional Reserve	1299 (18%)	125 (6%)
MA-6 Managed Wildlife Area	447 (6%)	1 (<1%)
MA-1,7,8 Special Management	13 (<1%)	23 (1%)
MA-10 Riparian Area *(see hydrology specialist report (Bousfield 2010) for field-verified stream course RR and percentages of proposed treatment area)*	1623 (22%)	297 (16%)
MA-15 Partial Retention VQO	759 (10%)	343 (19%)
MA-17 General Forest	3088 (42%)	1063 (57%)
Total	**7,320**	**1852**

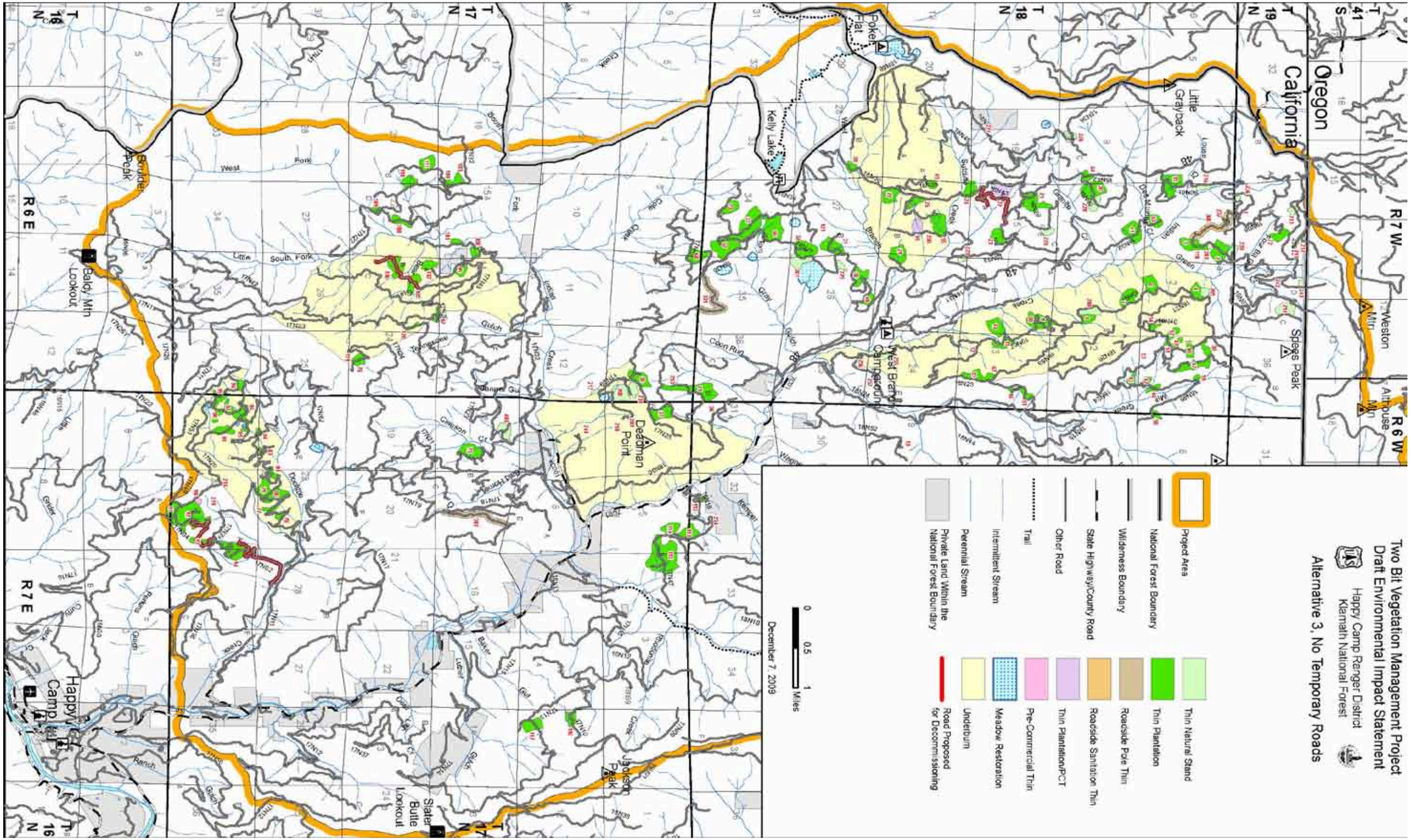


Figure 5. Proposed activities for alternative 3 – No temporary roads

2.2.4 Alternative 4 - Minimal Underburning

Alternative 4 would authorize approximately 2,850 acres of treatment across the 68,000 acre project area (Figure 6[3]). Of this, underburning is prescribed across approximately 570 acres of National Forest System lands (less than 1% of the project area, see figure 6). Thinning is proposed for approximately 1,980 acres. Most commercial thinning is proposed within existing plantations; 315 acres (16% of proposed thinning) are proposed for natural stands.

Alternative 4 also includes specialized thinning treatments, totaling 140 acres, including roadside sanitation thinning, roadside pole harvest and thinning to restore a hardwood stand. In addition, approximately 160 acres of conifer-encroachment thinning would be conducted to enhance natural meadows.

These activities would occur in a variety of Forest Plan Management Areas, including General Forest, Late-Successional Reserves, and Riparian Reserves (see table 9).

Implementation of alternative 4 is expected to last 10 years or more from the time the decision is made to completion of the project. This project is intended to provide forest products, restore forest health and reduce fuel hazard over a large area; although the total area treated under alternative 4 is substantially less than those proposed for alternatives 2 and 3, due to the reduction in underburning.

Elements of alternative 4 are summarized in the table below.

Table 9. Acres of treatments proposed for alternative 4

Total Acres that would be treated	2,850 acres
Underburning	570 acres
Commercial thinning	1,980 acres
Specialized Treatments	140 acres
Meadow Enhancement	160 acres
Road Decommissioning	4.1 miles in 6 segments
Temporary Road Construction	2.9 miles in 26 segments
Re-opening/Reconstruction of Existing Temporary Roads	4.3 miles
Landing Sites	250 landings needed (128 are existing); 122 new landings constructing totaling 60 acres
Mastication	1,490 acres

The primary difference between alternatives 2 and 4 is total acres treated with underburning. All other aspects of alternative 4 (thinning & specialized treatment; logging systems; roads, landings and skid trails; meadow enhancement; and road decommissioning) are the same as those previously described for alternative 2. Differences between these alternatives are described below.

[3] Note: stream layers shown on the following map have not been field verified; for field-verified stream locations, see Two Bit Hydrology Specialist Report (Bousfield 2010)

Underburning and Fuels Treatment

Proposed prescribed burning activities under alternative 4 are substantially different than that described for alternatives 2 and 3. Approximately 505 acres of underburning in combination with landing pile burning is proposed within thinning units, and 120 acres is proposed for hand pile burning. Meadow enhancement units (160 acres) would also be hand piled and pile burned. Mastication is proposed instead of prescribed burning to treat fuels within many thinned units to minimize the production of smoke. Mastication is proposed for 719 acres within thinning units. Mastication with some limited underburning is proposed for 773 acres, for a total of 1,490 acres of mastication.

Outside of thinning units, approximately 570 acres of underburning is proposed over approximately a ten- year period. Noncommercial thinning of small trees and brush may occur within this underburn area as needed to promote effective fuel consumption. Underburning outside of thinning units would occur within several Forest Plan Management Areas, including LSR, RR and General Forest, as shown in the table below.

Table 10. Acres and percent of treatment area for proposed treatments by Forest Plan Management Area for alternative 4

Management Area	Underburning Acres and Percentage of Treatment Area	Silvicultural Treatment Acres *(does not include meadow enhancement)* and Percentage of Treatment Area
MA-5 Late Successional Reserve	0	125 (6%)
MA-6 Managed Wildlife Area	0	1 (<1%)
MA-1,7,8 Special Management	0	23 (1%)
MA-10 Riparian Area *(see hydrology specialist report (Bousfield 2010) for field-verified stream course RR and percentages of proposed treatment area)*	265 (46%)	353 (17%)
MA-15 Partial Retention VQO	5 (1%)	363 (17%)
MA-17 General Forest	300 (53%)	1255 (59%)
Total	**570**	**2120**

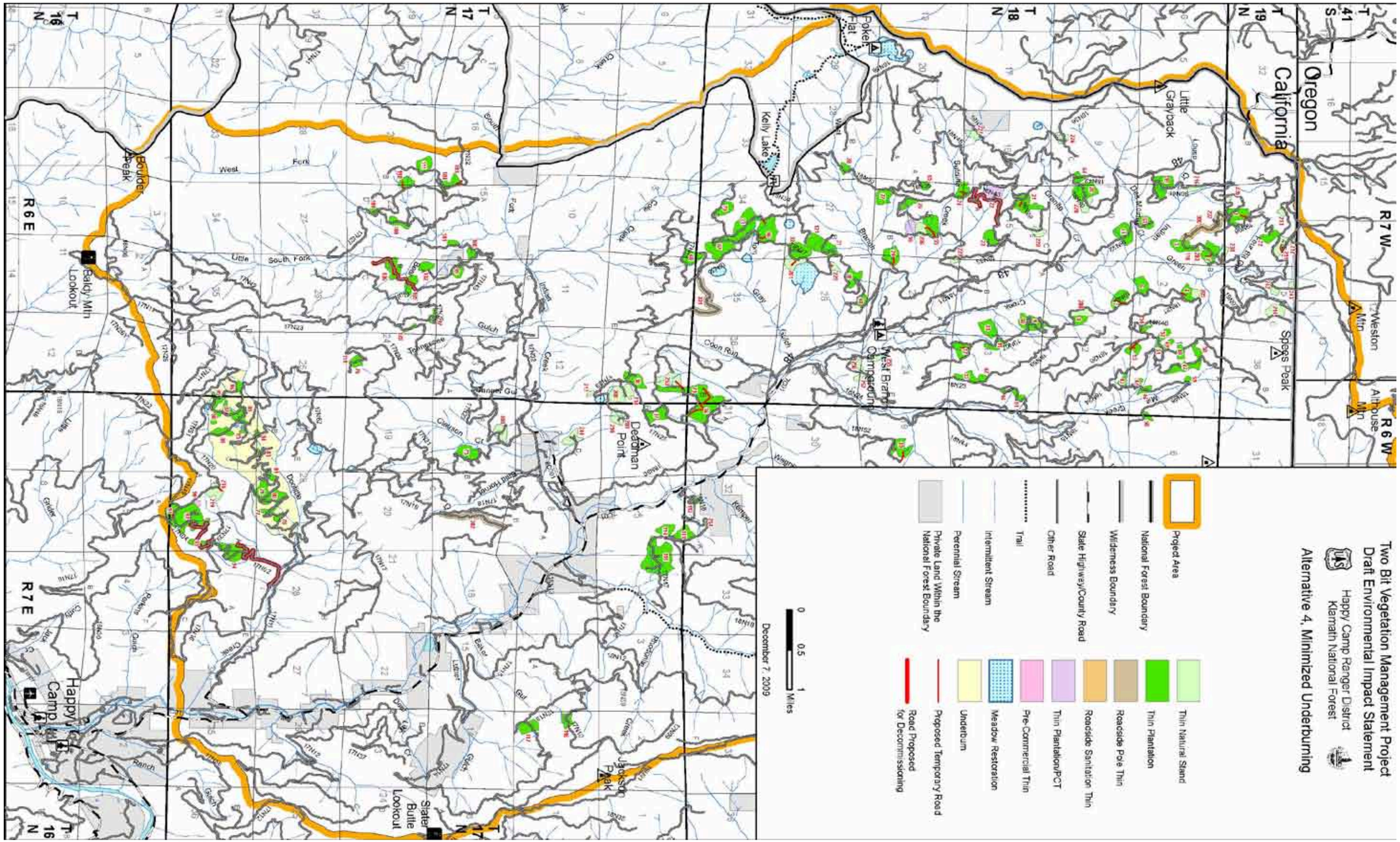


Figure 6. Proposed activities for alternative 4 –minimized underburning

2.3 Summary of Best Management Practices (BMPs) and Project Design Features Common to All Alternatives

This section summarizes the Best Management Practices and Project Design Features associated with the project, organized by resource. Some of these design features may be redundant to discussion about the alternatives above; however, they are repeated here to provide a comprehensive list.

2.3.1 Best Management Practices

Best Management Practices (BMPs) are developed to comply with Section 208 of the Clean Water Act. BMPs have been certified by the State Water Quality Resources Control Board and approved by the Environmental Protection Agency (EPA) as the most effective way of protecting water quality from impacts stemming from non-point sources of pollution. These practices have been applied in timber sales and road construction projects in watersheds over the last 25-30 years and have been found to be effective in protecting water quality within the Klamath National Forest. Specifically, effective application of the USDA Forest Service Region 5 BMPs has been found to maintain water quality that is in conformance with the Water Quality Objectives in the North Coast Regional Water Quality Control Board's (NCRWQCB) Basin Plan.

USDA Forest Service Region 5 BMPs (USDA Forest Service 2000) have been monitored and modified since their original implementation in 1979 to be more effective. Numerous on-site evaluations by the NCRWQCB have found the practices to be effective in maintaining water quality and protecting beneficial uses/resources (e.g., domestic use, anadromous and resident fish). The Forest monitors the implementation and effectiveness of BMPs on randomly selected projects each year. BMP effectiveness requirements were met on 90-100 percent of the sites sampled in 2000-2007(USDA Forest Service 2009).

The following list of BMPs (table 11) was selected for the Two Bit Project and was obtained from the publication: *Water Quality Management for Forest System Lands in California: Best Management Practices* (USDA Forest Service 2000b). These BMPs would be implemented using design features described below and those described as part of the alternatives, and will be refined during burn planning and timber sale contract preparation and administrative processes. How each BMP would be implemented specific to this project is described in more detail in appendix E. The Forest Service also developed the following project design features (table 12) to be used as part of all of the action alternatives.

Table 11. Best Management Practices selected for the Two Bit Project

BMP ID	BMP Title
1.1	Timber Sale Planning Process
1.2	Timber Harvest Unit Design
1.3	Determination of Surface Erosion Hazard for Timber Harvest Design
1.4	Use of Sale Area Maps and/or Project Maps for Designating Water Quality Protection Needs
1.5	Limiting the Operating Period of Timber Sale Activities
1.6	Protection of Unstable Lands
1.8	Streamside Management Zone Designation
1.9	Determining Tractor Loggable Ground
1.10	Tractor Skidding Design
1.11	Suspended Log Yarding in Timber Harvesting
1.12	Log Landing Location
1.13	Erosion Prevention and Control Measures during Timber Sale Operations
1.14	Special Erosion Prevention Measures on Disturbed Land
1.15	Revegetation of Areas Disturbed by Harvest Activities
1.16	Log Landing Erosion Control
1.17	Erosion Control on Skid Trails
1.19	Stream Course and Aquatic Protection
1.20	Erosion Control Structure Maintenance
1.21	Acceptance of Timber Sale Erosion Control Measures before Sale Closure
1.25	Modification of Timber Sale Contract
2.1	General Guidelines for the Location and Design of Roads
2.2	Erosion Control Plan
2.3	Timing of Construction Activities
2.4	Stabilization of Road Slope Surfaces and Spoil Disposal Areas
2.5	Road Slope Stabilization Construction Practices
2.7	Control of Road Drainage
2.11	Control of Sidecast Material During Construction and Maintenance
2.12	Servicing and Refueling Equipment
2.13	Control of Construction and Maintenance Activities Adjacent to Streamside Zones
2.14	Controlling In-Channel Excavation
2.16	Stream Crossings on Temporary Roads
2.17	Bridge and Culvert Installation
2.19	Disposal of Right-of-Way and Roadside Debris
2.21	Water Source Development Consistent with Water Quality Protection

BMP ID	BMP Title
2.22	Maintenance of Roads
2.23	Road Surface Treatment to Prevent Loss of Materials
2.24	Traffic Control During Wet Periods
2.26	Obliteration or Decommissioning of Roads
5.6	Soil Moisture Limitations for Mechanical Equipment Operations
6.1	Fire and Fuel Management Activities
6.2	Consideration of Water Quality from Prescribed Burning Effects
6.3	Protection of Water Quality from Prescribed Burning Effects
7.8	Cumulative Off-Site Watershed Effects

2.3.2 Project Design Features

The following design features apply to all action alternatives. Table 12 displays these features by resource area and the land base affected.

Table 12. Project Design Features by resource area and where they apply

Design Features	Land Base
Soil and Water	
No more than 15 percent of a harvest unit would be disturbed by primary tractor skid trails, cable yarding corridors, landings and roads.	All commercial harvest units
85 percent of each harvest unit would meet the Regional soil quality analysis thresholds for total porosity, soil displacement, soil organic matter, soil hydrologic function, erosion and soil buffering capacity.	All commercial harvest units
Existing skid trails would be reused whenever practical. Existing skid trails would be used unless it is on a slope steeper than 35 percent, on an area where ground-based equipment is excluded or on highly erosive soils, unstable areas, wetlands or meadows. All skid trail locations would be agreed to by the Forest Service.	All commercial harvest units with skid trails
Skidding would generally not occur on slopes greater 35 percent. Slopes between 35 percent and 45 percent within tractor logging units would be felled with a mechanical harvester (feller buncher) or by endlining from roads and skid trails.	All areas
Ground-based equipment (e.g. feller bunchers, masticators, tractors) would be restricted primarily to slopes of 35 percent or less. However, in certain situations, equipment would be allowed to operate on slopes up to 45 percent depending on site-specific conditions.	All areas
Temporary roads would generally be constructed on ridgetops and flats and on slopes less than 20 percent that avoid positions that would deliver sediment directly to streams. Temporary roads would not be constructed on slopes greater than 35 percent.	All areas
Generally, new skid trails would not be developed on slopes greater than 35 percent or where ground-based equipment is excluded. Skid trails with substantial cut and fill would not be created except for short distances to connect benches as determined necessary by the Timber Sale Administrator and only when there are no other alternatives. Skid trails that connect benches in dormant landslide terrain may have minor sections on slopes greater than 35% but skid trails with substantial cut and fill would not be used to log slopes steeper than 35 percent.	All commercial harvest units with skid trails
All skid trails would be hydrologically stabilized/restored prior to the wet season and/or following project implementation. Skid trails would be waterbarred within 25 feet of landings and roads, where needed. Waterbars would also be placed on all main skid trail sections that exceed 20% gradient. Spacing of waterbars would be a minimum of every 100 feet or in accordance with Regional standards. Straw mulch or fine slash would also be used where needed.	All commercial harvest units with skid trails

Design Features	Land Base
Skidding equipment and all ground-based equipment would operate during dry soil conditions following the wet weather logging guidelines.	All commercial harvest units with skid trails
Existing landings would be used instead of creating new landings wherever feasible and all landings would be hydrologically restored after use.	All areas
Pre-existing temporary roads would be used instead of constructing new temporary roads unless the pre-existing road is located on highly erosive soils, unstable areas, wetlands or meadows or if the pre-existing temporary road is located within the inner half of a stream course Riparian Reserve and adding surface aggregate would not eliminate or greatly reduce the risk of sedimentation.	
All temporary roads would be hydrologically stabilized/restored prior to the wet season and/or following project implementation. Outsloping, waterbarring, berm removal, and slash cover would be used when needed, and roads would be blocked to vehicle access. Fills and culverts would be removed from channels.	All commercial harvest units with temporary roads
Existing levels, or a minimum of 5 logs/acre of coarse woody debris (CWD) greater than 20 inches in diameter and 10 feet long, if available, would be retained for soil productivity needs.	All areas
Existing CWD would be protected by having all ground-based equipment avoid the larger diameter logs as much as practical.	All commercial harvest units
Where excessive numbers of downed trees creates a fuel hazard, existing logs (greater than 20 inches in diameter and 10 feet long) may be lowered down to the Regional minimum of 5 logs/acre (at the landscape scale; although efforts would be made to achieve this where possible at the stand level).	All areas
Post-treatment total soil cover would range from 60-80 percent depending on slope steepness and soil texture.	All areas
At least 50 percent cover, as fine organic matter (less than 3 inch material), would be retained in all units.	All areas
Mulching with straw or fine organic matter would be used to minimize soil erosion and increase soil productivity in all heavily disturbed areas (include some skid trials and landings) to achieve 90 percent or greater cover that is two inches thick.	All areas
Main skid trails in units with projected ≥15% detrimental disturbance (23 units) will be evaluated post-project using detailed transects as well as field compaction data to determine their need for subsoiling. If subsoiling is required it will be done under dry soil conditions (dry down to 24 inches) with winged rippers to a depth of at least 18 inches.	Units 1, 2, 9, 12, 18, 19, 20, 23, 29, 49, 53, 64, 67, 71, 87, 88, 89, 203, 208, 226, 237, 255, 400
All burning would be done under an approved Burn Plan that specifies a burn prescription for each area. These prescriptions will account for fuel loading, fuel moisture, soil moisture, slope, aspect, etc., and will result in the desired quantity of fuel consumed for each prescribed burn. A fuel management specialist, who may utilize recommendations from a soil or earth scientist, will prepare prescriptions.	All underburning areas
Hand and machine bunching piles will be burned under safe conditions to prevent fire spread or excessive scorching of surrounding vegetation.	All underburning areas
Underburning would be accomplished in conditions that allow safe burning. Fire crews, equipped to control fire spread, will monitor underburning.	All underburning areas
Ground cover amounts recommended by Project soil scientist would be retained to keep erosion of the underburned sites within the limits of the burn plan and LRMP guidelines for soil cover.	All underburning areas
Underburning would be designed to ensure that high and moderate soil burn severity would not result.	All underburning
Stream Course Riparian Reserves	
Commercial harvesting in both natural and plantation stands would not occur in inner gorges.	Commercial harvest units in natural stands and plantations

Design Features	Land Base
Commercial harvesting would not occur within 10 feet of ephemeral and intermittent streams Commercial harvesting would not occur within 25 feet of a perennial stream Restrictions on commercial harvesting within Riparian Reserves of intermittent streams (that flow into June on an average water year) outside of the above 10-foot no-treatment zone would also apply unless certain criteria are met: 1) Commercial harvesting would only occur within 10 to 50 feet of the stream if current overstory canopy cover is equal to or greater than 85% and this overstory canopy cover would not be reduced below 85% 2) Commercial harvesting would only occur within 50 to170 feet of the stream if current overstory canopy cover is equal to or greater than 65% and this overstory canopy cover would not be reduced below 65 % 3) If overstory trees are not at their site potential height and/or site conditions do not allow attainment of the above canopy cover percentages then harvesting which would retain current overstory canopy cover or potentially enhance future overstory canopy cover may occur within 10 to 170 feet of the stream, upon consultation with a Hydrologist. 4) No restrictions on commercial harvest apply outside of the 170-foot buffer zone. Restrictions on commercial harvesting near perennial streams outside of the above 25-foot no-treatment buffer zone would also apply unless certain criteria are met: 1) Commercial harvesting would only occur within 25 to 75 feet of the stream if current overstory canopy cover is equal to or greater than 85% and this overstory canopy cover would not be reduced below 85 % during harvest 2) Commercial harvesting would only occur within 75 to170 feet of the stream if current overstory canopy cover is equal to or greater than 65% and this overstory canopy cover would not be reduced below 65 % during harvest 3) If overstory trees are not at their site potential height and/or site conditions do not allow attainment of the above canopy cover percentages then harvesting which would retain current overstory canopy cover or potentially enhance future overstory canopy cover may occur within 25 to 170 feet of the stream, upon consultation with a Hydrologist. 4) No restrictions on commercial harvest apply outside of the 170-foot buffer zone.	Commercial harvest units in natural stands; units requiring canopy cover retention include 216; 227; 242; 243; 244; 253; 255
Commercial harvesting would not occur within 10 feet of ephemeral and intermittent streams or within 25 feet of a perennial stream (does not apply to off-site pine).	Commercial harvest units in plantations
Commercial harvesting would not occur on active landslides or toe zones located within stream course Riparian Reserves (does not apply to off-site pine).	Commercial harvest units
All trees contributing to stream bank integrity or that overhang the stream channel would be retained.	Commercial harvest units
Harvesting would occur up to the edges of wetlands or meadows that are within or adjacent to commercial treatment units, where needed for meadow enhancement goals.	Commercial harvest units
Ground based equipment would not operate within a minimum of: 10 feet of ephemeral streams, 25 feet of intermittent streams and 50 feet of perennial streams - these distances are minimums and may be larger based on site conditions such as continuous slopes (> 20%) leading directly into the stream channel, slope breaks, low soil cover, unstable ground or erosive soils, to be determined by an Earth Scientist during unit layout. Ground based equipment would not operate within in extremely unstable areas (as designated by a geologist), inner gorges or areas with highly erosive soils (as designated by a soil scientist); within 10 feet of meadows or wetlands that are within or adjacent to commercial treatment units; or on slopes greater than 35 percent in stream course Riparian Reserves. Trees may be harvested between the equipment exclusion and commercial harvest buffer by a feller buncher reaching in or tractor endlining.	Commercial harvest units

Design Features	Land Base
Full suspension cable yarding would be used over stream channels and within 25 feet of stream channels and one-end suspension cable yarding would be used in the remainder of the surrounding stream course Riparian Reserves.	Commercial harvesting with cable yarding
No new landings would be constructed within stream course Riparian Reserves and new landings would be preferred over pre-existing landings if the existing landing is located in a stream course Riparian Reserve or on erosive soils or unstable areas. All landings would be re-contoured and hydrologically stabilized prior to winter and/or following project implementation.	Commercial harvesting units with landings
Primary skid trails would generally be at least 50 feet from stream courses; any exceptions to this would be approved by an Earth Scientist. Secondary skid trails would only cross ephemeral and intermittent streams when dry and in locations approved by an earth scientist.	Commercial harvesting units with skid trails
Temporary roads would not be constructed within stream course Riparian Reserves.	Commercial harvesting units with temporary roads
Predominant/relic or large dominant trees that are not marked for thinning, but are felled for operations or safety in Riparian Reserves would be retained on the ground unless to do so would pose an operational, safety or fuels hazard.	All areas
Except for controlled ignition to reduce fuel accumulations that, in the case of wildfire, could cause moderate to high burn severity, ignition of prescribed fire would generally not occur in the inner half of stream course Riparian Reserves or inner gorges; prescribed fire would be designed to mimic a backing fire in these areas as much as possible.	All areas with underburning
Pile burning would not occur within 25 feet of any stream course.	All areas
Prescribed fire would be designed to mimic a backing fire in the inner half of stream course Riparian Reserves or inner gorges.	All areas with underburning
The steep portions of Unit 22 west of Road 18N43 would be excluded from treatment to break in slope; A newly constructed temporary road is preferred over an existing temporary road in this location due to proximity to a stream.	Unit 22
One culvert and crushed rock (aggregate surfacing) would be used for existing temporary road.	Unit 29
Steep portions would be excluded in western portion of unit and stream channel would not be crossed with equipment.	Unit 30
Tom Gray Gulch would be buffered to the north within 10 feet of gorge/break in slope	Unit 33
Commercial harvesting would be restricted to the western half of the unit only and would not occur within 50 feet of landslide scarp. Skidding would not occur across scarp down to Road 18N33B.	Unit 56
Tom Gray Gulch would be buffered to the south within 10 feet of break in slope.	Unit 66
Road 17N02 would be surfaced with crushed rock (aggregate) near stream.	Unit 94
Stream would be buffered 170 feet.	Unit 216
Incised channels would not be crossed with equipment.	Unit 244
Portion of unit between Indian Creek mainstem and Road 19N07 would be burned in the spring to the maximum extent practical.	Underburn Unit 1
Portion of unit bordered by West Branch Creek, Sutcliffe Creek and Road 18N30 and FS Highway 48 would be burned in the spring to the maximum extent practical.	Underburn Unit 2
Portion of underburn between Indian Creeks mainstem (east) and 18N30 (west) would be burned in the spring to the maximum extent practical.	Underburn Unit 3
Geology	
Temporary roads and landings would not be constructed within geologic Riparian Reserves	Harvest units with temporary roads or landings

Design Features	Land Base
In particularly sensitive areas (as defined by a geologist), proposed roads and landings would be jointly reviewed by earth science, timber administration, and engineering personnel to assess landslide risk and to resolve potential conflicts. If deemed necessary by reviewers, the alignment would be flagged and reviewed in the field. Design measures would be developed to increase stability of cuts and fills and eliminate conditions that concentrate runoff and protect water quality.	active landslides (units 242, 19, 41, 20, 220, 30, 112, 115, 258, 101, 109, 86, 89, 95); inner gorges (243, 214, 216, 59, 46, 6, 42, 41, 43, 8, 64, 61, 11, 22, 227, 12, 24, 55, 18, 28, 33, 36, 71, 302, 75, 101, 105, 80, 78, 77, 94, 96, 219, 90) and toe zones of dormant landslides(units 238, 118, 16)
If rock is needed for the project, rock pits would be evaluated by a geologist on site before development. The assessment would address landslide potential, sediment delivery potential, asbestos hazard, quantity and quality of material, and potential for underlying caves or tunnels. Rock pits would avoid Riparian Reserves, and would be water-barred and shaped for drainage after use. Rock quarry development plans would be prepared if more than 5000 cubic yards of material were removed from a quarry or where further resource damage may occur.	All areas
Treatments in geologic riparian reserves would meet the objectives of the Aquatic Conservation Strategy (ACS).	All areas
Ground-based equipment would not be used within the unstable land component of geologic Riparian Reserves.	
Prescribed fire in geologic Riparian Reserves would be low severity. There may be rare exceptions where small areas (less than an acre) may burn at high or moderate severity due to localized heavy fuel accumulations. The following activities would minimize this risk: a) Geology personnel would inform fire personnel of any known active landslides or unstable areas are covered with heavy fuels, and coordinate in development of burn plans; b) Ignition patterns would be modified, and local fuel concentrations hand piled within sensitive landslide areas and other types of Riparian Reserves; c) Prescribed fire would generally be backed down into Riparian Reserves and ignition would generally not occur there. However, there may be exceptions where the goal of low severity can best be met by allowing ignition within Riparian Reserves.	Underburn units
Purchasers of the timber sale would be informed of harvest units and roads underlain by ultramafic rock which may contain asbestos. If timber haul routes change during project implementation, any additional roads would be checked against the bedrock map to determine if they are underlain by ultramafic rock, and the asbestos standards applied. Standard mitigation measures would be applied, including watering roads during use, surfacing with material which does not contain asbestos, and use of OSHA-approved air filtering apparatus. Crews constructing fire lines for underburns would similarly be informed of areas underlain by ultramafic rock. Mitigation measures would be applied, including constructing lines during wet soil conditions, watering lines as appropriate, and using OSHA-approved air filtering apparatus.	All areas
Cable yarding corridors would not be placed in geologic Riparian Reserves unless assessed in the field by an earth scientist.	
Full suspension cable yarding would be used in geologic Riparian Reserves. Outside of geologic Riparian Reserves, one-end suspension would be used.	All areas with commercial harvest with cable logging
Gouging (as a result of logs dragged during one-end suspension) would be water barred and covered with logging slash to effectively mitigate erosion and concentration of surface runoff.	

Design Features	Land Base
Timber Preparation and Earth Science shops would establish contact prior to the marking of units to assure that prescriptions in Riparian Reserves are properly implemented. Similar coordination would be needed to address any post-planning changes in project design. Fire and Earth Science shops would closely coordinate burn plans affecting Riparian Reserves. After the sale is sold, the Sale Administration and Earth Science shops would establish and maintain contact to allow for field reviews of final flagged road alignments and landings as needed.	All areas
Forest Vegetation	
Hardwoods would be maintained in thinning units where possible and as needed to meet the desired condition. Some larger hardwoods designated by the prescription would have competing trees removed from around them to a distance of 25 to 35 feet.	All commercial harvest units
Relic and predominant trees within thinning units would be maintained through guidelines in the silvicultural prescriptions or by designating them as leave trees.	All commercial harvest units
Where appropriate for the site, sugar pine and naturally occurring ponderosa pine would be maintained within thinning stands through measures in the silvicultural prescriptions or by designating them as leave trees.	All commercial harvest units
Approximately 200-300 Port Orford-cedar seedlings would be planted in wet areas where the cedar is now being partially replaced by Douglas-fir.	Unit 22
Port Orford-cedar would have increased protection from exposure to root disease by including measures that require contractors and purchasers coming from areas within the natural range of Port Orford-cedar to wash all vehicles and equipment before entering the project area	All areas
Identified sugar pine known to be blister rust resistant would be protected during underburning by brushing around the tree and/or constructing fire line around the tree prior to burning	1-2 trees located in the north portion of Underburn 1
Protection and/or enhancement measures for areas of weeping spruce, Port Orford-cedar, Pacific yew and western white pine trees would be incorporated into site-specific prescriptions, where appropriate.	Underburn 2
Port Orford-cedar would have increased protection from exposure to root disease by including measures that require contractors and purchasers coming from areas within the natural range of Port Orford-cedar to wash all vehicles and equipment before entering the project area and through measures taken to restrict operations during wet months on designated road segments within units.	Units 22, 24, 55, 206, and 94; Road 17N39A, 18N33B, and 18N43 between Unit 22 and 24, and 18N43A
Three genetic test areas located within Underburn Unit 2 would be excluded from underburning treatments	Underburn 2
Borax –True fir stumps over 14 inches in diameter would have borax applied to them after cutting to reduce colonization of annosus spores. Borax would not be applied within 5 feet of stream courses or 5 feet of sensitive plants.	Approximately 403 acres that include a majority of the natural stands and plantations mostly in the higher elevations in the north and western portions of the project area
Fisheries	
Water drafting in streams that support salmon and steelhead would be performed in accordance with National Marine Fisheries Service water drafting specifications (USDC 2001) designed to prevent adverse direct and indirect effects to anadromous salmonids by requiring intakes to be screened to prevent entrainment of fish, and by limiting rate of water drafting. Existing water drafting sites would be used and no new water drafting sites would be constructed.	All areas with perennial streams that support salmon and steelhead
Terrestrial Wildlife	

Design Features	Land Base
Protocol surveys for northern spotted owls (NSO) will be conducted in 2009 and 2010. For areas that include removal or downgrade of NSO habitat, surveys would be conducted to the 1992 U.S. Fish and Wildlife protocol. In areas where habitat would not be removed or downgraded, a three visit year of action survey may be substituted for the 1992 protocol surveys. These areas would be primarily thinning in non-suitable NSO habitat and underburns.	All areas
A seasonal restriction of February 1st to September 15th would apply to all activities that modify NSO habitat (including activities that degrade or are beneficial) within 0.25 mile of a NSO activity center or unsurveyed suitable habitat. This same restriction also applies to activities that remove or downgrade suitable habitat within 0.7 miles of an activity center or unsurveyed suitable habitat. A seasonal restriction of February 1st to July 9th would apply to all activities that create noise above ambient levels within 0.25 mile of an occupied activity center or unsurveyed suitable habitat.	
A seasonal restriction of February 1st to July 31th would apply to all activities that create smoke within 0.25 mile of an occupied NSO activity center or unsurveyed suitable habitat.	All areas
If protocol surveys indicate that historic NSO activity centers and/or suitable habitat are not occupied by breeding NSOs, seasonal restrictions may be waived.	
Prescribed burning will not be implemented in more than 50 percent of a northern spotted owl's 0.5 mile activity center or 1.3 mile home range in any given year. The Wildlife Biologist would coordinate with Fuels Specialist on this measure.	All areas
When burning in spring, smoke would be managed so that light to moderate smoke is present within a canyon or drainage but dissipates or lifts within 24 hours. If heavy or concentrated smoke begins to inundate occupied NSO nesting/roosting habitat or occupied activity centers late in the afternoon, ignition would be discontinued.	Underburning units
No more than 50 percent of the nesting NSO habitat within a 7th field watershed would be under-burned within a given year	All areas
No more than 50 percent of the suitable habitat within an occupied NSO core area and no more than 50 percent of the suitable habitat within an occupied NSO home range would be under-burned annually.	Underburning units
Review of underburns post treatment would be conducted by the district biologist to determine amount of NSO habitat degradation. If treated areas are determined to have not degraded NSO habitat, then a greater number of acres may be underburned within an NSO core, home range or 7th field watershed.	Underburning units
In unsurveyed "high probability" habitat and known NSO activity centers, no burning would occur between 2/1 and 7/9 or spring surveys would be conducted during the year of activity (3 visits prior to action, starting after March 1 with visits at least 5 days apart)	Underburning units
Protect existing course woody debris by having ground-based equipment avoid large diameter logs greater than 20 inches and 8 feet long as much as practical. Where excessive number of downed trees creates a fuel hazard, existing logs may be lowered down to the Regional minimum of 5 logs/acre across the landscape.	All commercial thinning units
Snags greater than 20 inches dbh or groups of snags would not be felled unless hazardous to operations. Some wildlife trees greater than 20 inches dbh that posses multiple tops, broken tops, cavities or other wildlife features would be maintained with the units.	All commercial thinning units
Surveys for blue grey tail dropper (BGTD) would be conducted in all riparian reserves that are located within proposed units of natural stands prior to harvest of natural stands. If surveys locate any BTGD, locations would be protected from ground-disturbing activities in accordance with forest sensitive species protocol and surveys would be conducted in all suitable habitat within proposed units. For known locations of BGTD project design features have been developed to minimize the likelihood of adverse impacts to this occupied habitat	Natural stands
Avoid use of landings and skid trails in the western edge of the unit to minimize disturbance to BGTD habitat	Unit 116

Design Features	Land Base
Goshawk surveys would be conducted in and around historic goshawk nest locations. If nesting goshawks are located a 0.5 mile radius circle buffer (504 acres) would be established around nest location. Sixty percent canopy cover in dense mature forest conditions (greater than 60% canopy cover with trees greater than 24 inches dbh (4B, C+) would be maintained. The remaining 40 percent would be maintained in a mosaic dominated by large trees with open understory (3N, G-4P, N G+). Habitat modifying activities would be restricted between March 1 and August 31 within the primary nesting zone (504 acres). Loud and continuous noise within 0.25 miles of active nests would also be restricted between March 1 and August 31 annually.	All units
Cultural Resources	
Flag and avoid all archeological sites with potential to be affected by proposed activities.	All areas
Consider cultural use plants when developing prescribed burn plans, including burning that would enhance Hazel and Beargrass that are used in traditional Karuk baskets.	Underburning Units
If previously unidentified cultural resources are located during project activities, all work would stop within the area of the site and the Heritage Resources Program Manager for the Klamath National Forest would be contacted.	All areas
Lands / Special Uses / Implementation	
Where feasible, post-logging slash piles and cull decks in certain areas would be made available for firewood removal by the public.	All areas
A buffer zone around the spring and waterline near Deadman Point located in Underburn Unit 3 would be designated and then excluded from treatment	Underburn Unit 3
Water would be used on roads when needed to minimize dust generation during implementation	All areas
Fuels and Air Quality	
Project implementation would adhere to applicable State of California and State of Oregon air quality laws and regulations.	All burn areas
Smoke management plans would be submitted to the Siskiyou County Air Pollution Control District for each burn plan. Burning would occur during favorable weather conditions when smoke is transported away from sensitive locations.	All burn areas
Burning would be conducted to meet course woody debris standards and guidelines. Spot weather forecasts would be used to ensure favorable “within prescription” weather conditions for the burn and for smoke transport.	All burn areas
Prescribed burn plans would include measures to avoid unacceptable conditions related to smoke concentrations, duration, and placement.	All burn areas
All burning would be conducted under an approved Burn Plan that specifies a burn prescription for each area. These prescriptions would account for fuel loading, fuel moisture, soil moisture, slope, aspect, etc. so that the desired quantity of fuel consumed for each prescribed burn would result. A fuel management specialist, using recommendations from soil or earth scientist, would prepare prescriptions.	All burn areas
Landing and hand piles would be burned under controlled settings to contain fire spread.	All burn areas
Underburning would occur under prescription, when conditions allow for safe burning operations. Fire crews, equipped to control fire spread, would monitor underburning.	All burn areas
Burn prescriptions would be developed with interdisciplinary team input and approved by a line officer.	All burn areas
Visual Resources	
Tree marking paint would not be visible on trees seen from Road 18N30 to the break in slope (at eye level from the road); A post-burn review would be conducted to determine the need for flush cut stumps; variable spacing up to a 30-foot maximum, would be used for thinning and white fir would be favored for removal; and precommercial thinning to 20-foot spacing within 20 feet of the road would be used.	Unit 22
Variable density thinning would be used with variable spacing and variable species removal and stumps would be cut as close to the ground as possible.	Meadow enhancement Unit 5
Threatened, Endangered and Sensitive Plants	
If any new threatened, endangered or sensitive species populations are discovered during project implementation, a botanist would be notified to determine if any additional protective measures are necessary.	All areas

Design Features	Land Base
Soil productivity standards would be applied for conservation of surface organic matter and large woody material to maintain sensitive fungi habitat components	All areas
Aquatic Conservation Strategy and Riparian Reserves Objectives would be adhered to in order to maintain species diversity and sensitive fungi habitat components. Silvicultural practices in Riparian Reserves would be used to control stocking, reestablish and manage stands, and acquire desired vegetation characteristics including species diversity needed to attain Aquatic Conservation Objectives. Yarding disturbance within Riparian Reserves would be minimized.	All areas
Klamath Mountain buckwheat (*Eriogonum hirtellum*): Protect all individuals and habitat; buffer if necessary to keep equipment off plants and habitat; no-cut buffer not needed. Only allow low-intensity broadcast prescribed burn. No fireline construction in occurrences.	UB-3 and UB-4
Pacific fuzzwort (*Ptilidium californicum*): Do not-cut individual host trees, and thin thru occurrence to 50-60% canopy closure; OR avoid/protect subpopulation in each unit with buffer and allow impacts to outlier plants. Hand pull heavier slash in occurrence prior to prescribed burning.	Units 200, 201, 211, 213, 214, 216,219, 220, 227, 228, 238, 242, 243
Clustered lady's slipper orchid (*Cypripedium fasciculatum*): Protect individual plants from direct effects; thin through occurrence to 50-60% canopy closure – end line or helicopter log removal only; OR avoid/protect subpopulation in each unit with buffer; allow impacts to outlier plants. Only allow low-intensity broadcast prescribed burn through populations.	Unit 302
Howell's lousewort (*Pedicularis howellii*): Protect individual plants from direct effects; thin through populations to 50-60% canopy closure – end line log removal only; OR avoid/protect subpopulation in each unit with buffer and allow impacts to outlier plants. Only allow low-intensity broadcast prescribed burn through populations.	Meadow Enhancement Unit 5
Species-specific mitigations for additional Sensitive/ Survey and Manage plant occurrences located during implementation would be followed. For these and the above species, district botanist would flag any needed buffers before timber marking	All areas
Avoid placing hand piles and thinning slash directly in meadow areas or on sensitive plant populations	Meadow enhancements
When fire is prescribed in meadow areas, only low-intensity broadcast burning would be used. Fire ignition within meadow areas would mimic natural fire spread with limited drip torch use. Drip torches would not be used in wet meadow areas. The district botanist would be consulted for further direction.	Meadow enhancements
Noxious Weeds	
Equipment would be cleaned to reduce introduction of noxious weeds	All areas
Vehicles would not be parked and equipment would not be staged in areas where weed populations are known to occur whenever possible. Areas to avoid within the project analysis area are to be provided to all implementation staff and contractors.	All areas
Wherever seed, straw mulches or gravel is used to restore or maintain areas within the project area, certified weed free seeds straw, mulches, and/or gravel should be specified in any contract.	All areas
Seed decommissioned roads, landings, and heavily used skid trails with native grass seed and/or non-persistent/sterile cereal grains as needed.	All areas
As part of the Forest noxious weed program, inventories for noxious weeds would occur for 3 years after the project is completed or as long as it takes the vegetation to recover from project disturbance (as measured by ground duff cover and forb and shrub layer cover).	All areas
Avoid direct disturbance to the weed populations of Dyers woad (*Isatis tinctorum*), Scotch broom (*Cytisus scoparium*), Meadow Knapweed (*Centaurea pratensis*), Star Thistle (*Centaurea solstitialis*) and Spotted Knapweed (*Centaurea maculosa*)	All areas
Follow species-specific mitigations for additional non-native/invasive plant occurrences located during implementation.	All areas

2.4 Monitoring Common to All Alternatives

- Areas underburned would be monitored following treatment to determine how much and with what fire intensity northern spotted owl habitat was burned
- Known northern spotted owl sites would be monitored annually through 2011.
- Historic northern goshawk sites would be monitored through 2011.
- Best management practice monitoring would be conducted according to USDA 2002 and would occur on a random sample. Since many of these actions would not occur all at once, they may be included in monitoring pools for up to a decade.
- Stream shade on perennial and large intermittent streams adjacent to plantation riparian reserves would be monitored to determine whether project design features were successful in meeting residual shading requirements
- Marking of trees for harvest or poles would be monitored by District personnel to ensure that tree marking guidelines are followed and meet planned objectives.
- Timber harvest operations would be monitored by qualified sale inspectors and other District personnel to ensure that project design features and BMPs are implemented appropriately and that unacceptable levels of damage would not occur.
- Prescribed burning activities would be monitored for consistency with burn plans and achievement of project objectives. Hand work would be monitored during implementation by District contract inspectors.
- After thinning and after fuels treatment, some units would be informally reviewed to see how well they met stand objectives. In stands where the objectives include reducing ponderosa pine and increasing other species, natural regeneration of desired species would be monitored.
- Natural regeneration before and after underburning would be monitored in several units including Units 3, 11, 51, 64,95, 99,201, and 227.
- Post-project implementation monitoring for noxious weeds would occur in order to detect any new sites established within the project area and to quickly treating these areas
- Treated riparian reserves would be monitored to evaluate the implementation and effectiveness of project design features.
- In the event of a landslide-producing storm in the years following the activity the Riparian Reserves would be monitored for landslide response. In particular, such monitoring would examine landslide rates in thinned areas relative to undisturbed (unlogged) sites.
- Surveys would occur in areas deferred from archeological survey due to heavy impenetrable brush that have a high probability to yield cultural sites, after brush has been removed.

2.5 Alternatives Considered but Eliminated from Detailed Analysis

Federal agencies are required by NEPA to rigorously explore and objectively evaluate all reasonable alternatives and to briefly discuss the reasons for eliminating any alternatives that were not developed in detail (40 CFR 1502.14). Public comments received in response to the proposed action provided suggestions for alternative methods for achieving the purpose and need. Some of these alternatives may have been outside the scope of the purpose and need,

duplicative of the alternatives considered in detail, or determined to be components that would cause unnecessary environmental harm. Therefore, a number of alternatives were considered, but dismissed from detailed consideration for reasons summarized below.

2.5.1 Maximize Harvest

This alternative was developed to respond to the significant issue of economics and includes suggestions made by members of the public. The re-entry period would be increased to 30-40 years (instead of 20-30 years) particularly in plantations. Aim for canopy and stocking guidelines, harvest unit location, numbers of harvest units and harvest system design that together combine to optimize the economic potential for prospective bidders while at the same time meeting the specified purpose and need.

USFS agrees that a longer re-entry period for plantations is a reasonable way to increase the economic potential of the sale while also reducing the resource impact from more frequent entries under a 20-30 year rotation period. A longer rotation period (30-40 years instead of 20-30 years) for some plantations (where the IDT agreed this could be achieved while still meeting the standards and guidelines of the Forest Plan) is included in alternative 2 - proposed action. The other aspects suggested (unit spacing, harvest design, etc.) are already aspects of project design and prescription development routinely used by the USFS. These are considered in context with the standards and guidelines in the Forest Plan and other guiding documents. For these reasons, this alternative was dismissed from further detailed analysis.

2.5.2 Citizens Alternative

This alternative was specifically suggested by the public and includes using only the existing road system and previous skid trails, no treatment in natural stands in T19E, R6E sections 34-35, post-harvest prescribed fire, underburning, riparian reserves treated only with hand-work, helicopter yarding or using existing skid trails, and reducing road densities. The specific components of this suggested alternative are addressed separately below, as follows:

Use only existing road system and previous skid trails: Using only the existing road system is addressed by alternative 3; however, it is not feasible to use only existing skid trails for this project. There are few remaining skid trails in plantations; these were dozer piled and planted over in the past and are difficult to locate in many instances. All action alternatives include the use of existing skid trails when they can be located and when their use would minimize new ground disturbance. This recognizes that some existing skid trails, when they can be located, are not necessarily in the best location to minimize new ground disturbance; in some instances creating a new skid trail in the proper location would result in less soil erosion than using an existing skid trail that is in a bad location (e.g. position on slope, soil type, landslide area that could create additional problems). Operations would only occur when soils are dry and use would be meet standards. Skid trails would be kept to 15 percent or less of an area and feller

bunchers would be used whenever possible since they result in less pressure and thus less potential to compact soil. For these reasons, using only existing skid trails was dismissed from further detailed analysis.

Native unlogged (or lightly logged) fire-suppressed stands on moderate slopes (natural stands) that have existing logging road access are thinned from below (retaining 60% canopy and all large diameter and late-successional trees) and yarding using the least damaging method practicable: Stands selected for treatment based on existing road access is addressed by alternative 2. Some natural stands such as units 211, 212, and 213 are extremely dense and silvicultural prescriptions designed to reduce density that would be applied to these units would leave canopy cover above 60 percent. Other natural stands are less dense and have either areas of thinner soil with less stocking or have open areas due to past harvest (e.g. units 208, 225, 243) In these units, thinning of clumps and dense patches to below 55percent of maximum stand density index for a period of 20-30 years would bring the canopy cover to less than 60 percent. Most stands would likely remain between 50 percent and 60 percent canopy cover. Some natural stands (e.g. unit 400 and portions of unit 234) would have heavy thinning in order to restore stand structure for oaks, other hardwoods, and older pine; a canopy cover of 60 percent would not provide the open structure necessary to enhance conditions for those species. Thinning is generally from below (see description of thinning in this chapter). The predominant, relic/legacy, dominant, and the best co-dominant trees would be maintained within stands. In order to meet the desired stocking levels, which would help maintain the health of older trees, some trees that may be considered “large” by some may need to be removed. Relative to the other trees within areas of localized competition, the largest trees with the best crowns would be left.

No treatment in natural stands in T19N, R6E, Sections 34-35: These seven natural stands are accessible by the existing road system and are dense stands in need of thinning. They all occur in General Forest and Partial Retention Forest Plan land allocations. Two of these stands are near the maximum stand density index (SDI) for Douglas-fir and have the highest SDI in the project and most of the stands have not had fire in them for more than 100 years. Underburning alone would not reduce the stand density or crown bulk density enough to affect stand structure and reduce the risk of crown fire. These stands are experiencing some mortality and fuel is accumulating. Proposed treatments in these stands under alternatives 3 and 4 are consistent with the direction for these land allocations. One of these stands (Unit 242) and five other natural stands would not be treated under alternative 2. Post-harvest slash treatment methods, including prescribed fire in treated units, is a component of all action alternatives.

Only hand work, helicopter yarding or use of existing skid trails in Riparian Reserves: Use of only hand work and helicopter yarding are not feasible due to cost of implementation. Project design features have been developed for Riparian Reserves by specialists on the

interdisciplinary team in hydrology, soils, geology and fisheries. These design features would apply to any action alternative and were developed to minimize the potential for adverse impacts to Riparian Reserves and to ensure compliance with all applicable Forest Plan Standards and Guidelines for these important areas.

Road densities are reduced as recommended by the watershed analysis (USDA Forest Service 1997) and the late successional reserve assessment (LSRA) (USDA Forest Service 1999c): Road decommissioning is a component of all action alternatives analyzed, for a total of 4.1 miles of road decommissioning as part of this project. The Watershed Analysis does not give an actual road density reduction figure but makes recommendations on road management in the Indian Creek Watershed. Since the Watershed Analysis was written, several projects have been undertaken to reduce road densities in this watershed through decommissioning, storm-proofing and hydrological stabilization (e.g. 1999 Happy Camp Road Decommissioning EA (USDA Forest Service 1999a), 1999 East Fork Road EA (USDA Forest Service 1999b), 2005 Mill Luther Watershed Restoration EA (USDA Forest Service 2005b). The 2004 Indian Creek Roads Analysis (USDA Forest Service 2004b) recommended the decommissioning of 28 miles of road and storm-proofing of 136 miles of road. This project contributes to the goal of reducing road densities in the Indian Creek Watershed.

As per the management recommendations in the forestwide LSRA (USDA Forest Service 1999c), the proposed action would reduce road densities in the Runway LSR.

2.5.3 Initial Proposed Action

Alternative 2 - proposed action is not exactly the same as the initial proposed action that was distributed for public input during the scoping period. The initial proposed action included thinning treatments on approximately 2,200 acres and underburning across approximately 8,600 acres. Approximately 3.6 miles of temporary roads were initially proposed and approximately 4.3 miles or roads were proposed for decommissioning. Thinning and fuels treatment methods discussed during scoping are the same as those described for alternative 2 - proposed action.

The initial proposed action and alternative 2 - proposed action described above are quite similar; however, several refinements have been made since the scoping period based on additional field review by the IDT and other internal scoping efforts that created the need to make some modifications to the initial proposed action. These modifications were mentioned in a flyer sent to the project mailing list in June 2009, posted to the project website, and discussed during the public field trip on June 22, 2009. No additional comments or concerns were received in response to this notification. Alternative 2 - proposed action better addresses the purpose and need for action and the public input received to date, and more accurately reflects on-the-ground conditions; therefore, the initial proposed action was dismissed from further detailed analysis.

2.6 Alternatives Compared

Table 13. Summary of alternative components and how well alternatives achieve project objectives

Component / Objective	Alternative 1 No Action	Alternative 2 Proposed Action	Alternative 3 No New Temporary Roads	Alternative 4 Minimized Underburn
Alternative Components				
Total treatment acres (all treatments combined)	0	9,530	9,330	2,850
Total underburning acres	0	7,250	7,320	570
Total thinning	0	1,980	1,710	1,980
Total specialized treatment acres	0	140	140	140
Total meadow enhancement acres	0	160	160	160
Total acres of natural stands commercially thinned (% of total thinning treatment)	0	315 (16%)	180 (11%)	315 (16%)
Total acres of plantations commercially thinned (% of total thinning treatment)	0	1,665 (84%)	1,525 (89%)	1,665 (84%)
Total miles of road decommissioning	0	4.1	4.1	4.1
Total acres of mastication	0	0	0	1,450
Miles of temporary roads constructed	0	2.9	0	2.9

Component / Objective	Alternative 1 No Action	Alternative 2 Proposed Action	Alternative 3 No New Temporary Roads	Alternative 4 Minimized Underburn
Potential sawlog volume produced from commercial thinning (CFF, hundred cubic feet)	0	46,240	39,785	46,240
How Alternatives Achieve Project Objectives				
Reduce stand densities	Not met; existing high stand densities would persist; self-thinning would occur	Met: the majority of thinned stands would be below desired stand density index following treatments in 2014 and 2039	Met: the majority of thinned stands would be below desired stand density index following treatments in 2014 and 2039; objective would be met but would not be realized on as many acres as Alternative 2 or 4 since Alternative 3 would treat fewer acres	Met: the majority of thinned stands would be below desired stand density index following treatments in 2014 and 2039
Improve structural diversity within stands, where applicable	Not met; existing lack of diversity in many stands would persist	Met; prescriptions in treated stands, particularly in natural stands and in specialized treatment areas would encourage increased species diversity	Met; prescriptions in treated stands, particularly in natural stands and in specialized treatment areas would encourage increased species diversity	Met; prescriptions in treated stands, particularly in natural stands and in specialized treatment areas would encourage increased species diversity; because fewer acres would be underburned, species diversity would not be achieved on as many acres as proposed in alternatives 2 or 3
Maintain or enhance natural meadows and wetlands	Not met: conifer encroachment into natural meadows would continue; over time natural meadows would shrink in size	Met; meadow enhancement treatments (thinning and prescribed burning) would occur on 160 acres	Met; meadow enhancement treatments (thinning and prescribed burning) would occur on 160 acres	Met; meadow enhancement treatments (thinning and prescribed burning) would occur on 160 acres

Component / Objective	Alternative 1 No Action	Alternative 2 Proposed Action	Alternative 3 No New Temporary Roads	Alternative 4 Minimized Underburn
Maintain or enhance hardwood diversity	Not met; existing lack of hardwood diversity in many areas would persist; over time the hardwood component in many stands would die out due to shading	Met; thinning to restore hardwood stands would occur on 18 acres. In addition, prescriptions for other stands, particularly natural stands, would encourage hardwood regeneration as would prescribed burning	Met; thinning to restore hardwood stands would occur on 18 acres. In addition, prescriptions for other stands, particularly natural stands, would encourage hardwood regeneration as would prescribed burning	Met; thinning to restore hardwood stands would occur on 18 acres. In addition, prescriptions for other stands, particularly natural stands, would encourage hardwood regeneration as would prescribed burning; because fewer acres would be underburned, hardwood diversity would not be achieved on as many acres as proposed in alternatives 2 or 3
Protect mid- and early-seral forest from loss due to wildfire	Not met; current stand densities and high fuel loading in many areas would continue to promote the likelihood of a high intensity fire throughout the project area	Met in thinned stands and to a lesser extent in those areas underburned but not thinned; while proposed treatments would not prevent high intensity fire and the loss of mod and early-seral forest due to wildlife in all areas, it would move the project area toward desired conditions	Met in thinned stands and to a lesser extent in those areas underburned but not thinned; while proposed treatments would not prevent high intensity fire and the loss of mod and early-seral forest due to wildlife in all areas, it would move the project area toward desired conditions; because somewhat fewer acres would be treated, this objective would be met on somewhat fewer acres than Alternative 2	Met in thinned stands and to a lesser extent in those areas underburned but not thinned; while proposed treatments would not prevent high intensity fire and the loss of mod and early-seral forest due to wildlife in all areas, it would move the project area toward desired conditions; because substantially fewer acres are proposed for underburning, this objective would be met on fewer acres than Alternatives 2 or 3.
Develop late-successional conditions, increase patch size and reduce risk of loss of northern spotted owl habitat from wildfire	Not met; Existing LSR areas would not be treated to enhance development large trees and other late successional conditions	Met: actions proposed in LSRs (thinning and burning is proposed in a portion of each LSR) is consistent with the goals for these areas and would promote the development of LSR conditions, increasing patch size and reducing risk of loss due to	Met: actions proposed in LSRs (thinning and burning is proposed in a portion of each LSR) is consistent with the goals for these areas and would promote the development of LSR conditions, increasing patch size and reducing risk of loss due to wildfire	Met: actions proposed in LSRs (thinning and burning is proposed in a portion of each LSR) is consistent with the goals for these areas and would promote the development of LSR conditions, increasing patch size and reducing risk of loss due to wildfire

Component / Objective	Alternative 1 No Action	Alternative 2 Proposed Action	Alternative 3 No New Temporary Roads	Alternative 4 Minimized Underburn
		wildfire		
Maintain or improve watershed conditions and the quality of the Indian Creek water source	Not met; while actions would not be taken to further degrade existing conditions within the Indian Creek Watershed, existing road densities would remain high. Over time, improvements would be realized as disturbed areas revegetate	Met; a net reduction of 1.4 miles of the existing road density would be realized due to decommissioning of existing roads, but temporary roads would be created and existing temporary roads re-opened (and hydrologically restored following use), Riparian Reserve treatments would maintain, and in the long term, improve water quality; short-term effects to temperature and sedimentation due to RR thinning would be small compared to long term increases in stream shade and reduction of high severity wildfire risk which could destroy RR and cause adverse sedimentation.	Met; because no new temporary roads would be created under Alternative 3, the net reduction in road density would be 4.1 miles, greater than for Alternatives 2 or 3; however, like Alternatives 2 and 3, existing temporary roads would be reopened and other ground disturbing actions, including skid trail creation, would occur. Riparian Reserve treatments would maintain, and in the long term, improve water quality; short-term effects to temperature and sedimentation due to RR thinning would be small compared to long term increases in stream shade and reduction of high severity wildfire risk which could destroy RR and cause adverse sedimentation.	Met; a net reduction of 1.4 miles of the existing road density would be realized due to decommissioning of existing roads. However, because temporary roads would be created and existing temporary roads re-opened (and hydrologically restored following use). Riparian Reserve treatments would maintain, and in the long term, improve water quality; short-term effects to temperature and sedimentation due to RR thinning would be small compared to long term increases in stream shade and reduction of high severity wildfire risk which could destroy RR and cause adverse sedimentation.
Improve and maintain good growth rates	Not met; existing high stand densities in many areas, particularly in plantations would prevent good growth rates	Met on 1,980 acres of thinned stands; prescriptions would be designed to promote the development of large trees and provide adequate growing space, particularly in	Met on 1,710 acres thinned stands; prescriptions would be designed to promote the development of large trees and provide adequate growing space, particularly in thinned plantations; because fewer acres are thinned under	Met ion 1,980 acres thinned stands; prescriptions would be designed to promote the development of large trees and provide adequate growing space, particularly in thinned plantations

Component / Objective	Alternative 1 No Action	Alternative 2 Proposed Action	Alternative 3 No New Temporary Roads	Alternative 4 Minimized Underburn
		thinned plantations	Alternative 3, this objective would be realized on fewer acres than alternatives 2 or 4	
Minimize insect and disease damage through stocking control	Not met; no treatments would occur to reduce existing levels of insect or disease; as stand densities increase in many areas and especially during periodic drought, it is likely that occurrences of insects and diseases would increase within the project area over time; pine plantations in particular would have heavy mortality from beetles	Met; Met on 1,980 acres of thinned stands; thinning would reduce tree competition for water and nutrients leaving the remaining trees more able to produce defenses against diseases and insects, and would remove some of the weakest and more vulnerable trees, particularly in thinned plantations; dwarf mistletoe treatment would specifically occur on 36 acres	Met; Met on 1,710 acres of thinned stands; thinning would reduce tree competition for water and nutrients leaving the remaining trees more able to produce defenses against diseases and insects, and would remove some of the weakest and more vulnerable trees, particularly in thinned plantations; dwarf mistletoe treatment would specifically occur on 36 acres	Met; Met on 1,980 acres of thinned stands; thinning would reduce tree competition for water and nutrients leaving the remaining trees more able to produce defenses against diseases and insects, and would remove some of the weakest and more vulnerable trees, particularly in thinned plantations; dwarf mistletoe treatment would specifically occur on 36 acres
Maintain existing plantations	Not met; dense plantations would remain in their current condition and would continue to self thin over time as stand density increases	Met on 1,665 acres of plantations that are thinned to promote the development of large trees and enhanced structural and species diversity	Met on 1,525 acres of plantations that are thinned to promote the development of large trees and enhanced structural and species diversity	Met on 1,665 acres of plantations that are thinned to promote the development of large trees and enhanced structural and species diversity

Table 14. Summary of environmental effects by alternative

Resource Area	Alternative 1 No Action	Alternative 2 Proposed Action	Alternative 3 No Temporary Roads	Alternative 4 Minimized Underburning
Forest Vegetation				
Stand Density Index (SDI) in 2039 Desired condition is 55 percent or less of maximum SDI Existing Condition is 69% maximum SDI	78% maximum SDI	45% maximum SDI	45% maximum SDI, but on slightly less acres	45% maximum SDI
Trees per Acre in 2039 Desired condition varies by tree species and diameter and stand age Existing condition is 357	165; moderate decrease due to density-related mortality	66: substantial decrease due to removal by thinning and fuels treatment	66; substantial decrease due to removal by thinning and fuels treatment	66; substantial decrease due to removal by thinning and fuels treatment
Quadratic Mean Diameter (QMD) in 2039 A larger QMD is desired - the proportion of large trees in a stand compared to the proportion of small trees. Large trees are desired for a variety of reasons including increased fire resiliency, wildlife habitat, and future wood value; many trees are currently less than 10 inches DBH	18: increase in QMD due to competition-induced mortality (self-thinning); modeling predicts most of the trees that die in a 30 year period would be smaller suppressed trees.	22.4: greater increase than Alternative 1 in QMD due to removal of small and moderate-sized trees by thinning and fuel treatment	22.4: greater increase than Alternative 1 in QMD due to removal of small and moderate-sized trees by thinning and fuel treatment, but on slightly less acres	22.4: greater increase than Alternative 1 in QMD due to removal of small and moderate-sized trees by thinning and fuel treatment

Resource Area	Alternative 1 No Action	Alternative 2 Proposed Action	Alternative 3 No Temporary Roads	Alternative 4 Minimized Underburning
Existing condition is 11				
Achievement of Forest Plan Management Area Goals	Not met	Met and desired conditions achieved in treated stands	Met and desired conditions achieved in treated stands	Met and desired conditions achieved in treated stands
Fire and Fuels				
Fire behavior in 2029 during severe (90th percentile) conditions as measured by surface flame length Desired condition is less than 4 feet Existing condition is 5.6	6.4	2.8 in areas thinned and underburned 6 in areas underburned only	Same as Alternative 2 but on slightly less acres	2.8 in areas thinned 6 in areas underburned only 6.6 in areas masticated
Fire Type in 2029 (surface fire, passive crown fire, active crown fire, conditional crown fire). Desired condition is a combination of surface and passive crown fire Existing condition is conditional crown fire	Conditional crown fire	Surface fire in all treated areas	Same as Alternative 2 but on slightly less acres	Same as Alternative 2 but on substantially fewer acres
Summary		Increased fire resiliency and reduced fire behavior in areas treated over time	Increased fire resiliency and reduced fire behavior in areas treated over time	Increased fire resiliency and reduced fire behavior in areas treated over time
Air Quality				
Smoke emissions containing particulate matter with diameters less than 10	PM10: 1.04 PM 2.5: 0.88 CO: 11.5	PM10: 0.77 totaling 5,583 PM2.5: 0.65 totaling	PM10: 0.77 totaling 5,636 PM2.5: 0.65 totaling 4,758 CO: 8.6 totaling 62,952	PM10: 0.77 totaling 439 PM2.5: 0.65 totaling 371 CO: 8.6 totaling 4,902

Resource Area	Alternative 1 No Action	Alternative 2 Proposed Action	Alternative 3 No Temporary Roads	Alternative 4 Minimized Underburning
micrometers (PM10), less than 2.5 (PM2.5), and carbon monoxide (CO) in tons/acre and total tons	All due to wildfire	4,713 CO: 8.6 totaling 62,350 All due to prescribed burning	All due to prescribed burning	All due to prescribed burning
PM10: Fugitive dust emissions from log hauling	None	17.8 tons/year	17.8 tons/year	16 tons/year
Summary	Substantially more total smoke emissions due to a wildfire, often concentrated in time	25 percent fewer tons/acre emissions during prescribed burning than a wildfire; substantially fewer total tons than a wildfire; emissions staggered through time These short-term adverse effects to air quality would be minimized by project design features and compliance with all State Standards	Essentially the same emissions as Alternative 2 These short-term adverse effects to air quality would be minimized by project design features and compliance with State Standards	92 percent fewer total tons of emissions than Alternatives 2 or 3 due to substantially less underburning These short-term adverse effects to air quality would be minimized by project design features and compliance with State Standards
Geology				
Thinning and burning treatments proposed on *unstable land in Riparian Reserves*	0	1042 (87 acres of this is thinning)	1041 (86 acres of this is thinning)	270 (87 acres of this is thinning)
Treatments proposed on ultramafic rock	0	3292 (825 acres of this is thinning)	3277 (825 acres of this is thinning)	2190(825 acres of this is thinning)
Cubic yards of sediment produced per decade based on cumulative watershed effects modeling	Not applicable	19-125 yards of sediment per decade due to roads; 81-806 due to other treatments	2-71 yards of sediment per decade due to roads; 81-806 due to other treatments	19-125 yards of sediment per decade due to roads; 81-806 due to other treatments

Resource Area	Alternative 1 No Action	Alternative 2 Proposed Action	Alternative 3 No Temporary Roads	Alternative 4 Minimized Underburning
Risk Ratio and Forest Plan Goals	Not applicable	Below established threshold and has a moderately high to high probability of meeting all Forest Plan geological program goals	Below established threshold and has a moderately high to high probability of meeting all Forest Plan geological program goals	Below established threshold and has a moderately high to high probability of meeting all Forest Plan geological program goals
Soils				
Detrimental Soil Disturbance (Percentage of areas proposed for treatment). Desired condition is less than 15 percent. Existing condition is 7 percent	7	11	11	11
Achievement of Forest Plan Soil Standards and Guidelines	Not applicable	High probability of meeting Forest Plan Soil S&Gs	High probability of meeting Forest Plan Soil S&Gs	High probability of meeting Forest Plan Soil S&Gs
Water				
Proposed acres of treatments in stream course riparian reserves	0	Thinning: 230 Underburning: 1530; net reduction in road density of 1.4 miles	Thinning: 168 Underburning: 1530; net reduction in road density of 4.1 miles	Thinning: 230 Mastication: 80; net reduction in road density of 1.4 miles
USLE risk ratios for surface soil erosion sediment volume	No change	0.30	0.29	0.27

Resource Area	Alternative 1 No Action	Alternative 2 Proposed Action	Alternative 3 No Temporary Roads	Alternative 4 Minimized Underburning
Threshold of Concern in 1.0 (so desired condition is less than 1.0)				
GEO risk ratios for mass wasting (landslides) Threshold of Concern in 1.0 (so desired condition is less than 1.0)	No change	0.50	0.50	0.50
Equivalent Roaded Area (ERA) risk ratios Threshold of Concern in 1.0 (so desired condition is less than 1.0)	No change	0.52	0.52	0.52
Achievement of Forest Plan Standards and Guidelines	Indian Creek watershed not currently meeting desired conditions due to landslide terrain, dense road network and long history of mining and forest management; no change in existing condition	Short-term, site-and reach-scale adverse impacts that would not be measurable at the watershed scale; long-term beneficial impacts to sedimentation, stream temperature and channel morphology due in part to greater fire resilience and road decommissioning; all predicted effects within established thresholds of concern, although elevated levels are noted in some 5th field watersheds; would meet Forest Plan S&Gs	Short-term, site-and reach-scale adverse impacts that would not be measurable at the watershed scale; long-term beneficial impacts to sedimentation, stream temperature and channel morphology due in part to greater fire resilience and road decommissioning; all predicted effects within established thresholds of concern, although elevated levels are noted in some 5th field watersheds; would meet Forest Plan S&Gs	Short-term, site-and reach-scale adverse impacts that would not be measurable at the watershed scale; long-term beneficial impacts to sedimentation, stream temperature and channel morphology due in part to greater fire resilience and road decommissioning; all predicted effects within established thresholds of concern, although elevated levels are noted in some 5th field watersheds; would meet Forest Plan S&Gs

Resource Area	Alternative 1 No Action	Alternative 2 Proposed Action	Alternative 3 No Temporary Roads	Alternative 4 Minimized Underburning
Fisheries				
Coho salmon, Chinook salmon and steelhead/rainbow trout	No direct effects; long-term adverse impacts possible if a wildfire were to start in project area	Via predicted effects to 17 fish habitat indicators: may affect but is not likely to adversely affect federally listed as threatened coho salmon; may impact individual sensitive Chinook salmon and steelhead/rainbow trout but is not likely to result in a trend toward federal listing or loss of viability for steelhead and resident rainbow trout	Same as Alternative 2	Same as Alternative 2
Botany and Noxious Weeds				
12 Forest Service Sensitive Species	No change; adverse impacts possible if a wildfire were to start in project area	No impact to 4 species; may impact individuals of 9 species but not likely to result in a trend toward federal listing or loss of viability	No impact to 4 species; may impact individuals of 9 species but not likely to result in a trend toward federal listing or loss of viability	No impact to 5 species; may impact individuals of 8 species but not likely to result in a trend toward federal listing or loss of viability; mastication has potential to adversely affect fungi species
3 High Priority and 2 Moderate Priority Noxious Weeds	No change; increased susceptibility to noxious weeds if a wildfire were to start in project area	Increased risk of spread (considered low), minimized through project design features	Increased risk of spread (considered low), minimized through project design features	Increased risk of spread (considered low), minimized through project design features
Terrestrial Wildlife				

Resource Area	Alternative 1 No Action	Alternative 2 Proposed Action	Alternative 3 No Temporary Roads	Alternative 4 Minimized Underburning
2 Threatened or Endangered species and critical habitat; 14 Forest Service Sensitive Species	No change; adverse impacts possible if a wildfire were to start in project area	May affect but not likely to adversely affect the northern spotted owl; no effect to marbled murrelets or their critical habitat or to northern spotted owl critical habitat; may impact individuals of 8 sensitive species but is not likely to result in a trend toward federal listing or loss of viability; no impact to 5 sensitive species	Same as Alternative 2	Same as Alternative 2
Managed Wildlife Area	No change; no improvement to late succession reserve conditions	No adverse effect to the quality of habitat; beneficial effects expected over the long-term	Same as Alternative 2	Same as Alternative 2
Late Successional Reserves	No change; no improvement to late succession reserve conditions	No adverse effect to the quality of habitat; beneficial effects expected over the long-term	Same as Alternative 2	Same as Alternative 2
11 Management Indicator Species	No change	Negligible to minor short-term adverse impacts during project implementation; long-term beneficial impacts due to habitat improvement	Same as Alternative 2	Same as Alternative 2
Migratory Birds	No change	May impact individuals during project implementation but not expected to result in a trend toward federal	Same as Alternative 2	Same as Alternative 2

Resource Area	Alternative 1 No Action	Alternative 2 Proposed Action	Alternative 3 No Temporary Roads	Alternative 4 Minimized Underburning
		listing or loss of viability		
Socioeconomics				
Estimated Revenue (1999 dollars)	0	$628,471	$523,400	$628,471
Job Creation	0	183	162	173
Net Present Value (NPV; sum of total costs subtracted from the sum of total benefits)	0	(2,595,396)	(2,890.486)	(1,521,906)
Benefit-Cost Ratio (B-C; sum of benefits divided by the sum of costs). A ratio greater than 1 suggests that the benefits are greater than the costs. Use with the NPV to describe overall benefits	0	0.19	0.14	0.28
Summary	This alternative would yield no economic benefits or costs.	Would create the most jobs due treatment of more acres compared to other alternatives. Second highest B-C ratio and NPV among action alternatives, but these do not account for benefits to other forest resources.	Least amount of economic benefits, but these figures do not account for benefits to other resources.	Highest NPV and benefit-cost ratio due in part to lower cost of management activities (fewer acres) but would yield different on-the-ground benefits. Does not account for benefits to forest resources, just revenue from sale of sawtimber
Summary		Highest NPV and benefit-cost ratio for Alternative 4 due in part to lower cost of management activities (fewer acres) but would yield different on-the-ground benefits. Does not account for benefits to forest resources, just revenue from sale of sawtimber		

Resource Area	Alternative 1 No Action	Alternative 2 Proposed Action	Alternative 3 No Temporary Roads	Alternative 4 Minimized Underburning
Scenery and Recreation				
Visual Quality Objectives	No change	Meets all Forest Plan VQOs; viewsheds would remain natural or near-natural appearing and treatments would be visually subordinate to the landscape; no activities seen from high sensitivity viewpoints	Same as Alternative 2	Same as Alternative 2
Recreational Opportunities	No change	Minor, short-term adverse impacts to dispersed recreational opportunities during project implementation; use and opportunity would remain essentially the same over the long term	Minor differences but essentially the same as Alternative 2	Minor differences but essentially the same as Alternative 2
Inventoried Roadless Areas	No change	15 acres thinning of small encroaching conifers and 21 acres of prescribed burning to restore natural meadow conditions; no road construction; all actions consistent with roadless area characteristics and management direction	Same as Alternative 2	Same as Alternative 2
Cultural Resources				

Resource Area	Alternative 1 No Action	Alternative 2 Proposed Action	Alternative 3 No Temporary Roads	Alternative 4 Minimized Underburning
Archeological Sites	Minor to major adverse effects if a wildfire were to start in project area	Negligible to moderate adverse impacts, minimized through project design features	Negligible to moderate adverse impacts, minimized through project design features; less effect than Alternatives 2 or 4 due to no temporary roads	Negligible to moderate adverse impacts, minimized through project design features
Culturally Significant Areas	Minor to major adverse effects if a wildfire were to start in project area	Negligible to moderate adverse effects; beneficial effects realized due to enhanced condition of desired plant species and reduced risk of wildfire	Negligible to moderate adverse effects; beneficial effects realized due to enhanced condition of desired plant species and reduced risk of wildfire	Negligible to moderate adverse effects; beneficial effects reduced due to substantially less underburning
Climate Change				
Greenhouse gas emissions and natural variability	No direct, immediate or short-term change in greenhouse gas emissions in the project area and no direct change in climate or vegetation patterns; risk of high severity fire would continue (and the subsequent release of large pulses of greenhouse gases via smoke from large wildfire).	Short-term, localized, minor adverse impacts due to release of greenhouse gases during prescribed fire due to smoke and to a lesser extent, through use of chainsaws and motor vehicles. Would not appreciably or measurably contribute to global climate change. Moving the area toward a more natural range of variability would contribute to a more resilient ecosystem less susceptible to shifts in temperature or rainfall patterns.	Same as Alternative 2	Less greenhouse gas emissions due to substantially less prescribed burning

Chapter 3. Affected Environment and Environmental Consequences

This Chapter is organized by resource and describes aspects of the environment likely to be affected by implementation of alternatives (affected environment) and environmental effects (direct, indirect, and cumulative) that would result from implementing alternatives (environmental consequences). Together, these descriptions form the scientific and analytical basis for comparison of alternatives presented in Chapter 2.

3.1 Methodology

The impact analysis and conclusions contained in this chapter were based on forest staff knowledge of the resources and site, reviewing of existing literature and agency studies, information provided by specialists within the Forest Service and other agencies, and professional judgment. The methodology section at the beginning of each resource heading describes any additional specific data collection/analysis or other methods used for that resource. Potential impacts in this chapter are described in terms of type (direct, indirect, cumulative and are the effects beneficial or adverse?), context (are the effects site-specific, local, or even regional?) duration (are the effects short-term or long-term?), and intensity.

Direct effects occur at the same time and in the same locations as actions that cause them. Indirect effects are those that occur at a later time or in a different location than the actions that were their cause. Cumulative impacts result from the additive impacts of this project with past, present, and reasonably foreseeable future actions in or near the area.

For purposes of this analysis, short-term effects are those expected within the next 1 to 10 years (throughout the course of project implementation) and long-term effects are those that are expected between 10 and 20 years or more (after implementation is complete), unless specifically defined in individual resource sections below.

3.2 Past, Present and Reasonably Foreseeable Actions

According the Council on Environmental Quality (CEQ) NEPA regulations, “cumulative impact” is “…the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such actions” (40 CFR 1508.7).

The project area lies wholly within the Indian Creek 5th field watershed (Figure 7), which is approximately 86, 200 acres in size, and was evaluated in detail during 1990-1995 by the Forest Service (USDA 1997). Because the Two Bit project area lies completely within this watershed and encompasses a large percentage of it, and because of the potential for impacts of multiple actions on the natural environment within one watershed, it was selected as the area for cumulative impact analysis for most resources analyzed in this chapter. Some resources also

consider effects at the smaller 7th field watershed scale as well; figure 7 depicts all 7th field watersheds that make up the larger Indian Creek 5th field watershed. However, the area of cumulative impact may differ depending on the resource affected. For example, air quality could be affected by actions outside of a watershed boundary. If a different cumulative impact area is chosen for a specific resource, it is discussed in that specific resource section later in this chapter.

The Indian Creek watershed has been the focus of two watershed-specific analysis efforts in the recent past: The 1997 Indian Creek Watershed Assessment (USDA 1997) and the 2004 Indian Creek Roads Analysis (USDA 2004b). The Indian Creek Watershed has approximately 318 miles of system roads, with an average road density of 3.1 miles per square mile (Bousfield 2010 and USDA 2004b). Populated communities near the watershed include Happy Camp, Seiad Valley, Yreka and Scott Valley. Generally, the major use of private property located within the watershed is for the rural residential life-style. There are also commercial uses, with some ranching and agricultural parcels, mining, and smaller tracts of timberlands. Most residences are occupied year-round, while a few are visited by the property owners seasonally.

Contemporary uses by Native Americans in the watershed area include gathering traditional resources such as artisan and basketry materials and Native American religious freedom uses. Artisan and basketry gathering sites have been identified by Native Americans within the watershed area (McCovey 2009).

The baseline for cumulative effects analysis is the current condition. The cumulative effects analysis in this EIS is consistent with Forest Service National Environmental Policy Act (NEPA) Regulations (36 CFR 220.4(f)) (July 24, 2008), which state, in part:

> *"CEQ regulations do not require the consideration of the individual effects of all past actions to determine the present effects of past actions. Once the agency has identified those present effects of past actions that warrant consideration, the agency assesses the extent that the effects of the proposal for agency action or its alternatives will add to, modify, or mitigate those effects. The final analysis documents an agency assessment of the cumulative effects of the actions considered (including past, present, and reasonable foreseeable future actions) on the affected environment. With respect to past actions, during the scoping process and subsequent preparation of the analysis, the agency must determine what information regarding past actions is useful and relevant to the required analysis of cumulative effects. Cataloging past actions and specific information about the direct and indirect effects of their design and implementation could in some contexts be useful to predict the cumulative effects of the proposal. The CEQ regulations, however, do not require agencies to catalogue or exhaustively list and analyze all individual past actions. Simply because information about past actions may be available or obtained with reasonable effort does not mean that it is relevant and necessary to inform decision making. (40 CFR 1508.7)"*

A catalog of certain actions occurring within the Indian Creek watershed was done as part of a watershed analysis (Bousfield 2010) and is summarized in the table below. In-progress or planned actions, known as of this writing, are also included and were compiled from the Klamath National Forest Schedule of Proposed Actions (queried on July 22, 2009) and with

input from district staff. As discussed in Chapter 1, although many Forest System roads in the project area are in good condition, some would require programmatic maintenance before proposed operations would begin, in order to bring them up to current standards. Programmatic maintenance on Forest System roads is a routine action that is on-going and has been evaluated in a separate environmental analysis.

In-progress and planned projects are included in table 15 that follows.

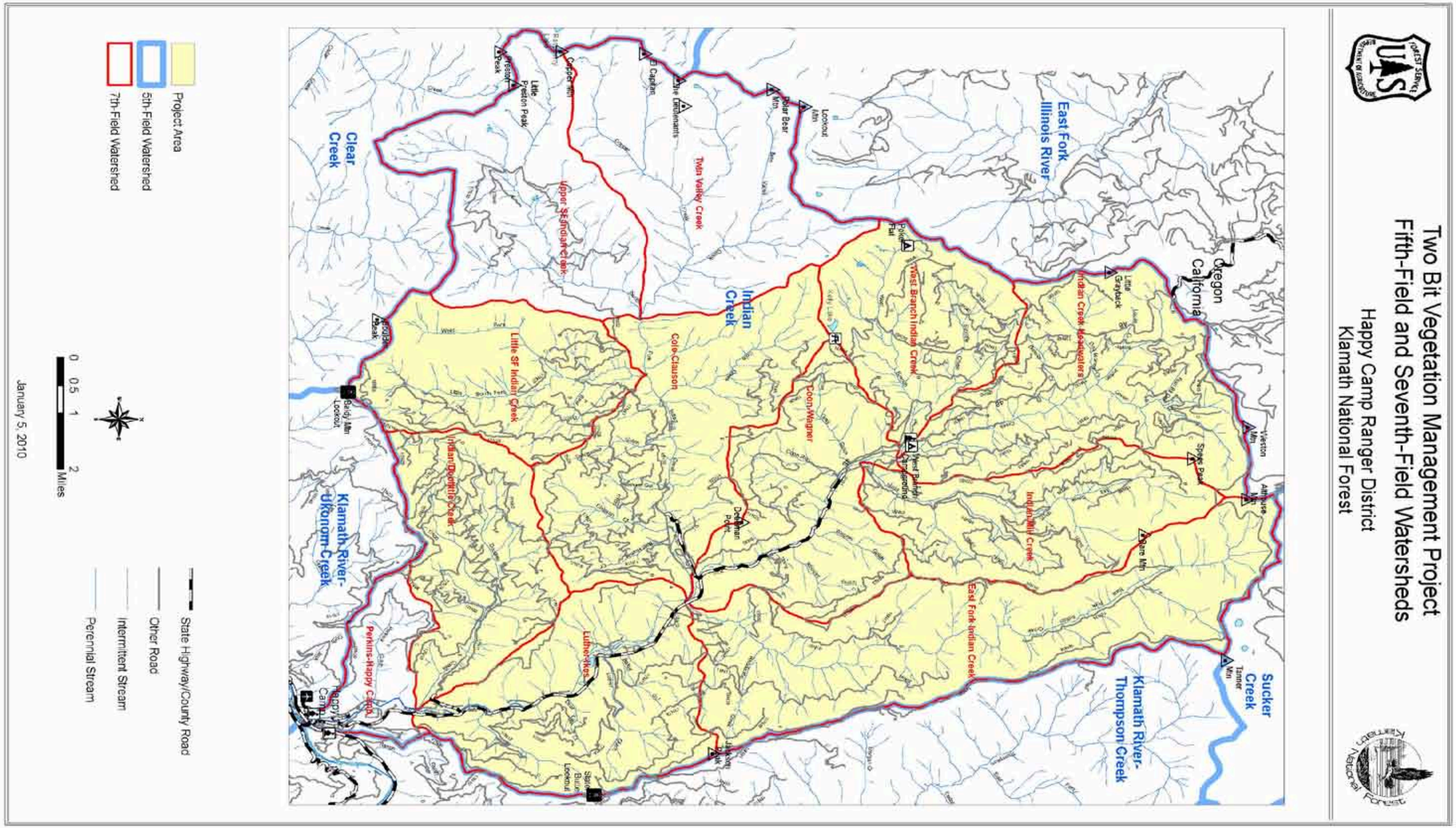


Figure 7. Indian Creek 5th - field watershed and relationship to Two Bit Project Area and 7th - field watershed boundaries

The Indian Creek Watershed Analysis (USDA Forest Service 1997) provides a detailed description of conditions of the watershed including past history, reflecting the aggregate impact of prior human actions and natural events that have affected the environment, and might contribute to cumulative effects, up to 1997. Actions and events since 1997 were also considered and are included in tables 15 and 16 below.

Approximately 23,500 acres within the 86,200-acre watershed (or 27%) have been treated or are planned for treatment in the foreseeable future with either a timber sale or an underburn/fuels reduction project, the majority of which has been on Forest System lands. Since 1987, approximately 3,500 acres were burned in wildfires. Road decommissioning has also occurred in the watershed, totaling approximately 20 miles. These roads are now no longer part of the road network. Since the Watershed Analysis was written, several projects have been undertaken to reduce road densities in this watershed through decommissioning, storm-proofing and hydrological stabilization. The 2004 Indian Creek Roads Analysis (USDA Forest Service 2004b) recommended the decommissioning of 28 miles of road and storm-proofing of 136 miles of road.

There are currently no known plans for logging that affect habitat on private lands, although approximately 390 acres of harvest occurred on private lands within the watershed between 1999 and 2003.

The affected environment sections in Chapter 3 discuss the current conditions in the project area. Cumulative watershed effects analysis assumes all planned projects have been completed.

Tables 15 and 16 below display acres of projects within Indian Creek 5th field watershed.

Table 15. In-progress or planned activities within the Indian Creek Watershed

Project	Type/Timing	Approximate Acreage
Happy Camp Fire Protection 03 Analyzed with a categorical exclusion	Fuels management/On-going	742
Happy Camp Fire Protection Commercial Phase II Thinning Analyzed with an environmental assessment	Fuels management/On-going	182
Happy Camp Fire Protection Phase II Underburning Analyzed with a categorical exclusion	Fuels management/Planned	1168
Happy Camp Fire Protection Phase II Roadside Understory Fuels Reduction Analyzed with a categorical	Fuels management/Planned	328

Project	Type/Timing	Approximate Acreage
exclusion		
Happy Camp Fire Protection Phase II Understory Fuels Reduction Analyzed with a categorical exclusion	Fuels Management/Planned	722
Elk Slashing and Reforestation Analyzed with a categorical exclusion	Timber and Fuels Management/On-going	203
Mill/Luther Watershed Improvement Project	Watershed/On-going	96.3 miles of road storm-proofing and 11.3 miles road decommissioning
Totals		3,345 acres 96.3 miles road storm-proofing 11.3 miles road decommissioning

Table 16. Acres of completed, in progress or planned activities within the Indian Creek 5th Code Watershed, since 1953

Activity Type	Acres (unless otherwise specified)
Timber harvest or fuels treatments	19,836
Wildfires	3,613
Road Projects	19.5 road miles decommissioned; on-going programmatic maintenance of system roads
Total	23,449 19.5 road miles decommissioned

3.3 Forest Vegetation

3.3.1 Methodology

Data describing the existing condition were collected through site visits, 2008 and 2009 informal stand exams, GIS vegetation layers, and the Indian Creek Watershed Analysis. The Classification and Assessment with Landsat of Visible Ecological Groupings (CALVEG) system was used to provide more recent vegetation information than the 1997 watershed analysis. CALVEG uses “existing vegetation” to classify stands and utilizes color infrared satellite imagery and field verification at the regional level to classify California existing vegetation communities. The latest imagery updates were in 2004 and field verification has continued.

Stand information was calculated using traditional methods and spreadsheets to derive stand averages for various forest measurements. The Forest Vegetation Simulator (FVS) program (Dixon 2002) was also used for some stands to generate averages for stand conditions from the data collected and to model the effects of treatments on density, diameter growth, and stand composition. The sampling and modeling are an approximation of actual conditions. The modeling does not replicate exactly the existing conditions or conditions that would occur after treatments. For this analysis, FVS was used to generally characterize and display existing conditions and the nature and magnitude of treatment effects to support decisions to be made. FVS provides probable outcomes to compare alternatives and fine tune silvicultural prescriptions for treatment stands.

The alternatives are compared using the following indicators

- Post-treatment change in forest density as measured by Stand Density Index (SDI); the desired SDI is 55% of maximum or less
- Predicted maintenance or improvement in tree vigor, growth, and susceptibility to damage from insects and disease as measured by SDI
- Species composition and structure related to tree vigor and potential fire damage as measured by comparison of before and after treatment trees per acre (TPA) and quadratic mean diameter (QMD)
- Acres of existing plantations treated

SDI is used as an indicator to assess stand conditions related to inter-tree competition and describe stand characteristics resulting from proposed treatments or no treatments. SDI is a widely used measure developed by Reineke in 1933 that expresses relative stand density in terms of the relationship of a number of trees to stand quadratic mean diameter (Helms 1998). The relationship between the average individual tree-size in tree stands experiencing density-related or suppression mortality has been shown to be exceedingly predictable for a number of herbaceous and tree species. In the ecological literature, the relationship is commonly referred to as the “self-thinning rule”. This fundamental relationship, generally independent of stand age and site quality, provides an excellent basis from which to develop an understanding of the competitive interactions between individuals in a population (Long 1985).

QMD was chosen as an indicator because of its relationship to the health of trees and susceptibility to damage from fire and its relationship to calculating SDI. Low production of stem wood (small diameters) per unit of foliage has been associated with the tree’s inability to accumulate reserves of nutrients, carbohydrates and water or to produce defensive compounds. Stem growth occurs once the resource demands of foliage and root growth have been met (Waring 1987, Oliver 1996). Larger trees develop thick bark that isolates the cambium from heat damage and have more available surface area; this remains functioning if portions of the tree are killed by fire. QMD combined with TPA also reflects the number of small diameter trees that may function as ladder fuels.

Changes in the percent of basal area (BA) for desired species will be discussed qualitatively with support from modeling. BA over time is a better measure of establishment in a stand than

the number of trees. This is because seedlings and saplings may number in the hundreds per acre, but most will not survive in the understory if they are suppressed out of the stand by a larger overstory.

3.3.2 Affected Environment

Approximately 76 percent of the project area is classified (using CALVEG) as Pacific Douglas-fir and 14 percent as white fir. The rest of the project area (10 percent) includes seven hardwood cover types, five shrub types, three herbaceous types, and barren, urban, and water areas. The Silviculture Specialist Report (Sharp 2010) contains descriptions of Pacific Douglas-fir and white fire types as well as the 15 other cover types that comprise the project area.

The coastal influence in the northern and western portions of the Two Bit project area is particularly noticeable. Within the Douglas-fir and white fir forest types in this area, understory of Douglas-fir, white fir, and incense-cedar are common. Hardwoods are less common above 4,000 feet in elevation and are replaced by shrubs and herbaceous plants in the understory. Port Orford-cedar only occurs naturally in the western portion (and below approximately 4,400 feet on the northern boundary) within or adjacent to streams and wet areas. Western white pine replaces sugar pine in cooler areas generally above 3,600 to 4,500 feet and occurs mostly in the western portion of the project area. Brewer spruce occurs on cooler sites on north and east aspects at elevations above 3,500-4,000 feet in the western and northern portion. Chinquapin is the most common hardwood found in the understory in much of the project area.

In the southern and eastern portions of the project area, less precipitation falls and coastal influences are more moderate. On mid-slopes and ridges, drier-site species such as sugar pine, black oak, and madrone are common. Ponderosa pine is generally only present on ridges below 4,000 feet on thinner soils with low water- holding capacity. Jeffery pine occurs on ultramafic soils.

Black oak, madrone, and chinquapin occur together or are dispersed by stand conditions. Black oak is most abundant on south or western aspects in the southern half of the project area. Madrone occupies stands with deeper soils in this area. Chinquapin is more common on moist gravelly soils. Tan oak is found on the more mesic sites with deeper soils mostly in the southern portion of the watershed at lower elevations. Tan oak is shade tolerant and can also be found in shrub or tree form in the understory in stands with high canopy cover throughout the project area generally below 3,800 feet. Canyon live oak occurs on thinner and rocky soils and is more common in the southern portion of the project area where less precipitation falls. Big leaf maple is scattered throughout the project area and grows best on deep, well drained soils with abundant moisture. It is quite tolerant to shade and commonly establishes in forest understory. On drier upland sites, big leaf maple can replace oaks and madrone in the absence of significant disturbance (Niemiec et al. 1995, pgs 12-18). It exists in both of these roles within the Two Bit project area.

Canopy Cover

The generally wet climatic conditions over the last 200 years have contributed to an extensive coniferous cover. Additionally, the decrease in the amount of fire over the last 80-100 years has allowed understory vegetation to survive and accumulate. White fir has moved into natural stands and plantations at lower elevations; within or adjacent to stands proposed treatment, the oldest and largest trees are Douglas-fir. White fir trees typically about 150 years old, are scattered in cooler areas down to 2,300 in elevation, but the majority of white fir below 4,000 is younger regeneration that has come in over the last 100 years.

Table 17 displays canopy closure within the project area. Nearly 87 percent of the area has a canopy closure greater than 40 percent. Canopy cover has increased since the Indian Creek Watershed Analysis (USDA Forest Service 1997) was completed.

Table 17. Existing condition, acres by vegetation cover (canopy closure)

CWHR Closure Class	Vegetation Cover (Canopy Closure)	Total Acres	Percent of Project Area
Not Determined/ Not Applicable		4,236	6.3
Dense Cover	> 60%	48,535	71.4
Moderate Cover	40.0 – 59.9%	10,539	15.5
Open Cover	25.0 – 39.9%	3,812	5.6
Sparse Cover	10.0 – 24.9%	837	1.2
Grand Total		67,959	100

Past Harvest

Approximately 18 percent of the project area includes plantations from past regeneration harvest. Table 18 displays the acres by forest type that have been harvested with a regeneration prescription in the past. No regeneration harvest has taken place in the Two Bit project area since 1995. Some of these older plantations are proposed for commercial thinning in this project.

Table 18. Existing condition, acres of forest type regenerated to plantation within the Two Bit Project Area

Forest Type	Acres
Douglas-fir – White fir	65
Jeffery pine	107
Mixed conifer - fir	125
Mixed conifer - pine	17
Pacific Douglas-fir	10,625
Port Orford-cedar	3
Red fir	5
White fir	975
Grand Total	**11,922**

Plantations between 40 and 50 years old are proposed for thinning. These plantations are on moderate to high sites; most often had tractor site preparation in the past to remove competing vegetation, and had cultural treatments such as release and precommercial thinning. These conditions have allowed good tree growth; 40 to 90 percent of the trees in the plantations are over 10 inches diameter breast height (dbh). Plantations were also chosen because they could be yarded with ground-based systems that make it more economical to thin and harvest small diameter trees.

Nearly 90 percent of the area that was harvested in the past is classified as Pacific Douglas-fir. There are, however, small areas within many plantations that have serpentinized soils, hardwood and shrub sites, or riparian vegetation. Approximately 25 percent of the plantations within the Douglas-fir and white fir types were planted with ponderosa pine; these are often referred to as off-site pine.

Insect and Disease Conditions

The last decade included two of the driest years recorded since the early 1900s resulting in accelerated tree mortality. Increasing density and dry conditions contributed to increased pine beetle mortality in sugar pine and other pines. Douglas-fir mortality, including older trees, increased on drier sites. Mortality is due to Flatheaded fir borers (*Melanophila drummondi*), Douglas-fir engraver (*Scolytus unispinosus*), and Douglas-fir beetles (*Dendroctonus pseudotsugae*) and laminated root rot (*Phellinus weirii*).

Insects and diseases that are most common in the treatment units include pine beetles (*Dendroctonus ponderosae, D. brevicomis, D. valens , Ips spp*), Douglas-fir engraver beetles (*Scolytus unispinosus*), Douglas-fir beetles (*Dendroctonus pseudotsugae*), western oak bark beetles (*Pseudopityophthorus pubipennis*), wood borers (*Buprestis sp*.), red ring rot (*Phellinus Phellinus Phellinus pini*), velvet top fungus (*Phaeolus schweinitzii*), black stain root disease

(*Leptographium wageneri*), and white pine blister rust (Furniss 1977, Scharpf 1993, and Sharp , personal observations). Phellinus *Phellinus pini* conks are the most obvious disease effecting Doulgas-fir in the natural stands within project area. *Phellinus pini* infection occurs most frequently in dense stands where self pruning creates entry points for spores that germinate on branch stubs remaining after shading has killed the branches (USDA Forest Service 2006).

Douglas-fir beetles have a preference for larger diameter trees and characteristics positively correlated with attack include poor growth, high stand densities, and bark and phloem thickness. Preventive control in inland forests can result from thinning and harvesting (Furniss 1977). The Two Bit project is near the transition zone between coastal and inland Douglas-fir, but as discussed earlier, much of the project area has a coastal influence. Consequentially, the Douglas-fir beetle mainly affects stands in the dryer site in the southwestern portion of the project area.

The Douglas-fir engraver usually attacks weakened, injured, dying and recently dead young Douglas-fir and is commonly the final killing agent for suppressed trees. Wood bores also commonly attack weaken or dying trees and are common in the project area. The oak bark beetle sometimes kills seriously weakened oaks and infests bole and branches of injured, fallen, or recently dead trees; they are present in nearly all dead oaks in the project area.

Black stain root disease affects mostly younger trees less than 60 years old on the Happy Camp District. It is a fungus that lives in the vascular system of roots and blocks the tree's water supply. Long distance spread is thought to be by root-infesting bark beetles and weevils in the project area; disease sites are small with often only 2-10 trees affected.

There are no known infestations of Port-Orford-cedar root disease (*P. lateralis*) within the Indian Creek Watershed.

Vegetation Conditions in Stands Proposed for Treatment

Treatments are proposed in approximately 142 units. In order to produce a manageable amount of stand-specific data to display FVS modeling, similar types of units were grouped into 17 stand/unit types for sampling and modeling. These 18 unit types are described below to provide detailed examples of the stand structures and species compositions of the units proposed for thinning. The effects of thinning on structure and composition are described in the environmental consequences section below. Individual stands that are represented may differ somewhat from the 18 unit types in species composition, stocking, and tree diameter distribution; the data shown precisely represent only the stand for which the data is taken. However, units represented by the sample units exhibit similarities in stand structure, age, site quality and past history and similar treatments are proposed for these representative stands. The units represented by each sample group are described in detail below and their characteristics are summarized at the end of the descriptions in table 19.

Species Key

BM – bigleaf maple (*Acer macrophyllum*)
BO – California black oak (*Quercus kelloggii*)
CY – canyon live oak (*Quercus chrysolepis*)
DF – Douglas-fir (*Pseudotsuga menziesii*)
PP – ponderosa pine (*Pinus ponderosa*)
WF – white fir (*Abies concolor*)
SP – sugar pine (*Pinus lambertiana*)
IC - incense-cedar (*Calocedrus decurrens*),

Unit 11 – Ponderosa Pine Plantation – 159 acres

Representing Units 2, 11, 12, 20, 30, 42, 81, 95, 96, 99, and 102

These plantations are predominately PP with varying amounts of hardwood, DF, IC, or WF. The elevation is low to moderate, the site quality is moderate to high, and PP is growing fairly well considering the density. SDI is high to very high for PP, generally around 75-85 percent of maximum; small groups of trees show pine beetle effects. In dense pockets, bole and tops of PP have broken and some have been up-rooted. Unit 30, in particular, has extensive pockets of pine beetle mortality. The more shade tolerant DF, including trees less than 10 inches dbh, are growing well with long, full crowns. Some stands (e.g., Unit 99) have heavy natural regeneration of DF, WF and IC under the PP canopy.

Objectives include increasing the percentage of DF, reducing pine density, and maintaining hardwoods that are being shaded out. Proposed thinning under action alternatives would include spacing in PP of about 30 feet, leaving most of the DF (including trees 8-10 inches dbh over larger PP), and free thinning to release hardwoods and other desired conifer species. Where the stands contain 10-20 percent DF or dense patches of DF, DF would be thinned to around 26 to 28-foot spacing. Some small diameter trees that are not large enough to harvest would be retained after treatment and natural regeneration would continue to occur.

Unit 31 – Douglas-Fir Plantation – 306 acres

Representing Units 13, 19, 29, 31, 36, 37, 61, 62, 65, 71, 76, 79, 83, 84, 85, 88, 113, 114, and 121

These plantations are generally well stocked with DF and some PP and hardwoods (chinquapin, madrone, black oak, canyon live oak). Tree size varies depending on soil depth, slope and water drainage within the unit with QMDs of 8-10 inches. Steeper areas and areas with serpentine influence have a high percentage of trees from 6-10 inches dbh. Most areas contain greater than 100 trees per acre less than 10 inches dbh and have pockets of young natural regeneration in more open areas. SDI is just over 60 percent of maximum for DF and growth has slowed over the last 10 years.

Objectives include reducing stand density and providing more growing space for the codominant trees and smaller trees left after thinning and maintaining or encouraging stand diversity including some of the hardwoods. Proposed thinning under action alternatives would

include spacing of DF larger than 10 inches to around 30 feet and leaving only 10-20 percent of the stand in small trees after thinning and fuel treatment. Some natural regeneration would occur.

Unit 33 – Douglas-Fir Plantation – 181 acres

Representing Units 33, 40, 41, 59, 67, 77, 78, 80, 93, and 119

These plantations have patchy stocking with areas of dense smaller diameter trees and brush or hardwood. Sites are generally lower quality. Some have steeper slopes and some are near ridge tops where soil is thin. Still the SDI averages over 60 percent of maximum. Most of the trees in Unit 67 are less than 10 inches dbh and may be thinned at a later time. Unit 40 also has few areas, mostly skid trails and tractor piled areas, where there are many trees over 10 inches dbh.

Objectives include reducing stocking with relatively heavy thinning so that stands would not need to be thinned again until the smaller trees grow and stands are approaching mid-maturity. Spacing of DF over 10 inches dbh would be around 33 feet and allow more rooting space on these less fertile sites. In stands near ridges, wide spacing would reduce the risk of crown fire.

Unit 48 – Douglas-Fir Plantation – 166 acres

Representing Units 4, 6, 7, 9, 16, 27, 28, 47, 48, 49, 50, and 63

These plantations are higher elevation and contain DF, and some WF, IC and PP. Some WF is appropriate at this elevation. Stocking is dense in most area of the stands with SDI around 55 percent-60 percent of maximum. Crowns are generally longer and narrower in these stands presenting a lower crown base height when considering fire torching risk. Snowbrush, bitter cherry, and chinquapin are common scattered or in patches. Some stands contain dense areas dominated by smaller diameter (5-9-inch trees) from natural regeneration.

Objectives include reducing stand density, reducing PP, maintaining IC, and maintaining DF as the dominant species over WF. Spacing will be 26-28 feet in trees over 10 inches with smaller scattered trees or groups of trees. Natural regeneration would occur; review of the units 10 years after treatment to would be recommended to assess for control excessive WF regeneration.

Unit 51 – Ponderosa Pine Plantation – 105 acres

Representing Units 3, 21, 43, 46, 51, 52, 53, 54, 58, 64, and 118

These stands are at higher elevation and were planted with PP and have only a few natural DF, IC, or WF and scattered hardwood. Five to 30 percent of the trees have broken or bent tops and many trees have bends or crooks in the upper bole from snow damage. These stands are dense to very dense and SDI may be as high as 95 percent of the maximum for PP in stands such as Unit 51. Pine beetle mortality is low in these stands presently, but stands are at high risk for heavy mortality at these densities. There is some natural regeneration or brush where stands are less dense or needle retention is so low sunlight can pass through the sparse crowns to the ground.

Objectives include removing badly damaged trees, maintaining the largest pine with the least amount of damage, and providing growing space for natural regeneration of DF, IC, and WF. Under action alternatives, PP would be thinned to a spacing of around 35 feet. Review of stands after fuels treatment is recommended to assess regeneration; planting would be considered if natural regeneration was not occurring in adequate amounts to provide stocking to replace the maladapted PP over the next 50 years.

Unit 97 - Ponderosa Pine Plantation – 72 acres

Representing Units 87, 97, 115 (partial 27 acres), 116, and 117

These are lower elevation PP plantations with few other conifers species. Due to the dense canopy, among other things, there is little regeneration of other species. Pines are growing well and are more adapted to the lower elevation, however due to the high density, stand heath is decreasing. Pine beetle mortality is occurring in Units 116 and 117.

Objectives include reducing stand density below 35 percent of maximum SDI to produce a widely spaced pine stand for more than 30 years. Action alternatives would maintain PP over 10 inches dbh at about 33-foot spacing.

Unit 100 – Douglas-Fir plantation – 376 acres

Representing Units 1, 22, 23, 24, 38, 55, 56, 68, 75, 86, 92, 94, 100, 105, 112, and 50 acres of 115

Stands are similar to Unit 31, but contain less young regeneration. These plantations are generally well stocked with mostly DF and scattered hardwoods (madrone, chinquapin, black oak). They contain pockets of deep soil with larger trees and heavy stocking and areas of poorer site with smaller trees and some small open areas. SDI is slightly over 60 percent and diameter growth has slowed to one half or less in the last 10-12 years from the previous growth. Self-thinning has started to occur, but is generally light.

Objectives include reducing stand density and maintaining or encouraging stand diversity including some of the hardwoods. Proposed treatments under action alternatives would include thinning of DF larger than 10 inches to around 28-foot spacing; in addition, some groups or scattered smaller trees would be left after treatment especially on thinner soils. Some natural regeneration would occur.

Unit 108 – Douglas-Fir Plantation – 87 acres

Representing Units 8, 10, 32, 60, 108, 120, and 203

These are DF plantations on high or very high site that have consistently 200-220 basal area per acre. Stands have high canopy closure (85-95%) and are in the stem exclusion phase; there is little natural regeneration and few hardwoods within the stands. Existing spacing among the plantations is varied, but stands that were thinned when young, have some plantations trees over

20 inches dbh. The SDI is just over 55 percent and although growth is still good on these high sites, it has slowed in the last 10 to 14 years to less than half of what it was previously growing. As the density continues to increase, around 57 percent of the trees can expected to die over the next 30 years based on modeling.

Objectives include reducing stand density and maintaining enough basal area to support another thinning entry in 25-30 years on regulated land. Objectives for stand 108 (within LSR) would be to maintain it as foraging habitat in the short-term by retaining 50 percent canopy cover or greater, maintaining a residual basal area of at least 120 square feet/acre, and allowing greater mortality when most of the trees are over 24 inches in diameter. Other units in this group are not considered foraging habitat because they are too dense for owls to use. Proposed treatments outside of LSR under the action alternatives would include thinning to about 27-foot spacing or removing around half of the basal area.

Unit 110- Douglas-Fir Plantation – Prescription for Stands that are not Foraging Habitat -140 acres

Representing Units 18, 26, 66, 70, 71, 89, 91, and 101

These stands are represented by data from Unit 110, but are not NSO foraging habitat. They would have a heavier thinning than similar units that are considered foraging habitat. These stands are on high sites and are similar to Unit 108 except the trees are generally at closer spacing, the basal area is less, the trees are smaller (trees mostly 14 inches dbh and a few larger) and there is either more natural regeneration under the canopy or more openings. Stands, such as Unit 66, do have sparser areas on steeper slopes or larger trees in areas with wider spacing or deep soil. The SDI is at or just over 55 percent of the maximum for DF.

Objectives include reducing stand density to a level where the stands would grow back to nearly 55 percent of the maximum in 30 years and improving fire resilient conditions.

Unit 110- Douglas-Fir Plantation with Foraging Habitat/LSR Prescriptions – 51 acres

Representing Units 103, 104, 109, 110, and 111

These stands are on high sites and are similar to Unit 108 except the trees are generally at closer spacing, the basal area is slightly less and the trees are smaller (trees mostly 14 inches dbh) with patches of wider spaced larger trees (18-20 inches DBH) and some mixed species. Unit 109 has some larger Port-Orford-cedar in wet areas. The majority of the hardwood is big leaf maple in more sparse areas of 109, 110, and 111. Units 103 and 104 include steeper slopes near ridge tops with thinner soils and madrone is the predominate hardwood in these stands; Unit 103 is outside of the LSR. The SDI is generally at or just over 55 percent of the maximum for DF.

Objectives for these units include maintaining foraging habitat by retaining at least 50 percent canopy cover and 120 square feet of basal area after treatment. Areas in the stand with less than 120 square feet of basal area would not be thinned. Treatments would be designed to

reduce density, grow larger diameter trees at an accelerated rate, and reduce fire hazard to maintain habitat in LSR units in the long term.

Unit 201 – Natural Stand Dominated by Douglas-Fir – 64 acres

Representing Units 200, 201, 209, 244, and 258

These stands are multi-aged and multi-sized and are dense with a variety of species at mid and lower elevations. They are mid and late seral stands with some older and relic trees. Unit 201 has had previous harvest and contains open areas with dense regeneration from 20 to 50 years old. Steeper slopes in Unit 200 are occupied by hardwoods with younger conifers at a wider spacing. These stands are on high quality sites and the SDI is well over 55 percent of maximum and, in parts of the stands, is close to 100 percent of the observed maximum for DF in the Klamath Mountains. These sites are high quality with available underground water. Competition mortality of species such as sugar pine (including larger trees) and shade intolerant hardwoods are occurring. Suppressed DF trees of various sizes are also dying in small amounts.

Objectives include reducing stand density, maintaining some of the more shade intolerant species, maintaining good growth rates in individual trees, reducing the risk of heavy competition-induced mortality, and utilizing potential mortality for wood products.

Unit 206 - Natural Stand Dominated by Douglas-Fir – 80 acres

Representing Units 205, 206, 214, 216, 218, 226, 228, 229, 236, 254, and 256

These stands are relatively young (many trees 90 to 130 years old), but all have areas that include older trees. All stands have unique characteristics, but have the SDI is similar and stand options are similar. The stands contain trees of various diameters depending on the spacing within each stand. Unit 214 is high elevation. Unit 228 is at mid elevation, but now is 70-80 percent WF and although it is not very active presently, there is WF mortality from *annosus* root disease; *armillaria* root disease is also present. Unit 256 was naturally regenerated after hydraulic mining in the early 1900's (Huey mine). The stands are dense and the SDI is around 93 percent of maximum. The average crown ratio is decreasing and growth has been decreasing for several decades due to density.

Objectives include reducing stand density, maintaining some hardwoods and sugar pine, maintaining good growth rates in individual trees, reducing the risk of heavy competition-induced mortality, and utilizing potential mortality for wood products.

Unit 213 - Natural Stand Dominated by Douglas-Fir and White Fir – 26 acres

Representing Units 211, 212, and 213

These are very dense stands at high elevations with a mix of DF and WF on south aspects. Stands are late seral with patches of smaller and younger trees. The SDI is close to the observed maximum for DF in this area, and at 68 percent of the maximum SDI for WF. These stands are

just on the south side of the ridge adjacent to the Oregon border and receive more precipitation that other parts of the project area allowing high stand densities. Douglas-fir are the oldest and largest trees in the stand. Most of the mortality in the stand has been smaller (20 inches dbh) WF. There are a few SP snags in the area, but it has died out of these stands due to high density.

Objectives include reducing stand density, maintaining the health of individual trees to retain the structural components of this stand, reducing a potentially high level of competition-induced mortality and greater fire risk that would be associated with the increase in surface fuels and utilizing potential mortality for wood products. The stands would be thinned to around 55 percent of maximum SDI for DF allowing some continued mortality to meet snag and CWD needs. Because these stands are older and very dense, they would be maintained at higher a density than other stands in the project.

Unit 225 - Natural Stand Dominated by Douglas-Fir – 76 acres

Representing U nits 208, 217, 220, 225, 243, and 253

These stands are generally less dense due to past thinning and sanitation harvest or a combination of environmental site conditions and harvest. Units 208 and 217 were underburned about 15 years ago. Several of the stands have dwarf mistletoe in a few of the older DF or WF. The average SDI is around 65 percent of the maximum, but varies throughout the stands. Stands contain a mix of trees that are different ages and sizes and include regenerated patches.

Objectives include reducing stand density especially in clumps, removing some of the diseased trees, and maintaining or improving fire resilient conditions across the stand.

Unit 227 – Natural Stand Dominated by Douglas-Fir – individual stand of 10 acres

This stand has large, old, decadent DF widely spaced with a mix of dense clumps of younger (80-130 years old) DF, WF and RF, and sparser areas with DF and true fir, scattered large sugar pine, a few small brewer spruce, and a dense layer of sadler oak averaging 3 feet tall. The dense portions of the stand are at nearly 80 percent of the maximum SDI and the rest of the stand is over 55 percent of maximum. There has been previous sanitation and salvage harvest of individual live and dead trees in the stand, mostly the large DF. The most noticeable pathogens in the stand are DF and RF mistletoe, *cytospora* canker in the RF, velvet top fungus, and blister rust in the sugar pine. Pine and fire beetles are mostly infesting suppressed trees and although much of the WF appears stressed, there are not large centers of mortality from *annosus* root disease. Most of the oldest DF have broken tops or are diseased. There is some mortality in all of the age classes.

Objectives include reducing stand density and promoting growth of large DF as replacement trees, maintaining species diversity including brewer spruce, improving overall stand health, utilizing potential mortality to maintain low levels of surface fuels, and reducing ladder and crown fuels.

Unit 234- Natural stand of Douglas-Fir or Ponderosa Pine with Black Oak or Madrone Clumps – 27 acres

Representing Units 234 and 400

Both of these stands have or had a large component of oak. Unit 234 is located on a small ridge that runs east and west and is mostly on a south aspect. The ridge has large black oak trees that have or are being been shaded out by the DF. The remainder of the stand has pockets of DF with sugar pine and IC and areas of wider spaced DF stocked at 160 basal area with scattered black oak. A few large madrones are growing around the perimeter on the north boundary. The SDI is at 55 percent of maximum for DF, but this equates to 79 percent of the maximum for black oak. The stand was underburned about 15 years ago, but a low level of slash still remains from past partial harvesting. Many of the dead oaks that have fallen are contributing to the surface fuel loading.

Objectives include reducing the amount of DF, promoting the presence of black oak and other hardwoods and maintaining a fire resilient stand on this ridge top.

Stand 400 includes Oregon white oak and black oak, madrone, chinkapin, tan oak, PP, and DF of mixed ages. The majority of the conifers are younger than the older oaks. The DF are thick in some areas and scattered in others, but have shaded out much of the younger hardwood. Most DF are in poor health on this “oak and pine” site and a number have dead tops or are dying from attacks of bores and beetles. The understory contains small suppressed trees with a ground cover of fescue and other grasses. There is yew and azalea in the wet area. Portions of the stand are flat so that wood cutter can access the area and about 5 percent of the hardwoods have been removed as firewood.

Objectives include removing the DF and tan oak where less shade tolerant oaks are present, maintaining large PP and some IC in the stand, and maintaining shade for the yew while allowing sunlight for the azalea.

Unit 238- Natural Stand Dominated by Douglas-Fir - Individual stand of 10 acres

This unit is a late seral stage stand with a few patches of younger trees. It is located on a rocky knoll on a south aspect. Species include DF, WF, IC and SP with huckleberry oak and grasses in the openings. The stand is on relatively poor soil, but there is available underground water. The SDI is at 80 percent of the maximum for DF, and appears to have developed under relatively open conditions so that the trees grew large and the site is now fully occupied. Nearly all the trees less than about 16 inches dbh have been suppressed out of the stand giving this dense stand an open appearance. Several of the sugar pine has died. Approximately 15-20 percent of the basal area is composed of trees greater than 42 inches dbh, 40-50 percent of the basal area includes trees from 26 to 40 inches dbh, and 35-45 percent of the basal area includes trees 24 inches dbh or less. The larger trees (34 inches dbh or larger) tend to be grouped together. Overall the stand is doing remarkably well considering site condition.

Objectives include reducing stand density to slightly less than 55 percent of the maximum SDI to maintain stand health and large trees and reducing risk of accelerated mortality.

Unit 255 - Natural Stand Dominated by Douglas-Fir - 35 acres

Representing Units 219, 242, 255 and 257

These are stands that average around 240 basal area per acre. Units 219 and 257 are younger and include trees generally less than 120 years old. Unit 242 (high elevation) and 255 contain more large, older trees; both also contain WF although unit 255 is at 2300 feet. The SDI of these stands is about 73 percent of the maximum for DF and some mortality has occurred. Hardwoods are scattered and are mostly being shaded out with the exception of big leaf maple. Objectives include reducing stand density below 55 percent SDI for not more than 30 years, reducing the percentage of WF, and maintaining hardwoods and sugar pine where possible.

Units 300 and 237 - Natural and Regenerated Stands Dominated by Douglas-Fir – Individual stands totaling 38 acres

Unit 237 is a stand that was harvested with a partial cut prescription in 1976 and re-entered in 1987 to be regenerated because the stand had less stocking that the site was capable of growing or was stocked with trees that were generally of low vigor. The regeneration harvest maintained several overstory trees, second growth patches, and small understory trees that are infected with Douglas-fir dwarf mistletoe. In part likely due to better growing conditions for the pathogen, these trees are now heavily infected and mistletoe has infected the adjacent Douglas-fir. The SDI in unit 237 is low other than a few overstory trees, the stand is composed of conifer seedling and saplings and brush; this unit was not modeled with FVS.

Objectives include removing badly infected trees and regeneration to promote conditions to improve future stand health.

Unit 300 is a strip approximately 200 feet wide on of both sides of Road 19N06 less than a mile in length. It contains small groups or individual trees that are infected with dwarf mistletoe. Larger trees include several co-dominant trees or isolated trees of the same size that are either located where they would infect healthy stands or regeneration. This unit is a mix of natural stands and stands harvested with varying prescriptions including thinning and regeneration harvesting. Due to the variation in condition and the small amount of trees that would be removed, this stand was not modeled with FVS

Objectives include removing badly infected mature trees and regeneration and slowing the spread of mistletoe along this one section of road.

Units 301 and 302- Dense Natural Regenerated Stands along Roads – Individual stands totaling 84 acres

Unit 301 contains IC and DF and Unit 302 is DF. The units contain thickets of saplings and pole sized trees that seeded in the fill slope after the roads were constructed and the area within about 100 of the road. Due to the variation in condition and the irregular intervals in which trees will

be removed over the next 10 to 20 years, this stand was not modeled with FVS. The SDI is high in the thickets (density-induced mortality is taking place) and generally lower away from the road fill.

Objectives include reducing stand density to produce larger trees with adequate growing space, improving conditions for road maintenance, and providing products available to the public under pole permits.

The sample units and modeling data are displayed in table below. The tables contained in the following environmental consequences section compare the SDI, TPA, and QMD of the various stand types modeled by the sample units.

Table 19. Representative units: existing conditions

Sample Unit	SDI (Percent of maximum for dominant species)	TPA	QMD	Desired species to be increased/maintained or less desired species to be reduced
11	371- (PP – 86%)	429	9.1	Increase DF, IC, hardwood
31 (DF portion)	352 (DF- 64%)	446	8.6	Increase Hardwood, IC
33	337 (DF- 62%)	452	8.3	Maintain hardwood, reduce WF
48	323 (DF - 59%)	464	8.0	Increase DF, IC
51	410 (PP - 95%)	383	10.4	Increase DF, WF, IC, hardwood
97 (LSR)	269 (PP - 63%)	399	7.8	Increase DF, IC, hardwood; reduce WF regen.
100	334 (DF - 61%)	280	11.2	Maintain madrone
108 (LSR)	322 (DF - 59%)	190	13.9	Maintain Big leaf maple
110 (not foraging habitat)	315 (DF - 56%)	260	11.3	Maintain hardwood, reduce WF regen,
110-LSR/foraging habitat	315 (DF - 56%)	260	11.3	Maintain hardwood, reduce WF regen,
201	544 (DF - 99%)	394	12.2	Maintain SP, IC hardwood, reduce WF.

Sample Unit	SDI (Percent of maximum for dominant species)	TPA	QMD	Desired species to be increased/maintained or less desired species to be reduced
206	511 (DF – 93%)	341	12.9	Reduce WF, maintain hardwood.
213	517 (DF - 95%)	110	26.3	Favor DF
225	355 (DF - 65%)	253	12.3	Maintain SP, hardwood; reduce WF
227 (clumps)	428 (DF - 78%)	206	15.8	SP, DF, BS; reduce WF
234	302 (DF - 55%) (BO - 79%)	135	16.5	Increase BO, SP
238	436 (DF - 80%)	81	28.6	Maintain SP
255	398 (DF - 73%)	264	12.9	Maintain hardwood; reduce WF
Weighted Average	**69%**	**357**	**11**	

3.3.3 Environmental Consequences

Alternative 1- No Action

Direct and Indirect Effects

Vegetation in the project area would continue to grow; stands would increase in density and tree mortality would increase over time. Table 20 shows modeled SDI values for alternative 1in 30 years. Thirty years is a reasonable amount of time to expect the modeling to retain accuracy and is about the time period identified by the Happy Camp Ranger District before another thinning would be considered.

Table 20. No Action Alternative, Comparison of SDI for Existing Condition and 30 Years Out

Stand example Unit No.	SDI (percent of maximum for dominant species)	2039 SDI (percent of maximum for dominant species)	Unit meets Desired SDI (55 percent of maximum)in 30 years
11 - PP plantation	371 (PP - 86%)	363 (84%)	No
31 - DF plantation	352 (DF - 64%)	386 (71%)	No
33 - DF plantation	337 (DF - 62%)	424 (78%)	No

Stand example Unit No.	SDI (percent of maximum for dominant species)	2039 SDI (percent of maximum for dominant species)	Unit meets Desired SDI (55 percent of maximum)in 30 years
48 - DF plantation	323 (DF - 59%)	492 (90%)	No
51 - PP plantation	410 (PP - 95%)	329 (77%)	No
97 (LSR) - PP plantation	269 (PP - 63%)	353 (82%)	No
100 - DF plantation	334 (DF - 61%)	454 (83%)	No
108 (LSR) - DF plantation	322 (DF - 59%)	373 (68%)	No
110 - DF plantation (not foraging habitat)	315 (DF - 56%)	388 (71%)	No
110-LSR/foraging habitat	315 (DF - 56%)	388 (71%)	No
201 - DF natural	544 (DF - 99%)	431 (79%)	No
206 - DF naural	511(DF - 93%)	382 (70%)	No
213 - DF natural	517 (DF - 95%)	331 (61%)	No
225 - DF natural	355 (DF - 65%)	422 (77%)	No
227 (clumps) - DF natural	428 (DF - 78%)	384 (70%)	No
234 - DF/BO natural	302 (DF - 55%) (BO - 79%)	353 (DF-65%) (BO-92%)	No
238 - DF natural	436 (DF - 80%)	280 (51%)	Yes with mortality
255 - DF natural	398 (DF - 73%)	402 (73%)	No
Weighted Average	**69%**	**78%**	**No**

Nearly all the stands in the project area (modeled by the sample stands) are at or above desired stocking levels; self-thinning is occurring and they are within the zone of imminent mortality (greater than 55% of the maximum SDI). The number of trees that can occupy a site decreases exponentially with time and with an increase in the average size of the trees (Oliver 1996, pg.343). Most of the mortality predicted over the next 30 years would be of regeneration in the understory or suppressed trees, but mortality would include some larger trees that would succumb to the competition pressure especially within groups of larger trees. Some of the large sugar pine and hardwoods in all stands that have those species have died.

None of the stands, except Unit 238, would be expected to reach the desired SDI of 55 percent of maximum in 30 years without some type of natural disturbance (fire, insects, blow down). Unit 238 is an older unit at high density composed mainly of larger trees. Competition-

induced mortality is predicted to reduce the stocking to less than 55 percent; when the trees are big, the death of over half the trees in the stand (table 21) is a substantial reduction in SDI.

The ponderosa pine plantations are at extreme risk to bark beetle mortality based on the calculated SDI for these stands, and several of the stands including Unit 11 are presently experiencing pockets of mortality from beetles. It is unlikely that these stands would actually maintain the calculated SDI for another 30 years without heavier than predicted losses from beetles. Unit 51 is near the maximum SDI and growth under the high level of completion as well as the fact that the trees are off-site ponderosa pine, has resulted in small, weak trunks and tops that are bending and breaking under the snow in about 30 percent of the trees. Nearly all the trees in this stand and similar stands have some bends in the top stems as the trees continue to grow up, but grow little in diameter. The crown ratios and needle retention is poor in the denser portions of all the pine stands. A crown ratio of 30 percent or less and poor growth has also been linked to beetle attack in pine (Fettig 2006).

Although codominant Douglas fir trees in plantations are still growing well in height, all stands sampled showed a marked decrease in diameter growth over the last 10-15 years. Stands have been experiencing low levels of self-thinning in the understory consistent with the onset of competition. Crown ratios in denser portions of all units are decreasing and are averaging 40 percent. The intermediate and suppressed trees have crown ratios less than 30 percent. This self pruning has contributed to a higher canopy base height resulting in a more fire resilient stand. However, as the SDI continues to rise over the next 30 years to the values predicted in table20, the average crown ratio would be substantially reduced. If heavy self-thinning occurs, the SDI would be maintained at lower levels, but dead trees from self-thinning contribute to the surface fuel loading, and can put stands at higher risk to damage from fire.

The natural stands chosen for treatment generally have high average SDI values although there is a great deal of variation in stand structure within stands and among stands. Within natural stands, irregular spacing creates unequal growing space for each tree, resulting in some trees having a little growing space when stand reach crown closure and other having much growing space at crown closure. This causes trees to differentiate in crown position and mortality occurs throughout the development of these stands, and there are no dramatic waves of mortality (Oliver 1996, pg 346). Stands would continue to have mortality and some reduction of tree vigor at these high SDIs, and this would put these stands at risk of high intensity fire, if a wildfire were to start in the project area.

Black oak in Unit 234 would likely all be shaded out within 30 years except those few trees in stand openings.

The QMD increases as the smaller trees die out of the stands and as the remaining trees continue to grow. Where mortality is mostly small trees, little additional growing space would be available and diameter growth in the stands would remain close to the decrease rates measured in the stands over the last 10-15 years. As stands become denser and trees age over the long term, growth rates would decrease to an even greater extent. Low growth rates (production of stem

wood per unit of foliage) have been associated with a tree's inability to accumulate reserves of nutrients, carbohydrates, and water or to produce defensive compounds (Warning 1987, Oliver 1996). As tree vigor and growth decline, trees become more susceptible to injury from a variety of insects and diseases.

Table 21. No Action Alternative for years 2009 and 2039, TPA and QMD

Stand Example Unit #	TPA - QMD , 2009 existing condition	2039 TPA - QMD	Decrease in TPA Increase in stand QMD (inches) in 2039
11 - PP plantation	429 - 9.1	198 - 14.6	231 TPA - 5.5 inches
31 - DF plantation	446 - 8.6	146 - 18.3	300 TPA - 9.7 inches
33 - DF plantation	452 - 8.3	187 - 16.6	265 TPA - 8.3 inches
48 - DF plantation	464 - 8.0	268 - 14.6	196 TPA - 6.6 inches
51 - PP plantation	383 - 10.4	116 - 19.2	267 TPA - 8.8 inches
97 (LSR) - PP plantation	399 - 7.8	244 - 12.6	155 TPA - 4.8 inches
100 - DF plantation	280 - 11.2	160 - 19.2	120 TPA - 8.0 inches
108 (LSR) - DF plantation	190 - 13.9	121 - 20.2	69 TPA - 6.1 inches
110 - DF plantation (not foraging habitat)	260 - 11.3	128 - 20.0	139 TPA - 8.7 inches
110 - DF plantation (LSR/ foraging habitat)	260 - 11.3	128 - 20.0	139 TPA - 8.7 inches
201 - DF natural	394 - 12.2	149 - 19.4	245 TPA - 7.2 inches
206 - DF Natural	341 – 12.9	107 - 22.1	234 TPA - 9.2 inches
213 - DF natural	110 - 26.3	43 - 35.6	67 TPA - 9.3 inches
225 - DF natural	253 - 12.3	179 - 17.0	74 TPA - 4.7 inches
227 (clumps) - DF natural	206 - 15.8	100 - 23.1	106 TPA - 7.3 inches
234 - DF/BO natural	135 - 16.5	86 - 24.1	49 TPA - 7.6 inches
238 - DF natural	81 - 28.6	33 - 37.9	48 TPA - 9.3 inches
255 - DF natural	264 - 12.9	153 - 18.2	111 TPA - 5.3 inches
Weighted Average	**357 – 11**	**165 – 18**	*Decrease due to self thinning mortality*

Density of all vegetation in the stands would continue to increase at a higher rate over the short and long term in the absence of burning or other natural disturbance. As stands accumulate vegetation, some trees and shrubs would die and surface fuel would increase. Under alternative 1, tree bole damage that can occur from underburning would be avoided. Alternative 1 would not reduce fire severity through reduction in ladder and surface fuels because there would be no underburning. Units 301 and 302 would continue to self-thin at a slightly higher rate than if some of the trees were thinned for pole products.

Under alternative 1, meadow treatments would not take place. Trees would continue growing and propagating within natural meadows so that open more xeric meadow areas would continue to shrink. Sanitation thinning for dwarf mistletoe in Unit 300 would not take place, increasing the risk of spread to neighboring stands. No specialized harvest treatments for pole thinning and hardwood enhancement would take place.

In Unit 400 (historically dominated by oak), oaks and other hardwoods would continue to be over-topped by conifers and would decrease over time. Douglas-fir is also dying in this stand and increasing the fuel loading. Dense patches of small trees are producing hazardous fuel conditions that could result in higher fire intensity during a wildfire that could kill the older oaks.

Because no action would be taken under alternative 1, there would be no resultant short-term adverse impacts from harvest operations or associated temporary roads or skid trails. Potential damage to trees (wounding) from operations would be avoided. Additional compaction of soils would be avoided because machinery would not be used within stands. However, though short-term adverse effects from operations would be avoided with alternative 1, long-term beneficial effects to tree growth and stand health would not be realized. Stands that are less dense could have some positive benefit because growth is still good and stands would remain more heavily stocked and result in a higher total wood production. However, for most stands in the project area, would production would be reduced due to density-related mortality and in the case of pine plantations; this would result in mortality from bark beetles.

Approximately 3.5 acres would remain forested if temporary roads are not constructed and between an estimated 40 to 60 acres would remain forested if new landings are not constructed.

Many of the roads proposed for decommissioning have become at least partially vegetated again with conifers, brush or hardwoods, and over the long-term this natural reclamation would slowly continue.

Cumulative Effects

All past activities or events affecting forest vegetation are considered in the description of the existing condition. Within the Indian Creek Watershed, in-progress or planned activities with a similar purpose and need as the Two Bit project would continue within the watershed; underburning and thinning from these projects would total approximately 3,345 acres. Additional density reduction and fuels treatment work proposed in the Two Bit project would not occur. An

opportunity would be missed to accomplish those types of treatments in combination with current projects and move the project area towards the desired condition.

Alternative 2 – Proposed Action

Direct/Indirect Effects

The direct effects of alternative 2 within thinned stands would be a reduction in stand density from cutting and removal of trees, crushing of some vegetation during harvest, and burning or piling and burning of vegetation for fuels treatment. Indirect effects would include increased growing space for trees remaining in the stand, increased individual tree growth, increased ability for trees to produce defensive compounds, decreased density-related tree mortality, increased retention of shade intolerant species, and decreased potential for crown fire risk. Burned units would experience reduction in tree density (to a lesser degree than thinned units) where mostly small vegetation in the understory would be affected. Direct effects are discussed together in this analysis with the indirect effects resulting from proposed actions including tree removal during thinning. For purposes of this analysis, meadow enhancement treatments and specialized treatments (pole harvest and sanitation) are combined with thinning. Effects of underburning are discussed at the end of this section.

Ninety-two percent of the thinning and underburning would take place in the Pacific Douglas-fir type, 4 percent in the white fir type, 1 percent in the Upper Montane Mixed Chaparral and the other 3 percent would be in 7 of the other vegetation types. Seventy five percent would occur in the Calveg dense cover classes with canopy cover greater than 60 percent. Thirty-two percent of the area treated would be in the small tree size class, 32 percent in the medium/large tree size class, and the remainder would be in smaller size classes.

Tree Thinning

Treatments would vary by degree of thinning leaving some stands more open than others depending on density goals related to Management Areas in the Forest Plan, stand characteristics, and environmental conditions. The overall direct/indirect effects of thinning treatments in all stands would reduce stocking and provide individual trees enough growing space to maintain healthy crowns and adequate rooting space. Individual tree growth would be maintained or improved over time depending on the age and condition of the tree. Predominant and relic trees would be maintained after thinning and would have reduced stress from competition.

Competition-related mortality would decrease in the long-term including pine beetle mortality in plantations. In stands where species are not well-adapted to the site or are growing as a result of fire suppression or other past conditions, thinning would increase the percentage of trees appropriate for the site. This would be done by removing mal-adapted trees and enhancing conditions for preferred species including natural regeneration.

Disease presence and susceptibility would decrease in the long-term after reducing competition and removing many of the weaker trees. Free thinning would allow species that have a low tolerance to shade such as sugar pine, black oak and madrone to be maintained within stands. Forest products would be provided as a by-product to the thinning treatments.

Changes in SDI

Many of the plantations would be thinned to low densities. Thinning to densities below 35 percent of max SDI would generally result in less growth of wood volume per acre over time, but is offset by greater volume and diameter growth per tree. For stand growth efficiency and production of wood products, an optimal thinning regime may include heavier thinnings when stands are younger and most capable of quickly reoccupying available growing space, as in the case of plantations. However, light thinnings in older stands would minimize unoccupied growth space where large trees are less capable of expanding into newly unoccupied growth space available after thinning (Oliver 1996, pg. 352). Within regulated lands, presently, fiber production is not practical in this area because of the lack of markets and high transportation and harvest costs relative to production costs in other parts of the country or import markets. Management to grow large trees for high quality, high value lumber or other resource values is an option chosen for many units in the Two Bit project. This management scheme is also consistent with principles to reduce fire severity within stands and maintain stand health and vigor.

Plantations in or adjacent to LSR that have been identified as NSO foraging habitat would have a lighter thinning to maintain habitat with greater than 50 percent canopy and at least 120 square feet of basal acre. This thinning would maintain the SDI below 55 percent of maximum for approximately 20 years, but SDI would climb to around 61 percent of maximum in 30 years. The QMD would increase (based on the modeling, slightly more than the heavier thinning due to the higher proportion of trees with 14-15 dbh retained) and the stands would benefit from an improved fire resilient structure. Natural stand that are presently foraging habitat would maintain those characteristics post treatment.

Off-site ponderosa pine plantations or those at high risk to bark beetles would have heavy thinning to reduce the amount of pine relative to other species in the stands and capture imminent mortality (Sample Units 11, 51, 97). Aggressive thinning of off-site pine trees would occur in these pine plantations throughout the stand including right up to steam banks (although no commercial harvest would occur in any inner gorges); trees contributing to streambank stability would not be removed.

DF plantations near ridges would have heavier thinning to reduce risk of crown fire to a greater extent (Sample Unit 33). Other stands identified by the Two Bit IDT as having stand health concerns or located in areas where access is unfeasible would also be expected to be thinned well below the desired level of 55 percent of maximum SDI to maintain lower densities for at least 30 years as modeled by FVS (Sample Unit 31).

Table 22 displays SDI of sample stands by existing condition, post treatment in 2014 and post treatment in2039.

Table 22. Alternative 2, comparison of SDI for Existing Condition, Post Treatment (CT and UB), and 30 Years Out

Stand example Unit #	Existing condition SDI (percent of maximum for dominant species)	2014 (Post CT & fuels treatment) SDI (percent of maximum)	2039 (30 years after thinning) SDI (percent of maximum)	Meets Desired Condition in 30 years; stand maintained below desired 55 percent of maximum SDI
11 - PP plantation	371 (PP - 86%)	127 (29%)	182 (42%)	yes
31 - DF plantation	352 (DF - 64%)	129 (24%)	215 (39%)	yes
33 - DF plantation	337 (DF - 62%)	113 (21%)	197 (36%)	yes
48 - DF plantation	323 (DF - 59%)	126 (23%)	243 (44%)	yes
51 - PP plantation	410 (PP - 95%)	100 (23%)	164 (38%)	yes
97 (LSR) - PP plantation	269 (PP - 63%)	110 (26%)	150 (35%)	yes
100 - DF plantation	334 (DF - 61%)	161 (29%)	256 (47%)	yes
108 (LSR) - DF plantation	322 (DF - 59%)	217 (40%)	321 (59%)	yes
110 - DF plantation (not foraging habitat)	315 (DF - 56%)	173 (32%)	282 (52%)	yes
110 – DF LSR/foraging habitat prescription	315 (DF - 56%)	191(35%)	333 (61%)	No[1]
201 - DF natural	544 (DF - 99%)	266 (48%)	326 (60%)	No[1]
206 - DF Natural	511 (DF - 93%)	245 (45%)	304 (55%)	Yes
213 - DF natural	517 (DF - 95%)	313 (57%)	308 (56%)	yes with mortality

Stand example Unit #	Existing condition SDI (percent of maximum for dominant species)	2014 (Post CT & fuels treatment) SDI (percent of maximum)	2039 (30 years after thinning) SDI (percent of maximum)	Meets Desired Condition in 30 years; stand maintained below desired 55 percent of maximum SDI
225 - DF natural	355 (DF - 65%)	204 (37%)	265 (48%)	yes
227 (dense patches) - DF natural	428 (DF - 78%)	259 (47%)	312 (57%)	No[1]
234 - DF/BO natural	302 (DF - 55%) (BO - 79%)	158 (DF-29%) (BO-41%)	225 (DF-41%) (BO-59%)	DF yes; BO No[1]
238 - DF natural	436 (DF - 80%)	276 (50%)	273 (50%)	yes with mortality
255 - DF natural	398 (DF - 73%)	243 (44%)	309 (56%)	yes
Weighted Average	**69%**	**30%**	**45%**	**Yes; met in most stands; moving towards desired in all stands**

[1] However, prescribed treatment substantially moves stand towards desired condition

Insects and Disease

Thinning in this project would remove many smaller insect- and disease-infected trees; crown thinning in dense clumps would remove some of the moderate size trees which are infected.

Phellinus (*Phellinus pini)* rots the heart wood and provides habitat for cavity nesting wildlife, particularly in larger trees; ninety-nine to one hundred percent of the largest dominant and predominant trees with *Phellinus pini* will remain after treatment because prescriptions include retention of these trees even if they are diseased. Reduction in competition for water and nutrients by removing infected and other trees would leave more resources remaining for trees to produce chemicals or structural changes which limit the spread of *Phellinus pini* or other diseases.

Velvet top fungus causes severe root and butt decay. It is most often found on older Douglas-fir within the project area and consequently few if any trees infected with this disease are likely to be thinned in this project. Velvet top can be spread through fire scars, root wounds, and root grafting making it important to limit residual tree damage when thinning and underburning. Thinning will reduce root overlap and root grafting to a small degree. However, the largest benefit to thinning related to this disease would likely be reduction in competition for resources so that trees that are uninfected would remain vigorous with the ability to resist further infections.

One of the recommended management techniques for several root diseases, some that affect Douglas-fir, is to improve the host tree vigor (Fillip 1990). One way to do that is to reduce competition by thinning while taking precautions not to produce conditions that could exacerbate a situation where root disease is already present. Many of these root diseases are present on the District, but do not appear often, or at least are not obvious, in the project area. Thinning prescriptions for the Two Bit project would consider any new information provided by Forest Service insect and disease specialists from the California region as needed.

Various research studies show the positive impact of thinning for reducing competition related to insect attack. There is a strong relationship between high densities and pine beetle attack for ponderosa (Fillip 2005, Oliver 1995, Fettig 2006). For sugar pine, from local observation and discussions with other silviculturists and pathologists, a similar relationship exists between density and pine beetles.

Management options to reduce the spread of Black Stain root disease include maintaining mixed species and increasing the spacing between trees so that root to root contact is limited (Wood 2003). When thinning, utilizing techniques that limit soil compaction can help prevent new infections. These techniques would be used for implementing alternative 2, including reusing existing skid trails and existing roads whenever possible and use of equipment that exerts low ground pressure (such as mechanical harvesters) where possible (see project design features-Chapter 2).

Some scientists have suggested caution in using thinning to control various insects (Black 2005). Awareness needs to be maintained concerning possible unintended consequences such as physical injury, soil compaction, temporary stress (thinning shock) due to changed environmental conditions, or excess slash available for breeding habitat which could result in susceptibility to certain insect and pathogens (Black 2005). Past wildfire or treatment underburning may also lead to weakening of residual trees making them more susceptible to insects or pathogens (Schmitt 2005). However, with knowledge of these potential risks, prudent silvicultural treatment can be implemented to minimize potential unwanted consequences (Fettig 2006, Filip 1990). Under alternative 2, actions such as designating skid trails in locations that reduce residual tree damage, applying borax to true fir stumps, and thinning from below to leave the larger trees would be used to minimize the potential for adverse impacts.

Changes in QMD and TPA

Diameter growth is very sensitive to changes in growing space (Oliver 1996, pg 346). As suppressed trees die, the average tree size increases. Growing space attained by dominating trees equals that relinquished by trees undergoing suppression, since the growing space stays about the same in a stand (Oliver 1996, pg 345). In plantations where trees have little difference in crown position (undifferentiated stands), thinning at younger ages, when crowns are relatively large, increases rate of growth response to thinning (Oliver 1996, 348). Most of the plantations in the Two Bit project still have crown ratios of 40 percent or greater on the best codominant trees and

would respond well to thinning. Denser portions of all plantations are experiencing reduction in crowns due to competition. The decrease is quite noticeable in plantations where the calculated SDI is over 60 percent. In natural stands, crown ratios vary greatly from 10 to 90 percent because of the irregular spacing and different ages. Trees with the poorest crowns would be identified for removal.

An average of approximately 40-50 percent of the trees that would be removed during treatments would be small trees less than 6 inches dbh. The increase in QMD from 2009 to 2014 (table 23) is mostly due to the "thinning effect" of removing smaller trees and leaving larger trees. Increase in QMD (table 23) due to the thinning effect still has a positive effect on stand structure relative to improved fire resiliency. Removal of the smaller trees concentrates growth on the remaining larger trees and removes many suppressed, unhealthy trees from the stands.

Table 23. Alternative 2 comparison of TPA and QMD for existing condition, post treatment in 2014, and post treatment in 2039

Stand Example Unit #	TPA - QMD, 2009 existing condition	2014 TPA - QMD	2039 TPA - QMD	Decrease in TPA and increase in stand QMD at year 2039 compared to the existing condition
11 - PP plantation	429 - 9.1	62 - 15.7	52 - 21.7	377 TPA - 12.6 inches
31 - DF plantation	446 - 8.6	74 - 14.2	65 - 21.0	381 TPA - 12.4 inches
33 - DF plantation	452 - 8.3	84 - 12.0	69 - 19.2	383 TPA - 10.9 inches
48 - DF plantation	464 - 8.0	69 - 14.6	81 - 19.8	383 TPA - 11.8 inches
51 - PP plantation	383 - 10.4	56 - 14.3	69 - 17.1	314 TPA - 6.7 inches
97 (LSR) - PP plantation	399 - 7.8	53 – 15.9	45 - 21.1	354 TPA - 13.3 inches
100 - DF plantation	280 - 11.2	70 - 16.8	67 - 23.0	213 TPA - 11.8 inches
108 (LSR) - DF plantation	190 - 13.9	78 - 19.0	71 - 25.5	119 TPA - 11.6 inches
110 (LSR) - DF plantation (not foraging habitat)	260 - 11.3	85 - 15.6	75 - 22.8	185 TPA - 11.5 inches
110 – DF plantation	260 - 11.3	108 - 15.6	87 – 23.0	80 TPA - 11.7 inches

Stand Example Unit #	TPA - QMD, 2009 existing condition	2014 TPA - QMD	2039 TPA - QMD	Decrease in TPA and increase in stand QMD at year 2039 compared to the existing condition
(LSR/foraging habitat prescription)				
201- DF natural	394 - 12.2	72 - 22.6	84 - 23.2	310 TPA - 11.0 inches
206 – DF natural	341 - 12.9	77 - 20.6	66 - 25.9	275 TPA - 13 inches
213 - DF natural	110 - 26.3	41 - 35.5	34 - 39.6	76 TPA - 13.3 inches
225 - DF natural	253 - 12.3	45 - 25.8	51 - 27.9	202 TPA - 15.6 inches
227 (clumps) - DF natural	206 - 15.8	67 - 23.2	62 - 27.3	144 TPA - 11.5 inches
234 - DF/BO natural	135 - 16.5	53 - 19.8	50 - 25.4	85 TPA - 8.9 inches
238 - DF natural	81 - 28.6	35 - 36.3	29 - 40.1	52 TPA - 11.5 inches
255 - DF natural	264 - 12.9	69 - 21.9	67 - 25.9	197 TPA - 13 inches
Weighted Average	**357 - 11**	**70 – 16.7**	**66 – 22.4**	*All stands would show reduction in TPA and increased QMD after treatment, moving stands towards desired conditions*

Thinning differs from natural death by suppression in stands by varying extents depending on age of the stand thinned and the trees removed. In young stands, trees which die from suppression usually occupy little growing space by the time they die; consequently, surrounding trees do not expand extensively before refilling the growing space. Thinning under alternative 2 would reduce density (TPA) more than self-thinning so that growth would increase and crowns would remain about 40 percent live crown ratio and the QMD would increase at a greater rate (refer to table 23) as compared to the no action alternative.

In older stands, suppressed trees can occupy more growing space at the time of death. Growing space released in a silvicultural thinning can mimic natural death if suppressed trees are removed shortly before they die. If suppressed trees are small, little growing space is release by removal of these trees and more dominant trees do not grow dramatically faster. Where

suppressed trees are larger, increased growth of residual trees upon death or thinning of suppressed trees is more dramatic because more growing space is released. Removal of progressively more dominant trees by thinning releases more growing space, and creates a longer time before the site is occupied again (Oliver 1996, pg 350). In older stands in the Two Bit project, thinning under alternative 2 would generally be from below, but would remove a combination of suppressed, intermediate, and codominant trees to reduce density without leaving these older stands below site occupancy for many years.

Underburning

Underburning treatments outside of harvest units are not included in table 23, but would slightly decrease the SDI of stands with larger trees. Burning would have a greater effect on density of smaller-sized vegetation within stands or shrub types because small plants are more easily killed by fire. Underburning outside of harvest units representing various stand types was modeled for the fire and fuel report (Isbell 2010).

Underburning would reduce the trees, hardwood, or amount of brush per acre, with the most mortality in vegetation under 6 to 8 inches in diameter. A few larger trees could also be damaged and later die in higher burn intensity patches. As underburning kills mostly smaller vegetation, within conifer stands, the QMD would likely be slightly higher post treatment. Plantation trees are more likely than natural older stands to sustain fire damage during treatment depending on the site preparation completed when the stands were planted. The younger plantation trees have thinner bark and are more easily damaged. Very young plantations that have not reached canopy closure or a stem exclusion stage have branches near ground level and can torch easily. Underburning would reduce stand density to some degree, reduce surface fuel in the short or long term, and would allow the natural process of fire to be returned to the ecosystems.

Underburning outside of harvest units would create small openings and reduce understory vegetation. Effects would vary depending on vegetation type and flammability, aspect, elevation, fuel accumulations, and weather conditions during the burning. At a fine scale, underburning would generally increase variety of conditions within stands allowing new age groups or species from earlier successional stages to emerge, or regeneration of existing species,. Likewise, in other areas, developing understory would be burned leaving some stands more single storied. Canopy uniformity could be reduced in younger stands that are more susceptible to fire. Burning would reduce surface fuels in the short term and could produce additional surface fuel overtime as dead material falls, particularly in areas where a larger proportion of dense vegetation would be killed.

Specialized Treatments (hardwood release, pole harvest, sanitation)

Thinning in stands 301 and 302 would reduce density to the degree that people chose to harvest poles in that area, but thinning would likely be small amounts over time. Although the difference might not be great, it would be an incremental step towards reducing fire risk and improving

stand conditions. In stand 400, thinning would be heavier to maintain the SDI at 55 percent of maximum for black oak and pine and vigor of those species would be expected to noticeably increase over the long term.

Meadow Enhancement

Alternative 2 would include removing encroaching trees along the edges of natural meadows in fifteen areas resulting in restoration of more natural meadow conditions similar to past conditions before fire suppression.

Roads and Skid Trails

Effects from creation of temporary roads and skid trails would be minimal. Some trees would be wounded along skid trails, but effects would be minor. If trees are wounded badly enough to cause long-term damage, they would be removed in the harvest. Careful planning during implementation would avoid all but minor damage. The width of skid trails and temporary roads would be less than the average spacing between trees, so the transportation system result in little impact to the stand. Soil compaction would be increased in main skid trails and temporary roads, but can be minimized by avoiding use during wet periods and reusing existing skids (Walters 2010). Skid trails typically revegetate within a few years and often have good conifer regeneration because conifers seed best on bare mineral soil. Thinning would benefit the entire stand, while the area with potential compaction would be less than 15 percent.

Road decommissioning would have little direct effect on vegetation within the project area. These roads are currently not usable due to a lack of maintenance and slides/washouts during floods.

Cumulative Effects

All past activities or events affecting forest vegetation were considered in the description of the existing condition. Within the Indian Creek Watershed, in-progress or planned activities with a similar purpose and need as the Two Bit project are considered cumulative effects for the purpose of this analysis. Underburning and thinning from these projects would total approximately 3,345 acres. Additional density reduction and fuels treatment proposed in the Two Bit project would potentially add 9,372 treated acres. The additional treatments would result in nearly 15 percent of the Indian Creek Watershed having some treatments that move stands towards the desired condition.

Alternative 3 – No Temporary Roads

Direct/Indirect Effects

Alternative 3 would thin 270 fewer acres, and would underburn 70 more acres outside of thinning units as compared to Alternative 2. The units that would not be thinned in Alternative 3 are 138 acres of plantations (Units 1, 12, 18, 36, 53, 121) and 132 acres of natural stands (Units 206, 209, 211, 219, 227, 242, 253, 256, 257, 258). Units 12, 206, 209,244, 256, and 258 are

within proposed underburns in Alternative 2 and would be underburned without thinning in alternative 3. Underburning alone in these 6 units would reduce surface and ladder fuels, but would only slightly reduce the stand density and would not reduce the SDI to below 55% of maximum in the short or long term.

The direct and indirect effects for the individual units (totaling 1,710 acres) that would be thinned with subsequent underburning in Alternative 3 would be the same as the effects for those same units under Alternative 2. The silvicultural prescriptions would not change for individual units and the modeling for the representative sample stands would be the same. Prescriptions for underburning, specialized treatments and meadow enhancement would also be the same and have the same direct and indirect effects. Design Features and Mitigation Measures would be the same, except that borax would be applied to approximately 54 fewer acres that would not be harvested as compared to alternative 2.

For alternative 3, approximately 1,679 acres would meet the objective of maintaining an SDI of below 55 percent of the maximum for 30 years. In comparison, this is approximately 90 acres less than what would meet that objective in alternative 2. Increases in stand QMD's would range from 1.3 to 10.9 inches more than under the no action alternative. Approximately 1,526 acres of dense plantations would be thinned as compared to 1,664 acres for alternative 2.

Thinning with subsequent underburning of the 1710 acres proposed in alternative 3 would result in a decrease in stand density on approximately two and a half percent of the acres within the project area, slightly less than alternative 2. The percent of changes for WHR density classes presented for the existing condition would be less than one percent because post harvest canopy closures would not change enough to be moved to a lower category for most of the stands.

Stand treatments would generally have little effect on vegetation outside of the stand boundaries. Reductions in fuel hazards and reduction in damaging agents, such as pine beetles or dwarf mistletoe, are expected to have some benefits to adjacent stands in the short and long term.

Cumulative Effects

All past activities or events affecting forest vegetation is considered in the description of the existing condition. Within the Indian Creek Watershed, in-progress or planned activities with a similar purpose and need as the Two Bit project are considered cumulative effects for the purposed of this analysis. Underburning and thinning from these projects would total approximately 3,345 acres. Additional density reduction and fuels treatment work proposed in the Two Bit project under alternative 3 would potentially add 9,330 treated acres. The additional treatments would result in nearly 11 percent of the Indian Creek Watershed having some type of treatment that positively impacts fire behavior as compared to 15 percent under alternative 2.

Alternative 4 – Minimized Underburning

Direct and Indirect Effects

Direct/indirect effects from implementing Alternative 4 are similar to Alternative 2 and 3 in regards to thinning and underburning and the results to measurement indicators. Alternative 4 would commercially thin 1,980 acres in plantations and natural stands the same as Alternative 2. However, mastication after harvest is proposed instead of underburning on 1,490 acres. Alternative 4 would include underburning outside of harvest units on 570 acres as compared to 7,250 acres proposed for underburning in Alternative 2. Other specialized thinning and Meadow enhancement treatments would be the same as Alternative 2.

Mastication

Mastication would affect primarily sub-merchantable trees and would have similar effects in reducing density as would underburning, however there would be some variation in treatment patterns. Mastication machinery cannot navigate steep pitches within units including those that may be steeper ground past the break in slope in Riparian Reserves toward streams. In thinning units, less of the steeper inclusions would have reduction of small diameter material from this fuels treatment. However, where the remaining leave trees are not too dense for the machine to operate, mastication is more likely to kill the unwanted vegetation and result in a more thorough job of reducing density in the understory. The same percentage of the ground may be treated because underburning would likely not kill small diameter vegetation within units where there is inadequate material to carry fire. In burning units where the machine could access, mastication only would result in a more continuous and precise thinning treatment compared to underburning alone. However, thinning slash would remain as surface fuel although in a different arrangement than if material were hand felled and left.

The ecological effect of mastication and similar techniques vary depending on the size, composition, and location of fuels left after treatment (Graham 2004).

The fuels assessment (see Fuels section later in this chapter) notes that mastication would be less effective in reducing fuel hazards after thinning when compared to underburning. Information on the long-term effects of mastication on soil productivity is still sparse (Walters 2010). Graham notes that the ecological effect of mastication and similar techniques vary depending on the size, composition, and location of fuels left after treatment (Graham 2004). Thin layers may dry and rewet readily and deep layers may have insufficient air circulation to decompose. When layers of small woody material are spread on the forest floor and decomposition does occur, large amounts of nitrogen are utilized reducing its availability to plants (ibid). Based on analysis in the Soils Report, mastication is assumed to have similar effects on soil productivity as does harvesting with established skid trails and resulting in 3 percent additional disturbance; mitigation for these effects includes the same practices and BMP’s to reduce soil disturbance as for ground based harvesting.

Underburning

Alternative 4 would have 570 acres of underburning outside of harvest units. This underburning was not modeled in FVS for the vegetation analysis, but would slightly decrease the SDI of stands with larger trees. Burning would have a greater effect on density of smaller-sized vegetation within stands or shrub types because small plants are more easily killed by fire. Underburning outside of harvest units representing various stand types was modeled for the fire and fuel report (Isbell 2010). Overall, underburning would reduce stand density to some degree, reduce surface fuel in the short or long term, and would allow the natural process of fire to be returned to the ecosystems. A reduction of underburning in 6,680 acres under alternative 3 as compared to alternative 2 would reduce these benefits of burning.

Cumulative Effects

All past activities or events affecting forest vegetation are considered in the description of the existing condition. Within the Indian Creek Watershed, in-progress or planned activities with a similar purpose and need as the Two Bit project are considered cumulative effects for the purposed of this analysis. Underburning and thinning from these projects would total approximately 3,345 acres. Additional density reduction and fuels treatment work proposed in the Two Bit project would potentially add 2,850 treated acres. The additional treatments would result in only 3 percent of the Indian Creek Watershed having some type of treatment that positively impacts fire behavior as compared to 15 percent for alternative 2.

Summary

Alternative 1

Stands proposed for treatment would remain dense and individual tree growth would continue to decrease. All stands proposed for thinning are presently at or over the desired 55 percent of the maximum SDI for the dominant or desired species and some stands are approaching maximum densities. These stands are experiencing inter-tree competition that slows growth, decreases vigor, and decreases the trees' ability to produce defensive compounds and accumulate reserves. Over the next 30 years as modeled using FVS (table 24), density-related mortality (self-thinning) would continue with between 36 to 70 percent of the trees dying over that period. Some of the stands that contain mostly older trees would have a net loss in basal area over the 30 year period. Although many of the trees that die would be small, surface fuels are expected to increase, dramatically in some stands, resulting in increased fire severity within stands if a wildfire were to occur (Isbell 2010). Diameter growth would continue, but at a slower rate than if trees had more growing space. Snow damage and bark beetle mortality would worsen in the pine plantations and heavy losses would be expected over the 30-year period. Mortality from breakage or beetles would leave large concentrations of dead material that would be too difficult to remove by hand because of the relatively large size of trees that would die.

None of the dense plantations would be treated. In the densest stands an opportunity would be lost to thin these plantations while crown ratios are still good and trees would respond quickly to reoccupy the additional growing space. In all stands, many smaller trees that are, or are becoming suppressed would remain in the stands and continue to utilize resource with little growth return. For all stands, the QMD would continue to increase.

Overall, alternative 1 would not meet project objectives for a fire-resilient ecosystem with sustainable densities. No timber products would be produced from alternative 1 and management activities would not be implemented to move stands toward desired conditions as outlined in the Forest Plan.

Alternative 2

Treatments would maintain the SDI at or below 55 percent of the maximum for the dominant species in approximately 94 percent of thinning units; these stands would meet density reduction project objectives. Stand 227 and stands similar to Unit 201 would be maintained below an SDI of 55 percent for 20 to 25 years. Stands similar to 213 and 238 with a majority of the trees over 20 inches in diameter would continue to have a low level of mortality after thinning which in combination with the thinning would keep stands under the 55 percent level for 30 years. This level of mortality is acceptable for these older stands and the basal area would remain steady over the next 50 years. Inter-tree competition would decrease and result in improved stand vigor and increase the trees' ability to produce defensive compounds and accumulate reserves. Diameter growth would increase in young stands and be maintained or improved in older stands. Mortality would be maintained at low levels and would not create a fuels risk. Future potential mortality would be utilized for wood products. Increases in the QMD for the stands proposed for thinning would be between 1.3 inches to 10.9 inches more than the no action alternative in a 30-year period. Approximately 1,664 acres of dense plantations would be thinned. Thinning in the LSR would increase the QMD an average of about 4 inches over the no action alternative. Plantations would be thinned when crown ratios are still high and trees can respond well from thinning. Off-site ponderosa pine and white fir would be reduced relative to other species in stands.

Thinning with underburning would reduce stand density to levels where competition for site resources would be reduced over present levels. Individual tree vigor and growth would be expected to increase over the next 10 years and be maintained for around 30 years with the additional growing space available. When trees have more resources available, they have the ability to produce higher amounts of defensive compounds to defend against attack from insects and some diseases. Thinning would also change the stand structure in a way that reduces potential severity from wildfire by raising the crown base, reducing the crown bulk density, reducing the high number of small trees, and increasing the average stand diameter. Stand QMD would be increased because many of the smaller trees would be removed and because growth of the remaining trees would increase with the additional growing space.

Overall, alternative 2 would meet project objectives to reduce densities, maintain hardwood diversity and protect mid and early-seral stands from loss due to wildfire. Alternative 2 would produce timber products and maintain good growth rates, minimize insect and disease damage, and accomplish maintenance thinning in plantations. In the LSR, plantation thinning with underburning would accelerate development of late successional habitat by providing trees enough growing space to maintain good growth or to grow large more quickly; reduction in hazardous fuels conditions would increase the chance that stands can be maintained through a wildfire.

Table 24. Comparison of no action alternative and alternative 2, SDI and increase in QMD for sample stands

Unit # of Stand example – species and stand condition	No Action Alt. SDI of 55 percent of maximum SDI in 2039	Alt 2 SDI of 55 percent of maximum SDI in 2039	No Action Alt. Increase in QMD 2009 – 2039 (inches)	Alt. 2 Increase in QMD 2009 - 2039
11 - PP plantation	No	Yes	5.5	12.6
31 - DF plantation	No	Yes	9.7	12.4
33 - DF plantation	No	Yes	8.3	10.9
48 - DF plantation	No	Yes	6.6	11.8
51 - PP plantation	No	Yes	8.8	6.7
97 (LSR) - PP plantation	No	Yes	4.8	13.3
100 - DF plantation	No	Yes	8.0	11.8
108 (LSR) - DF plantation	No	Yes	6.1	11.6
110 (LSR) - DF plantation	No	Yes	8.7	11.5
201- DF natural	No	No	7.2	11.0
206 DF Natural	No	Yes	9.2	13.0
213 - DF natural	No	Yes	9.3	13.3
225 - DF natural	No	Yes	4.7	15.6
227 (clumps) - DF natural	No	No	7.3	11.5
234 - DF/BO natural	No	DF - Yes, BO - No	7.6	8.9
238 - DF natural	Yes	Yes	9.3	11.5
255 – DF natural	No	Yes	5.3	13.0

Alternative 3

Alternative 3 would thin 270 fewer acres, and would underburn 70 more acres outside of thinning units as compared to Alternative 2. The direct and indirect effects for the individual units (totaling 1,710 acres) that would be thinned with subsequent underburning in Alternative 3 would be the same as the effects for those same units under Alternative 2. Fifty-one acres that

would be thinned and underburned in alternative 2 would be only underburned in alternative 3. While the these acres would have some reduction in density of small trees and a reduction in surface fuels, the underburning is not as effective in meeting desired condition for the stands as it thinning with subsequent underburning. Prescriptions for underburning, specialized treatments and meadow enhancement would also be the same and have the same direct and indirect effects.

Under Alternative 3 approximately 1,670 acres would meet the objective of maintaining an SDI of below 55 percent of the maximum for 30 years. In comparison, this is approximately 90 less acres then what would meet that objective in Alternative 2. Increases in stand QMD's would range from 1.3 to 10.9 inches more than under the no action Alternative; this increase is similar to Alternative 2, except 270 less acres would be thinned as compared to Alternative 2 and would not have the increased QMD. Approximately 1,526 acres of dense plantations would be thinned compared to 1,664 acres for Alternative 2.

Alternative 4

Alternative 4 would commercially thin 1,980 acres in plantations and natural stands the same as Alternative 2. However, mastication after harvest is proposed instead of underburning on 1,490 acres. Alternative 4 would include underburning outside of harvest units on 570 acres as compared to 7,250 acres proposed for underburning in Alternative 2. Other specialized thinning and Meadow enhancement treatments would be the same as Alternative 2.

Alternative 4 would thin and underburn on approximately 506 acres where a masticator could not be used due to topography. Thinning and underburning would best meet conditions that would result in reduced surface fuels and fire hazard. Thinning with mastication on approximately 1,490 acres would meet project objectives for density reduction and resulting benefits, with the exception that it would have a reduced value for fuels reduction.

Underburning outside of harvest units would be accomplished on 6,680 less acres as compared to alternative 2 and on 6,750 less acres compared to alternative 3. On the 570 acres that would be burned, underburning would reduce stand density to some degree, reduce surface fuel in the short and long term, and would allow the natural process of fire to be returned to the ecosystems.

3.4 Fire and Fuels

3.4.1 Methodology

Fuels, weather and topography influence how a fire will burn. Hazards associated with weather and topography cannot be changed but fuel loading, vegetation structure and vegetation composition can be modified to affect fire behavior and how fire effects stand conditions.

For this analysis, the Fire and Fuels Extension to the Forest Vegetation Simulator (FFE-FVS) was used to evaluate the predicted effects of implementing any one of the alternatives over a 40-year period. FFE-FVS is a model linking stand development, fuel dynamics, fire behavior, and

fire effects. This model was used to compare effects of the management alternatives and describe current conditions for the Two Bit project. Inputs for the modeling were obtained through field observations, plot data, and photo series (Maxwell and Ward 1980).

Flammap is a fire behavior mapping and analysis program used to analyze fire behavior characteristics (spread rate, flame length, fire type, etc.) over an entire landscape with constant weather and fuel moisture conditions. Flammap was used as a spatial model to look at crown fire potential, rate of spread, and flame length potential under defined burn conditions. It was also used to help describe current fuel model conditions associated to fire behavior.

Mastication under alternative 4 was assumed to have flame lengths similar to the no action alternative. This was determined due to the compactness of masticated fuels not adding to surface flame length, although fuel loading increases. FVS-FFE requires years to be modeled in order to interpret results.

Years modeled (2009 for thinning and 2014 for underburning) does not necessarily indicate when actual implementation will occur. The silviculture treatments and underburned areas were grouped by aspect (southwest and northeast) and stand type (plantation and natural) to address differing fire regimes and vegetation characteristics within the project area. South and west facing slopes were used due to more intense fire behavior and effects under current conditions. Similar trends in each measurement indicator were noticed regardless of aspect or vegetation type.

The current condition for each stand category provides a baseline for all treatment alternatives. It is anticipated that all proposed treatments other than thinning (i.e. underburning, mastication, etc.) would occur within 3 to 5 years post thinning. In this analysis fuels treatments are assumed to occur 5 years after silviculture treatment. This analysis builds upon the silviculture treatments and analysis in the vegetation report (Sharp 2010). Field observations, plot data, and photo series were collected for representative stands for plantations and natural stands. The analysis of potential fire behavior and stand characteristics is based on the interpretation of the FFE-FVS results. Each alternative is analyzed every 20 years (2009, 2029, and 2049) and for the underburn treatment year (2014).

Fire behavior and effects are defined under 50th percentile (dry or moderate) and 90th percentile (very dry or severe) conditions by aspect.

To model and predict fire behavior, fuels are often broken into fuel models that are mathematically put into a fire spread calculation of Rothermel 1972. GIS layers of the Stewardship and Fireshed coverage of the California Fuels Landscape were obtained to analyze current fuel models within the project boundary.

Fire hazard is a source of danger characterized by fuels. Wildland fire danger can be characterized by how a wildfire will burn or fire behavior. Hazardous fuels are excessive live or dead wildland fuel accumulations that increase the potential for uncharacteristically intense wildland fire and decrease the capability to protect life, property, and natural resources (USDI and USDA 2006). Therefore, when assessing wildland fire hazard, fuels and the resultant fire

behavior are the focus of the fire hazard analysis. The Forest Plan describes hazardous fuels and potential flame lengths as low, moderate, and high for use as indicators of potential fire behavior and resistance to control for fire suppression purposes. The following describes the fire hazard classes used in the Forest Plan that are also used in this section to evaluate the alternatives:

- Low Hazard - Flame lengths less than four feet and rate of spread less than 30 chains per hour: Fires can generally be attacked at the head or flanks by firefighters using hand tools. Hand line should hold the fire.
- Moderate Hazard - Flame lengths from 4 to 8 feet: Fires are too intense for direct attack at the head of the fire by firefighters with hand tools. Hand line cannot be relied on to hold the fire. Equipment such as dozers, engines, water and/or retardant support from aircraft can be effective.
- High Hazard - Flame lengths are greater than 8 feet: Fire would present serious control problems, such as torching, crowning and spotting. Control efforts at the head of the fire may be ineffective.

The alternatives are compared using the following indicators.

- Fire Behavior and Effects
    - Basal area mortality (percentage of basal area mortality that could be expected in a stand with a given species composition and structure under defined burning conditions)
    - Surface flame length (a visual and measurement indicator of surface fire intensity. Flame length is defined as the distance along the slant of the flame from the midpoint of its base to its tip)
- Fire type
    - Surface fire (S) – The fire remains on the forest floor. The combination of surface fire intensity and ladder fuels is not sufficient to move a fire into the crowns under the defined burning conditions.
    - Passive crown fire (P) – Individual tree or group torching occurs. The combination of surface fire intensity and ladder fuels allows for movement into the crowns under the defined burning conditions, but canopy bulk density is too low for fire to spread through the crowns under the projected wind speeds.
    - Active crown fire (A) – The combination of surface fire intensity, ladder fuels and canopy bulk density allows fire to move into, and spread through, the crowns under the defined burning conditions.
    - Conditional crown fire (C) – Canopies are dense enough to carry fire with the projected wind speeds, but the surface fire intensities and ladder fuels do not allow movement into the crowns. Crown fires may move into the stand from outside, but cannot be initiated from within the stand under the projected wind speeds.
- Stand Structure, Composition and Size
    - Crown bulk density is a measure of the compactness of tree crowns. It is defined as the mass of available canopy fuel per unit canopy volume. It is a bulk property of a stand, not an individual tree, and is represented as the available canopy fuel load divided by canopy depth (Scott and Reinhardt 2001). For any given species, more widely spaced trees have a lower canopy bulk density, which makes it more difficult to maintain crown fires. A canopy bulk density of less than 0.10 kg/m3 is recommended to minimize crown fire hazard (Graham et

al 1999). In general, stands on north aspects have higher canopy bulk densities, with greater portions of stands exceeding 0.10 kg/m3.

- Canopy base height is used as a measure of ladder fuel structure within a stand. It is defined as the lowest height above the ground at which there is a sufficient amount of fuel to propagate fire vertically into the canopy (Scott and Reinhardt 2001).
- Average stand diameter is used as a measure of the proportion of small and large trees in the stand.

The information used in the preparation of this section, including detailed results of model runs, comes from detailed analysis in the Fire and Fuels Report (Isbell 2010) and is available in its entirety in the project record.

3.4.2 Affected Environment

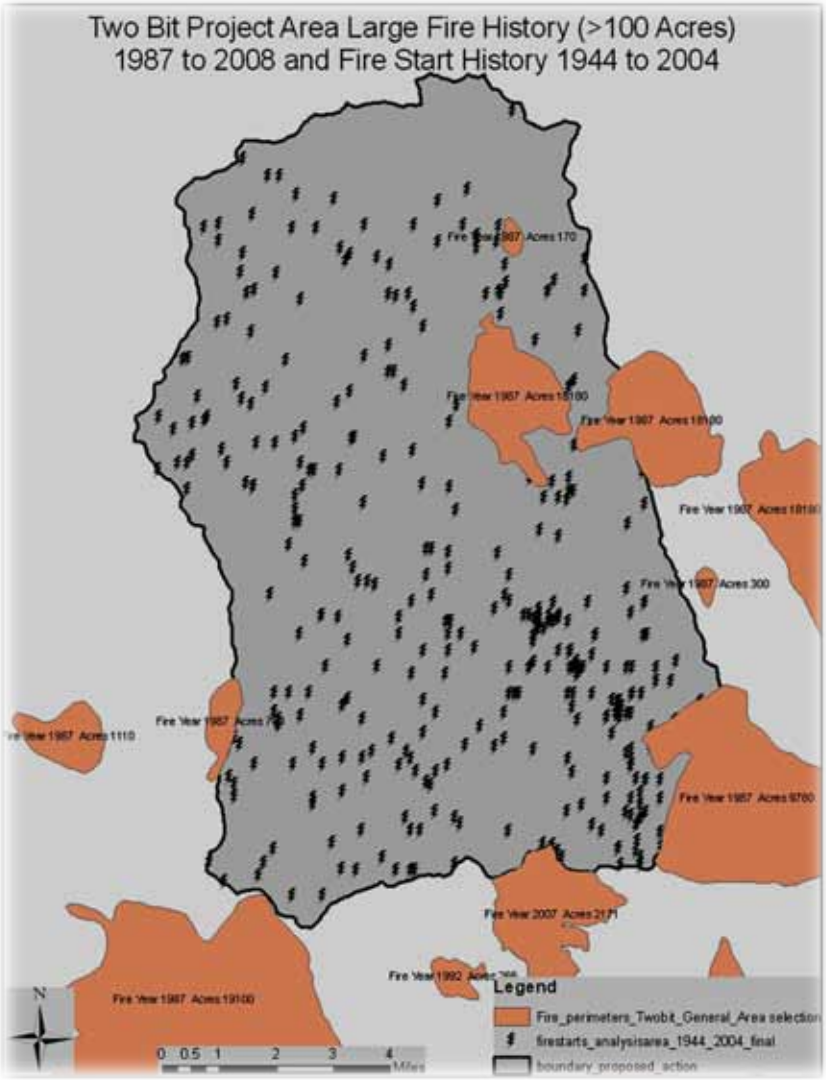
The Indian Creek Watershed Analysis (USDA Forest Service 1997) recommends reduction of stand density and fuels as a major component in maintaining and restoring ecosystem health. It also identified fire as a major disturbance in shaping the historic forest landscape. Implementation of actions that reduce stand and fuel densities and create functioning forests is identified as a priority.

The fire analysis area is the current project boundary. A study of fire history and landscape dynamics was done by Taylor and Skinner (1998) along Thompson Ridge; a ridge system that makes up the eastern boundary of the analysis area. Approximately half the Taylor and Skinner research study area is within the project boundary. The study found that the frequency, extent and severity of fires strongly-influenced forest structure in Douglas-fir dominated stands. The research also concluded that *"Tree species composition varied with elevation and aspect, and median fire return intervals were similar (12–19 years) among species composition groups. However, median fire return intervals (FRI) were shorter on south- (8 years) and west-facing (13 years) slopes than on northern (15 years) or eastern (16.5 years) aspects..... Patterns of past fire severity, inferred from age-classes, indicate that upper slopes, ridgetops, and south- and west-facing slopes experienced more severe fires between 1850 and 1950 than lower slopes or east- and north-facing slopes. Implications are that lower slopes and north and east aspects are more likely than other topographic positions to sustain or promote long-term, late-successional conditions. Prescribed fire will likely be an integral component of management plans that successfully maintain natural processes and structures in newly established late-successional reserves in the Klamath Mountains."*

Climate

The climate of the Two Bit project area is best described as Mediterranean; wet, cool winters and dry, warm summers. Happy Camp, CA receives approximately 54 inches of annual precipitation, primarily between the months of October through April. The higher elevations in the project area receive approximately 61 inches of rain. Summer thunderstorms are common, and can release

significant localized rain. These storms can also be dry with conditions that encourage fire ignition and spread from lightning strikes, with the summer of 2008 being the latest example of this pattern.



Fire History, Hazard and Risk

There have been 17 fires (5 acres or greater in size) that occurred or entered into the project boundary over a sixty year period (1944 to 2004). In this same time period, 367 fire starts have occurred within the project boundary. Figure 8 on this page is a map displaying year and acreage burned in the vicinity of the Two Bit project boundary and fire start locations within the project boundary.

Figure 8. Vicinity of the Two Bit project area large fire history

The Two Bit project area has a moderate fire risk value (between 0.5 and 0.99 fires expected to occur per decade for every thousand acres in the area being analyzed), based on this fire history. The primary source of ignition is lightning (70 percent) and humans (30 percent).

As shown in table 25, currently all stands are above the desired condition of less than 4 feet flame lengths under severe (90th percentile) and moderate (50th percentile) conditions. Flame lengths are similar through all categories, but are higher on average in plantations. Basal area mortality is also generally higher in plantations than in natural stands. Basal area mortality is

highest in south and west aspect plantations. Quadratic mean diameter is highest in natural stands; however, substantial components of smaller trees also exist within these stands.

Table 25. Current conditions based on modeling results from FVS-FFE

Current Conditions									
Aspect	50th Percentile Conditions			90th Percentile Conditions			Average Stand Diameter	Canopy Base Height	Canopy Bulk Density
	Flame Length	Fire Type	Basal Area Mortality	Flame Length	Fire Type	Basal Area Mortality			
North and East	4.6	S	16	5.9	S	40	14	26	0.105
South and West	4.9	S	14	5.6	C	55	13.1	29	0.089

Fire Regime and Historic Reference Conditions (Condition Class)

A natural fire regime is a general classification of how fire played a role in an ecosystem, in the absence of modern human intervention but including the influence of aboriginal burning (Agee 1993, Brown 1995). Coarse scale definitions of fire regimes have been defined by Hardy et al. 2001 and Schmidt et al. (2002) and interpreted for management of fire and fuels by Hann and Bunnell (2001). The five natural (historical) fire regimes as described by historical fire frequency (average number of years between fires) and historical fire severity (the effect of the fire on dominant overstory species) are described in the following table.

Table 26. Descriptions of Historic Natural Fire Regimes

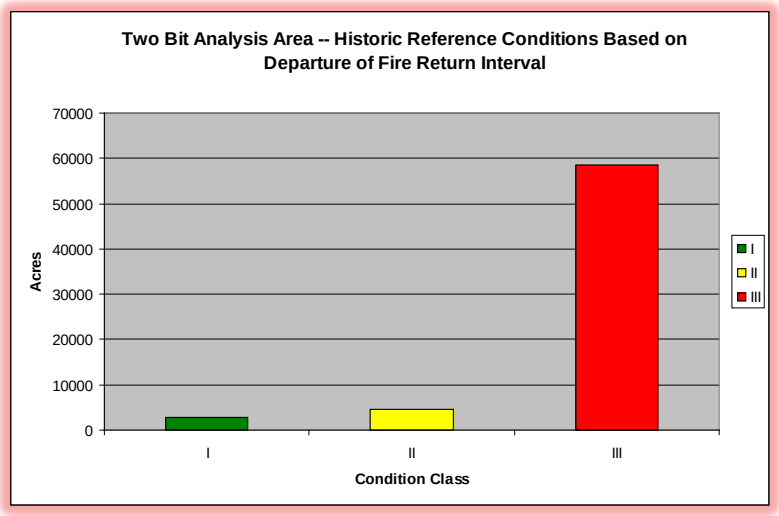
Historical Natural Fire Regimes	
Fire Regime Class	Description
I	0–35-year frequency[a], low and mixed severity[b]
II	0–35-year frequency, stand-replacement severity
III	35–100+ year frequency, low and mixed severity
IV	35–100+ year frequency, stand-replacement severity
V	200+ year frequency, stand-replacement severity

[a-] Fire frequency-the average number of years between fires. [b-] Severity -effect of fire on dominant overstory vegetation.

Historically, vegetation in the project area is the same as it is today (primarily Klamath mixed conifer and Douglas-fir) but seral stage distribution has changed over time. Historically, approximately 95 percent of the analysis area (table 27) supported vegetation at or below a fire return interval (FRI) of 35 years (Fire Regime I) based on Taylor and Skinner (1998) research and FRCC GIS data provided by Max Creasy, Ecologist, Northern California Province (USFS Region 5).

Table 27. Historic Fire Return Intervals in the Project Area

Historic FRI	Acres	Percent of Area
≤ 20	59631	90
>20 and ≤ 35	3305	5
> 35 and ≤ 65	2577	4
>65 and ≤ 100	473	1



Currently, however, approximately 89 percent of the analysis area is in condition class III (severely departed), seven percent is in condition class II (moderately departed), and four percent is in condition class I (within historical range of variability).

Figure 9. Fire Regime Condition Class based on Fire Return Intervals

3.4.3 Environmental Consequences

Alternative 1- No Action

Direct/Indirect Effects

Silviculture treatments and underburning would not occur. Stands in the project area would continue to self- thin and surface fuels would continue to accumulate. Increased amounts of surface fuels would result in increased flame lengths, fire intensity, and mortality.

The FVS-FFE model scenarios (current conditions after 20 years with no management action taken), indicate that fire hazard would remain moderate to high: flame lengths under both severe and moderate conditions would be above the desired condition of 4-foot flame lengths (table 28). This would influence direct attack suppression by needing mechanized equipment to support ground resources, and increase probabilities of crown fire activity. After a 40-year period, the trend in increased fuel loading, flame length, fire intensity, and mortality would continue; under severe (90th percentile) conditions, all stands are projected to be in the high fire hazard category; they would have conditional crown fire with an average flame length over 9 feet. Under moderate (50th percentile) conditions, all stands are projected to be in the moderate to high fire hazard category, having surface fire with an average flame length over 7 feet.

Table 28. Fire behavior measurement indicator results for the no action alternative

No Action Alternative						
Aspect	50th Percentile Conditions			90th Percentile Conditions		
	Flame Length	Fire[1] Type	Basal Area Mortality	Flame Length	Fire[1] Type	Basal Area Mortality
South and West 2009	4.9	S	14	5.6	C	55
South and West 2014	4.8	S	14	5.4	C	59
South and West 2029	5.3	S	9	6.4	C	100
South and West 2049	7.1	S	9	9.7	C	100

1 Fire type S stands for surface and fire type C stands for crown

Table 29. Structure, composition and size measurement indicators for no action

No Action Alternative			
Aspect	Average Stand Diameter	Canopy Base Height	Canopy Bulk Density
South and West 2009	13.1	29	0.089
South and West 2014	14.1	32	0.090
South and West 2029	17.8	42	0.100
South and West 2049	22.7	50	0.086

Modeled results are consistent with field observations. Dense stands, especially plantations, are starting to self thin creating additional fuel loading on the ground. Understory and less vigorous vegetation are becoming shaded out and dying. As trees die and fall, they accumulate as surface fuels, resulting in higher fire intensity.

Cumulative Effects

Vegetation structure would change over time, leading to increased fire hazard as stands continue to grow denser and fuel loading increases. As a result, wildfire-induced tree mortality would also increase. Although the effects of other ongoing and reasonably foreseeable actions within the watershed (see cumulative effects section at the beginning of this chapter) would decrease the density of trees in the watershed, reduce ladder fuels, and slightly decrease the likelihood of crown fire and fire behavior potential, these effects would have little impact on the increased fire hazard over 40 years because of the generally small spatial scale of these projects.

Alternative 2 – Proposed Action

Direct/Indirect Effects

After the stands are thinned (modeled in 2009 but applicable even if thinning does not occur until later, such as 2010-2011), they would still be susceptible to the effects of wildfire. If a

wildfire were to start soon after implementation of alternative 2 treatments, flame lengths would be at or above 4 feet except for natural stands on northeast aspects that are thinned and underburned.

However, FVS-FFE modeling results show that after underburning, by 2014 alternative 2 thinned stands would meet purpose and need and desired conditions under severe and moderate fire conditions. After 20 and 40 years (2029 and 2049) desired conditions would still be met in thinned and underburned stands. In underburn-only stands, flame lengths would exceed the desired 4 feet with all other measurement indicators showing a positive response in meeting the purpose and need. Stands that are both thinned and underburned showed the greatest resiliency to fire behavior and effects based on the modeling results. Table 30 and 31 below shows the results through time for each measurement indicator. Therefore, fire hazard would be reduced with implementation of alternative 2. Under both moderate (50th percentile) and severe (90th percentile) conditions, all stands are projected to be in the low fire hazard category in 2014 with flame lengths less than 4 feet. Fire hazard would remain low through 2049 in thinned and burned units but increases somewhat through 2049 in the units that are burned only, as shown below.

Table 30. Fire behavior and effects measurement indicators for proposed action alternative - Note that the underburn is not modeled until 2014

Alternative 2, Proposed Action						
Fuels Treatment by Aspect	**50th Percentile Conditions**			**90th Percentile Conditions**		
	Flame Length	**Fire[1] Type**	**Basal Area Mortality**	**Flame Length**	**Fire[1] Type**	**Basal Area Mortality**
Thin SW Aspect 2009	4.4	S	9	5.3	S	11
Underburn SW Aspect 2014	2.5	S	7	3.3	S	7
Thin and Underburn SW Aspect 2029	2.2	S	5	2.8	S	5
Thin and Underburn SW Aspect 2049	2.3	S	3	2.9	S	3
Underburn Only SW Aspect 2009	4.9	S	14	5.6	S	55
Underburn Only SW Aspect 2014	3.6	S	10	3.9	S	18
Underburn Only SW Aspect 2029	5.4	S	8	6.0	S	16
Underburn Only SW Aspect 2049	6.8	S	6	8.8	S	17

[1] Fire type S stands for surface and fire type C stands for crown

Table 31. Stand structure, composition and size measurement indicators for proposed action. Note that the underburn is not modeled until 2014.

Fuels Treatment by Aspect	Average Stand Diameter	Canopy Base Height Canopy Base Height	Canopy Bulk Density
Thin SW Aspect 2009	18.4	48	0.042
Underburn SW Aspect 2014	21.6	50	0.035
Thin and Underburn SW Aspect 2029	25.0	51	0.038
Thin and Underburn SW Aspect 2049	29.4	48	0.045
Underburn Only SW Aspect 2009	13.1	29	0.089
Underburn Only SW Aspect 2014	13.9	32	0.076
Underburn Only SW Aspect 2029	17.0	39	0.087
Underburn Only SW Aspect 2049	21.0	47	0.087

Therefore, proposed activities would reduce fire hazard in the project area in both the short-term (in the first year following treatments) and the long-term (through 2029 and 2049) but the long-term changes in reduced fire risk would vary by treatment type. These long-term changes would be noticeable primarily at the stand level in terms of fire behavior and effects through time but would have little influence on fire resiliency over the project area as a whole over time.

Cumulative Effects

The proposed activities for alternative 2 would have some effects over time (40 years) in reducing the fire hazard in the watershed. Meadow enhancement will restore meadows in the short-term but need to be repeated in order to have long-term effects. The effects of ongoing and reasonably foreseeable actions, including approximately 3,345 acres of timber and/or fuels management, would decrease the density of trees in the watershed, reduce ladder fuels, slightly decrease the likelihood of crown fire and fire behavior potential; these are positive changes that move toward desired conditions in the project area and across the watershed. However, these effects would have little impact on the increased fire hazard in the watershed over a 40-year timeframe. Repeated and more widespread management actions would be necessary over time to substantially change fire hazard on a large scale across the watershed. Alternative 3 – No Temporary Roads

Direct/Indirect Effects

The differences for fire hazard between alternative 2 and alternative 3 are small. In alternative 3, approximately 68 more acres of underburning would occur and approximately 268 fewer acres of thinning/underburning would occur. Not constructing new temporary roads under alternative 3 would not measurably affect fire behavior. These small changes would be noticeable only at the stand level in terms of fire behavior and effects through time but would have little influence on fire resiliency over the project area as a whole. For these reasons, the direct/indirect effects for alternative 3 are the same as alternative 2 described in detail above.

Cumulative Effects

Because the direct/indirect effects of alternative 3 are the same as those for alternative 2, the cumulative effects of alternative 3 are also the same as those previously described for alternative 2.

Alternative 4 – Minimized Underburning

Direct/Indirect Effects

Proposed thinning treatments, specialized treatments and meadow enhancement treatments would be the same as those for alternative 2. However, to reduce the amount of smoke-producing prescribed burning, thinning units on appropriate slopes would be masticated following thinning and would not be underburned.

After the stands are thinned (modeled in 2009), they would still be susceptible to the effects of wildfire and contain flame lengths at or above 4 feet, except natural stands on NE aspects for thin and underburn or mastication. Generally, fuels treatments (i.e., underburning and mastication) would occur within 3 to 5 years after silvicultural treatments occur (modeled in 2014). Stands both thinned and underburned showed the greatest resiliency to fire behavior and effects and met purpose and need and desired conditions throughout the 40-year analysis.

Thinned and masticated stands show increased flame lengths through time, but reduced stand density characteristics. Desired conditions of less than 4-foot flame lengths were not met under moderate or severe conditions under thinned and masticated units; however, all other measurement indicators show this treatment type meeting purpose and need. In stands that were underburned only, flame lengths exceed the desired 4 feet with all other measurement indicators showing a positive response in meeting the purpose and need. Tables 32 and 33 below show the results through time for each measurement indicator. These long-term changes would be noticeable primarily at the stand level in terms of fire behavior and effects through time but would have little influence on fire resiliency over the project area as a whole over time.

Table 32. Fire behavior and effects measurement indicator results for alternative 4.

Alternative 4 -- Minimize Smoke						
Fuels Treatment by Aspect	50th Percentile Conditions			90th Percentile Conditions		
	Flame Length	Fire Type	Basal Area Mortality	Flame Length	Fire Type	Basal Area Mortality
Thin SW Aspect 2009	4.4	S	9	5.3	S	11
Underburn SW Aspect 2014	2.5	S	7	3.3	S	7
Thin and Underburn SW Aspect 2029	2.2	S	5	2.8	S	5
Thin and Underburn SW Aspect 2049	2.3	S	3	2.9	S	3

Alternative 4 -- Minimize Smoke						
Fuels Treatment by Aspect	50th Percentile Conditions			90th Percentile Conditions		
	Flame Length	Fire Type	Basal Area Mortality	Flame Length	Fire Type	Basal Area Mortality
Underburn Only SW Aspect 2009	4.9	S	14	5.6	C	55
Underburn Only SW Aspect 2014	3.6	S	10	3.9	S	18
Underburn Only SW Aspect 2029	5.4	S	8	6.0	S	16
Underburn Only SW Aspect 2049	6.8	S	6	8.8	S	17
Masticate SW Aspect 2009	4.1	S	9	4.8	S	11
Masticate SW Aspect 2014	5.0	S	7	5.6	S	7
Masticate SW Aspect 2029	5.8	S	5	6.6	S	5
Masticate SW Aspect 2049	9.0	S	3	10.5	S	3

Note that underburn is not modeled until 2014.

Table 33. Stand structure, composition and size measurement indicator results for alternative 4. Note that underburn is not modeled until 2014.

Alternative 4 -- Minimize Smoke			
Fuels Treatment by Aspect	Average Stand Diameter	Canopy Base Height	Canopy Bulk Density
Thin SW Aspect 2009	18.4	48	0.042
Underburn SW Aspect 2014	21.6	50	0.035
Thin and Underburn SW Aspect 2029	25.0	51	0.038
Thin and Underburn SW Aspect 2049	29.4	48	0.045
Underburn Only SW Aspect 2009	13.1	29	0.089
Underburn Only SW Aspect 2014	13.9	32	0.076
Underburn Only SW Aspect 2029	17.0	39	0.087
Underburn Only SW Aspect 2049	21.0	47	0.087
Masticate SW Aspect 2009	18.4	48	0.042
Masticate SW Aspect 2014	21.6	50	0.035
Masticate SW Aspect 2029	25.0	51	0.038
Masticate SW Aspect 2049	29.4	48	0.045

Cumulative Effects

The cumulative effects of alternative 4 would be similar to those of alternative 2, although fewer acres of fuels treatments would occur in this alternative than in alternatives 2 or 3. The effects of ongoing and reasonably foreseeable actions, including approximately 3,345 acres of timber and/or fuels management, would decrease the density of trees in the watershed, reduce ladder fuels, slightly decrease the likelihood of crown fire and fire behavior potential; these are positive changes that move toward desired conditions in the project area and across the watershed. However, these effects would have little impact on the increased fire hazard in the watershed over a 40-year timeframe, as discussed for alternative 2. Under alternative 4 these effects would be even less apparent because fewer acres would be treated with underburning. Repeated and more widespread management actions would be necessary over time to substantially change fire hazard on a large scale across the watershed.

Summary

Alternative 2 would have the greatest effect on reducing fire hazard and improving stand structure and composition, and would meet the purpose and need for the project through time. Alternative 3 would improve fuel conditions similar to alternative 2 (and reduce fire hazard) but would improve density of vegetation on fewer acres. Alternative 4 would improve stand structure and composition on almost as many acres as alternative 2, but would improve fire behavior characteristics (and reduce fire hazard) on a much smaller area. Long-term changes would be noticeable primarily at the stand level; fire resiliency over the project area as a whole would likely be small due to the small amount of treated acres compared to large size of the project area. Because alternative 2 would treat more acres than alternatives 3 or 4, fire resiliency would be slightly greater at the project area-scale than alternatives 3 or 4.

Table 34 below is a summary of treated acres under each alternative by treatment type. The table also shows average flame lengths under severe conditions by treatment type for two given years. Flame lengths are displayed over other measurement indicators due to the biggest change in trends by treatment types. Under the No Action alternative, fire hazard would be moderate (flame lengths between 4 and 8 feet) but this drops to low (flame lengths less than 4 feet) for most treated areas in 2014 and remains low into 2029 for units that are both thinned and underburned.

Table 34. Comparison of alternatives by acres treated and average 90th percentile flame length for year 2014 (modeled underburn) and 2029 (15 years post-treatment)

Component Objective	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Average 90th percent Flame Lengths by Treatment 2014	Average 90th percent Flame Lengths by Treatment 2029
Total Treatment Acres	0	9,530	9,330	2,850	////	////
Total Underburning Only Acres	0	7,250	7,320	570	3.9	6.0
Total Thin and Underburn Acres	0	1,980	1,710	488	3.3	2.8
Total Thin and Masticate Acres	0	0	0	1,450	5.6	6.6
No Action – continuation of existing conditions	////	////	////	////	5.4	6.4

3.5 Air Quality

3.5.1 Methodology

Prescribed burning and wildfire result in smoke production. Smoke affects the quality of the air and visibility. These effects may be noticeable to residents and recreational users in the area, to adjacent communities, and in sensitive areas such as the Marble Mountain Wilderness Class I airshed and the Siskiyou Wilderness Class II airshed. Dust generated from vehicle traffic on roads in the project area also affects the quality of the air, and vehicles and equipment emit pollutants.

The Clean Air Act and its amendments require the Environmental Protection Agency (EPA) to identify and publish a list of common pollutants that could endanger public health or welfare, and to establish criteria for emissions in order to protect the public health and welfare. Six criteria pollutants have been identified, and of those, particulate matter with diameters less than 2.5 micrometers (PM 2.5) is of greatest concern from wildland burning. Most (80-90%) of the mass of wildfire smoke falls into the PM 2.5 classification.

The 1977 amendment to the Clean Air Act established a national goal of *prevention of any future and remedying of any existing impairment of visibility in mandatory Class I federal areas which impairment results from manmade pollution.* EPA has delegated to the states the responsibility to implement and enforce all laws and regulations pertaining to the Clean Air Act.

The emissions and impacts of prescribed burning and wildfire on air quality are difficult to quantify because of the many site-specific factors involved: fuel type, fuel loading, moisture conditions, combustion rate, and meteorological conditions. Particulate matter emissions can be

estimated through the use of fire modeling (First Order Fire Effects Model or FOFEM). FOFEM is recognized by the Forest Service Pacific Southwest Region as being the most current and accurate analysis tool available for emissions prediction (Reinhardt et al. 1997). It is based on extensive research in western forest ecosystems.

FOFEM was used to estimate emissions from a wildfire in the Two Bit project area compared to a prescribed burn. Both scenarios used the same fuel model and fuel loading approximations. The wildfire assumes a windy summer day under dry conditions and 20 percent crown fire. It also assumes that all the project area will be burned in a few days. The prescribed burn scenario assumes a typical fall day with moderate moisture conditions and only 10 percent of the project area to be burned in a given year.

Fugitive dust emissions were estimated using miles of log hauling based on unpaved forest service roads. Log hauling on unpaved forest roads was the only source of fugitive dust estimated under this project since intensity (total haul miles on unpaved roads) and velocity of travel (average of 15 mph) on unpaved forest roads would contribute the majority of the fugitive dust emissions. Other vehicles and equipment were not considered in the analysis for dust generation because they would operate on less bare ground (small portions of units on primary skid trails) and slower operating speeds (average of 5 mph). The alternatives were evaluated by estimating PM10 emissions in fugitive dust from logging trucks compared to those estimated for Siskiyou County.

The alternatives are compared using the following indicators:

- Distance and direction from area of smoke production to sensitive areas
- Predicted smoke emissions from each alternative based on fuel loadings
- Consistency of predicted smoke emissions with state and federal standards (The Clean Air Act, state guidelines, etc.)
- Fugitive dust emissions based on proposed logging haul routes

The information used in the preparation of this section, including detailed results of model runs, comes from detailed analysis in the Air Quality Report (Isbell and Bousfield 2010) and is available in its entirety in the project record.

3.5.2 Affected Environment

The Two Bit Project Area is located in northern Siskiyou County, California. The project area is within the Northeast Plateau Air Basin, which includes all of Lassen, Modoc, and Siskiyou Counties and is the fourth largest air basin in the state. Currently, Siskiyou County is in attainment for all federal and state standards (i.e. Siskiyou County does not exceed ambient air quality standards for regulated/monitored air pollutants) except for state standard for 8-hour ozone. Within Siskiyou County, the air quality regulating authority is the Siskiyou County Air Pollution District (SCAPCD) in Yreka, CA. The SCAPCD issues permits and specific standards and guidelines for prescribed burning including the establishment of emission limits.

Local communities such as the town of Happy Camp (0.5 miles south of project area and Seiad Valley (12 miles east of project area), local residents living in the project area and campgrounds are considered sensitive areas and could be affected by smoke and haze in from the project.

Class I airsheds are federally designated wilderness areas, national monuments, and other areas of special natural, recreational, scenic, or historical value. Class I designations apply to select pristine airsheds including national parks greater than 6,000 acres and wilderness areas greater than 5,000 acres. Wilderness areas that were federally designated prior to the 1977 amendments to the Clean Air Act were designated as Class I airsheds. The Marble Mountain Wilderness Class I airshed is approximately 15 air miles from the project area and Kalmiopsis Wilderness Class I airshed is approximately 25 air miles from the project area. Class II airsheds are clean air areas where a moderate amount of development is permitted. These include wilderness areas designated after 1977. The Red Buttes Wilderness Class II airshed is adjacent to the northeastern portion of the project boundary, and the Siskiyou Wilderness Class II airshed is adjacent to the western portion of the project boundary.

The Northeast Plateau Air Basin is classified as **attainment** for National Ambient Air Quality Standards (NAAQS). Within the State of California Clean Air Act, the basin is classified by the California Air Resources Board as **nonattainment** for particulate matter less than 10 microns or PM 10. Areas where particulate matter has exceeded standards have been in the communities of Alturas and Yreka where monitoring stations are located, and where there are air polluting industries and problems with wood smoke. State and federal ambient air quality standards are shown in table 35.

Table 35. State and federal ambient air quality standards

Pollutant	Averaging Time	Primary Standards Federal	State Standards California
PM10	Annual 24-hour	50* (arithmetic mean) 150	20 (geometric mean) 50
PM2.5	Annual 24-hour	15 65	12 ---
CO	8-hour 1-hour	10,000 [9] 40,000 [35]	10,000 [9] 20,000 [20]
*Units are micrograms per cubic meter (ug/m3); numbers in brackets are parts per million (ppm). From: California Air Resources Board (5/17/06)			

The following pollutants would be emitted during fuels and vegetation burning through the use of prescribed fire: PM10, carbon monoxide (CO), carbon dioxide (CO2), volatile organic carbon (VOC), and toxic compounds. PM10 would be emitted in the form of dust from timber hauling and logging operations, including road reconstruction and rehabilitation activities. Review of the highest four daily PM10 measurements for the three stations in Siskiyou County indicate Yreka and Mt. Shasta have exceeded the daily PM10 standard two times over the years

1997–1999. The Lava Beds National Monument exceeded the 24-hour standard one day in 1996 because of a prescribed underburn in the monument within 100 yards of the monitoring station.

3.5.3 Environmental Consequences

Alternative 1- No Action

Direct/Indirect and Cumulative Effects

Under the no action alternative, there would be no prescribed burning or logging operations and therefore no emissions of PM10, PM 2.5 and CO from burning, road use, fugitive dust generation, or vehicle and equipment emissions.

Alternative 1 would therefore not contribute to the effects of other past, on-going or planned activities in the project area or in the change to the cumulative air quality effects from the current situation.

If a wildfire were to start in the project area, substantial smoke impacts would result. PM2.5 concentrations would be 0.88 tons/acre (table 36). Total emissions would be greater than if burned under controlled conditions and would be concentrated in a short time frame thus having a substantial impact on the health of area residents and to nearby Class I and Class II airsheds. In addition, a wildfire may not be restricted to the area of this project so smoke from the burning of surrounding areas would make emissions even higher.

Because a wildfire would likely occur under hotter and drier conditions than a prescribed burn, burning would be more intense and more fuel would be consumed within the target area. This would mean more smoke and the hotter fire would cause the smoke to be lifted higher into the atmosphere where winds are stronger. Thus smoke would be transported longer distances and impact a much larger area than if burning is done under controlled conditions.

Indirect impacts on air quality from fighting a large wildfire would mainly be caused by exhaust from fire fighting vehicles.

Alternatives 2, 3 and 4

Direct/Indirect Effects

The action alternatives would generate short-term smoke emissions that would be suspended in the atmosphere, generated from prescribed fire. The action alternatives would also produce fugitive dust generated primarily through timber hauling activities. Indirect effects of prescribed fire include an expected decrease in wildfire emissions due to a reduction of overall fuel loading. Dust emissions from hauling would add to the fine particulate emissions locally and regionally.

Table 36 shows the estimated emissions from prescribed fire and wildfire for alternatives 1, 2, 3 and 4. Wildfire totals were not displayed (only tons per acre) because there was no determination on how large a wildfire may get. However, tons per acre estimates were compared between wildfire and prescribed fire treatments. It is important to note that total emissions from a wildfire would be a one-time event whereas total emissions from a prescribed fire would be over

a series of burns or multiple events. Table 36 shows that prescribed fire would result in fewer particulate emissions per acre burned than a wildfire and that this is the same for each alternative. The total tons of particulate emissions would be less for alternative 4 because substantially fewer acres would be prescribed burned under this alternative when compared to alternatives 2 or 3. Alternatives 2 and 3 are quite similar in total tons of emissions per acre because both have similar amounts of prescribed burning proposed.

Table 36. Estimated Emissions by Particulate Type (tons/acre and total tons)

Particulates	Alternative 1 No Action	Alternative 2 Proposed Action		Alternative 3 No New Temporary Roads		Alternative 4 Minimum Smoke	
	Wildfire tons per acre	Prescribed fire tons per acre	Prescribed fire total tons	Prescribed fire tons per acre	Prescribed fire total tons	Prescribed fire tons per acre	Prescribed fire total tons
PM10	1.04	0.77	5583	0.77	5636	0.77	439
PM2.5	0.88	0.65	4713	0.65	4758	0.65	371
CO	11.5	8.6	62350	8.6	62952	8.6	4902

Based on the above information, the amount and location of proposed burning may result in short-term impacts to local air quality due to the level of smoke produced, exacerbated by the tendency for smoke in these areas to settle in the basin and that this is greatest for alternatives 2 and 3 and substantially less for alternative 4. This can result in inconvenience and discomfort for residents along Indian Creek and in the town of Happy Camp, particularly those with allergies or breathing conditions. These short-term effects would be minimized through the implementation of project design features (Chapter 2) which include burning only on declared “Burn days” as determined by Siskiyou County Air Quality Management District’s Smoke Management Plan to avoid creating a nuisance, visibility impairment or impacts to public health. Burn-day determination is based on metrological conditions that tend to disperse the smoke. Burning on worst visibility days and best visibility days would be avoided. Burns would be conducted when the prevailing wind direction is away from Class I areas. Public education and information release are part of the prescribed burning procedures and would be followed. In addition, burning activities would be staggered over an approximately 10-year period; not all burning would be conducted at once.

While alternatives 2 and 3 would result in higher particulate emissions from prescribed burning than alternative 4, these alternatives would be more effective in reducing the likelihood of a wildfire by reducing fuel loading. Mastication proposed under alternative 4 is an effective treatment to reduce fire behavior characteristics such as crown fire potential, but it does not get rid of the fuels (like prescribed burning does); instead it changes ladder fuels and brush to ground fuels; in the short-term, these are still available to burn in a wildfire event and would have similar smoke production (Isbell, pers. comm. 2010).

Compared to emissions from a wildfire, all action alternatives would result in fewer emissions from smoke.

Estimates of fugitive dust generation were compared for all alternatives and are shown in table 37.

Table 37. Total miles of unpaved log truck travel. Estimated PM10 fugitive dust emissions from log haul and return trips by alternative

Action Alternative	Alternative 2 & 4	Alternative 3
Total Unpaved Haul Distance (miles)	67,996	60,581
PM10 per year (tons)	17.8	16.0
Relative to Siskiyou County yearly average for 2008 (%)	0.41	0.37

Average yearly emissions for Siskiyou County Air Pollution Control District can be found at http://www.arb.ca.gov/app/emsinv/emssumcat.php

The estimated yearly PM10 emissions from all alternatives are less than 0.5 percent of Siskiyou County total. Fugitive dust emissions, dispersion and transport would be mitigated by treating selected main unpaved haul routes with water and or chemical dust suppressants thereby reducing overall dust emissions and cumulative effects from the project activities (see project design features and BMPs, Chapter 2). Dust abatement methods would reduce total emissions between 50 to 80 percent (EPA 2006).

Cumulative Effects

Fine particulate matter would contribute to local, air basin, and broader regional pollutant loading. Local and air basin effects would include cumulative prescribed burn emissions from federal, state, and private lands in the area. Compliance with Burn Day, Marginal Burn Day, and No Burn Day designation, and coordination and permitting from the local air pollution control district, would minimize cumulative effects.

Because smoke can be transported for hundreds of miles the cumulative impact area may be quite large, but the further from the point of origin the more diffuse the smoke becomes; therefore impacts would diminish with distance from the project area. Although smoke would drain downstream similarly to water at night, during the day it may be transported high into the atmosphere and in any direction by the prevailing wind.

This project may contribute to regional haze, which results from the accumulation of diffuse pollutants from multiple sources including industry, fireplace and woodstove burning and other prescribed burns. Burning may occur simultaneously in other areas within the Northeast Plateau Air Basin. Other burns within the Indian Creek Watershed (tables 15 and 16) and other areas within the Air Basin contribute to cumulative effects from smoke.

Proposed management activities under the action alternatives, would contribute to the emissions that affect air quality. The impacts on air quality are difficult to address in terms of

cumulative effects. Large fires have occurred near the project over the past century as described in the Fire and Fuels report; however, those effects on air quality are gone and cannot be viewed cumulatively. If a wildfire occurred, there is a potential for the NAAQS to be exceeded depending on the size and duration of wildfire.

It is acknowledged that multiple prescribed burn activities, occurring at the same time, could cumulatively increase particulate levels. Generally, the effects of one burn activity are completed before another burn activity begins. Impacts to air quality would generally be confined to no more than a few hours, or at most a few days. The cumulative effect of prescribed fire on air quality is rather short-lived, because once the burn is over and the smoke has dissipated, the effect is over.

The effects of the actions alternatives from smoke are not likely to have cumulative effects with other activities in the airshed given the oversight by the Siskiyou county APCD that allows for good smoke dispersion. Daily regulation of amount of burning is managed to reduce impacts and negative effects of smoke. The number of days to accomplish prescribed burning in this project would compete with other burning in the airshed on any given day. The Forest Service would be responsible for establishing burn priorities and the Siskiyou county APCD would be responsible for managing all the burning on a given day. If air quality is exceeding thresholds when proposed activities are scheduled to occur, implementing either one of these alternatives may result in some delays in burning as a result of this increased demand.

There would also be some impact on air quality from engines used to operate vehicles, equipment and chainsaws during thinning and burning operations from any of the action alternatives combined with other activities in the Air Basin. These emissions are expected to be minimal and able to disperse readily.

3.6 Water

3.6.1 Methodology

The existing conditions within the project area were analyzed through a combination of office and field reviews. Existing data such as road sediment source inventories, channel habitat type surveys, and watershed analyses were reviewed in the office. Cumulative watershed effects models were also used to characterize the existing conditions. Field reviews of stream course riparian reserve (RR) function, channel characteristics, stream surveys, and sediment source identification confirmed the office assessments.

The effects of the alternatives were analyzed through field visits, GIS reports, and modeling. Field visits were used to develop the project design features based on stream channel characteristics and slopes and to correct any inconsistencies with existing GIS stream layers. GIS reports summarize the following activities located within stream course RRs: (1) miles of temporary roads (reconstructed and constructed), (2) acres of landings (new and existing), and (3) acres of commercial treatment and ground-based yarding. These activities in RRs relative to

the total RR acreage in a watershed helped determine whether there would be measurable effects to water quality.

Cumulative watershed effects (CWE) are analyzed on the Klamath National Forest using three models: (1) the equivalent roaded area (ERA) methodology, a Region 5 standard that scales vegetative disturbances as being equivalent to a road. It establishes a "threshold of concern" (TOC), ranging from 4.5-17 percent, as the acceptable percent ERA within a particular watershed; (2) the USLE methodology which predicts sediment volume delivered to stream courses by surface soil erosion; and (3) the empirical mass-wasting model (GEO) that predicts sediment volume delivered to stream courses by mass-wasting processes. A watershed's threshold of concern is reached when model-predicted sediment delivery exceeds background by 400 and 200 percent for USLE and GEO models, respectively. The GEO modeling is also used and discussed in the Geology section of this chapter.

CWE models were used to analyze cumulative effects of the existing road system (this assumes programmatic maintenance of Forest System roads) and past and present actions, in combination with proposed activities under each alternative. The CWE analysis models project-specific actions within the context of 7th field watersheds (drainages, from 3,000 to 10,000 acres in size). Seventh field watersheds are aggregated to characterize 6th and 5th field watersheds. The Indian Creek 5th field watershed is composed of four 6th field watersheds and twelve 7th field watersheds. Actions are proposed within nine of the twelve 7th field watersheds (figure 7). Appendix F contains a summary of the CWE modeling results for this project.

Effects can be neutral, beneficial or negative. All effects of the no-action and action alternatives are described in context to their spatial and temporal extent. The spatial scale is described at three levels: (1) Site – effects located in the stream channel adjacent to or nearby the treatment area and that do not extend downstream; (2) Reach – effects that extend downstream for less than 100 meters; and (3) Watershed – effects that can be measured in the response reach of a 7th field watershed. The temporal scale is described as being either short- or long-term in duration. Short-term (direct and indirect) is usually 1 to 3 years, but can be up to 10 years. Long-term (indirect) is any effect that persists for more than 10 years.

Surface sediment erosion recovers quickly (over several years) due to soil cover from needle cast and fallen branches covering disturbed sites. Sediment delivery due to mass-wasting is long-term and can last for several decades before hill slope hydrology is restored. Altered stream flows can be short- or long-term, depending on elevation and forest type.

Cumulative effects are short- and long-term since they combine direct and indirect effects resulting from all past, present, and reasonably foreseeable future actions. Since Forest System roads are considered permanent, and do not recover like vegetative disturbance, road-related sedimentation is constant year after year. Positive changes can occur by storm proofing, decommissioning, and administrative decisions that affect use levels.

The alternatives are compared using the following indicators:

- Changes in sedimentation – quantitatively modeled through USLE and GEO methodology and qualitatively evaluated using miles of temporary road, acres of landings and acres of ground-based equipment operating in stream course RRs.
- Changes in stream temperature – qualitatively evaluated through acres of proposed commercial treatment in stream course RRs.
- Altered channel morphology - measured through ERA-modeled outputs for degree of peak flow increase.

These three issues are linked since increased sedimentation could alter channel geomorphology, which could increase stream temperature. The results of the analysis using the above indicators (as summarized below and also described in appendix F) were then used to determine whether negative effects to beneficial uses of water would occur. These indicators came from the Forest Plan (USDA Forest Service1995a) and Indian Creek Watershed Analysis (USDA Forest Service 1997).

The Forest Plan (1995a) developed future desired conditions Forestwide and in designated management areas. The Forest Service adopted the Aquatic Conservation Strategy (Forest Plan, pages 4-6 and 4-7) and management area standards and guidelines to help achieve future desired conditions. Forestwide Standard and Guideline #1-3 for best management practices (BMPs) helps meet water objectives. Many standards and guidelines for RRs are also included in the Forest Plan and apply to this project (MA-10, pp. 4-133 – 4-144).

The information used in the preparation of this section, including detailed results of model runs, comes from detailed analysis in the Hydrology Report (Bousfield 2010) and is available in its entirety in the project record.

3.6.2 Affected Environment

The project area is located in the 135-square-mile Indian Creek watershed (figure 7). Indian Creek is the largest tributary to the Klamath River between the confluences with the Scott and Salmon Rivers. The Indian Creek watershed has high concentrations of dormant and active landslide terrain (see Geology section for more details) with a dense road network and a long history of mining and forest management. The residual effects of these past actions, in combination with the effects of past flood events, have led to a watershed whose sedimentation, stream temperature and channel geomorphology are not currently meeting desired conditions. Fire suppression has also created dense conditions in un-managed stands; reducing diversity and increasing the risk for high-severity wildfire (see Fire and Fuels section for more information). The Two Bit Vegetation Management Project was designed to help move a portion of the Indian Creek watershed towards the desired conditions.

This section has been organized into the most relevant aspects of water resource management and protection: beneficial uses, watershed condition, channel condition, riparian condition, and water quality and quantity.

Beneficial Uses

The Indian Creek watershed supports coho and Chinook salmon, steelhead/rainbow trout, and a few other non-game fish species and Indian Creek provides the most miles of habitat for salmon and steelhead than any other tributary within this reach of the Klamath River. Private residents located along the South Fork and main stem of Indian Creek withdraw water for domestic use. Table 38 summarizes the beneficial uses by 7th, 6th and 5th field watersheds.

Table 38. Beneficial uses with the Two-Bit Vegetation Management project area and existing watershed conditions

Watershed	Known Beneficial Use Types	Within Acceptable Thresholds of Concern (less than 1.0), based on ESLA, ERA and GEO modeling results?
7th – Field Watershed		
Indian Creek Headwaters	Resident and anadromous fish	Yes
West Branch Indian Creek	Resident and anadromous fish	Yes
Indian/Mill Creek	Resident and anadromous fish	Yes
Coon-Wagner	Domestic supply and resident and anadromous fish	Yes
Upper South Fork Indian Creek	Resident and anadromous fish	Yes
Twin Valley Creek	Resident and anadromous fish	Yes
Little South Fork Indian Creek	Domestic supply and resident and anadromous fish	Yes
Cole-Clauson	Domestic supply and resident and anadromous fish	Yes
East Fork Indian Creek[1]	Domestic supply and resident and anadromous fish	Yes
Luther-Ikes	Domestic supply and resident and anadromous fish	Yes
Indian/Doolittle Creek	Domestic supply and resident and anadromous fish	Yes
Perkins-Happy Camp	Domestic supply and resident and anadromous fish	No, for surface soil erosion
6th – Field Watershed		
Upper Indian Creek	Domestic supply and resident and anadromous fish	Yes
South Fork Indian Creek	Domestic supply and resident and anadromous fish	Yes
Lower Indian Creek	Domestic supply and resident and anadromous fish	Yes
5th – Field Watershed		
Indian Creek	Domestic supply and resident and anadromous fish	Yes
[1] East Fork Indian Creek is also a 6th-field watershed		Yes

Watershed Condition

The Indian Creek watershed has a long history of mining and timber harvest resulting in altered vegetation and stream channels. Three mining sites are still recovering: Grey Eagle (near Luther Gulch and Deer Lick Creek), Huey (near Mill Creek and main stem Indian Creek), and Classic

Hill (near Coon Run Creek and main stem Indian Creek). Suction dredging was prevalent until the 2009 statewide ban on dredging, especially on the lower South Fork and on the main stem between the South Fork and West Branch Creek. The effects of suction dredging on beneficial uses are not well understood.

Extensive past timber harvest created a dense road network throughout all of the 7th field watersheds, except Twin Valley Creek. The average road density in the Indian Creek 5th field watershed is 3.1 road miles per square mile with 0.65 road miles per square mile in stream course RRs (or approximately 21 percent). Hydrologic connectivity of Forest System and temporary roads to stream courses in the Indian Creek watershed ranges from 0.5 to 25.6 percent at the 7th field scale.

The Forest Plan Record of Decision (1995a) identified several locations in the Indian Creek watershed as areas with watershed concerns (AWWCs). These include all or portions of the following 7th field watersheds: Indian Creek Headwaters, Coon-Wagner, East Fork Indian Creek, and Luther-Ikes. The Indian Creek Watershed Analysis (USDA Forest Service 1997) recognized that watershed conditions in Indian/Mill Creek and Doolittle Creek were also of concern. The AWWCs are areas where a “cautious approach” for management will be applied, defined as activities that do not retard attainment of Forest Plan desired conditions, are carried out in support of forest health objectives, and result in a long-term benefit to the environment (USDA Forest Service 2006).

Since the Indian Creek Watershed Analysis (1997) was written, several projects have been undertaken to reduce road densities in this watershed through decommissioning, storm-proofing and hydrological stabilization (e.g. USDA Forest Service 1999a, USDA Forest Service 1999b, USDA Forest Service 2005b). The Indian Creek Roads Analysis (USDA Forest Service 2004b) recommended the decommissioning of 28 miles of road and storm-proofing of 136 miles of road. The Two Bit project contributes to the goal of reducing road densities in the Indian Creek Watershed.

Current conditions of the Indian Creek watershed based on modeling show that the only watershed over acceptable thresholds of concern, or TOC (equal to 1.0) is Perkins-Happy Camp for surface soil erosion. Although no activities are planned in the Perkins-Happy Camp 7th field under any of the alternatives, it is included in the analysis because it is a sub-watershed of the Indian Creek 5th field watershed. The ERA model results for equivalent roaded areas indicate that all other subwatersheds are currently below the threshold of concern. The USLE and GEO model results for sediment volumes delivered to stream courses by surface soil erosion and landslides, respectively indicate that all subwatersheds where treatment activities are proposed are within acceptable levels.

Channel Condition

The Indian Creek watershed is characterized by steep gradient, high-energy lower-order streams (Rosgen A-type channels), with lower gradient response reaches (Rosgen B-type channels) near

most of the sub-watershed's confluences with the South Fork and main stem of Indian Creek. The extensive dormant landslide terrain within the watershed has created an alternating bench-scarp landform on the upper- to middle-slope position, with deeply incised inner gorges in the lower-slope position. This landform has created many 1st-order, low-gradient streams on benches with weakly defined channels that eventually drop off of scarps leading down to inner gorges of 2nd- and 3rd-order streams. Many of the lower- (2nd and 3rd) order streams have been scoured by debris flows with depositional features persisting in the lower gradient response reaches and main stem of Indian Creek. Extensive stream surveys of Indian Creek's 6th field and a few 7th field response reaches were conducted in 1997, 1998, 2001 and 2009. Table 39 summarizes the survey results in terms of meeting Forest Plan desired conditions.

Table 39. Existing Pool conditions for surveyed stream reaches

Reach Name	Fine Sediment in Pool Tail-outs (percent of Average)	Primary Pools /6 Average Bankfull Widths (#)	Large Woody Debris per 1,000 Feet
Forest Plan Desired Conditions	Less than 15	1	20
Indian Creek Headwaters	5	0.1	0.2
Indian/Mill Creek	19	0.01	2.0
East Fork Indian Creek	11	0.04	0.8
Luther-Ikes	13	0.7	0.04
Indian/Doolittle Creek	11	0.1	0.3
Upper Indian Creek	5	0.1	0.8
South Fork Indian Creek	4	0.5	0
Lower Indian Creek	12	1.2	0

All reaches except Mill Creek meet desired conditions for fine sediment in riffles. Only Lower Indian Creek meets desired conditions for primary pool frequency. None of the reaches meet desired conditions for LWD. The effects of past floods (1955, 1965, 1974, 1997 and 2005) combined with one of the highest concentrations of landslides per watershed area on the Forest (See Geology section) overlaid by a dense road system are the main factors that have contributed to the poor channel characteristics in the Indian Creek watershed.

Current channel conditions in Indian Creek are strongly influenced by past flood events. The 1997 flood event (01/01/1997) caused debris slides that created debris flows in the main tributaries of Indian Creek. The main stem experienced hyper-concentrated steam flows, causing scour and deposition which reduced the size, volume, and depth of pools. The post-1997 flood assessment (USDA 1998) inventoried 25 landslides, 92 road related culvert or fill slope failures ((Emergency Repair (of) Federally Owned (roads) (ERFO sites)), and 11.8 percent of the stream channels being altered. The more recent 2006 flood event (12/30/2005) had much less resource and facilities damage than the 1997 flood. An official assessment of the 2006 flood was not conducted, but field reconnaissance discovered five ERFO sites. The most significant site was

where West Branch Creek undermined bridge supports, and the high flows reworked and mobilized a large alluvial feature.

Riparian Condition

The Indian Creek watershed has a history of forest management, starting in the mining era where trees were harvested to build houses, flumes, and other structures. The forest regenerated naturally without the use of modern reforestation techniques. Many stream banks in Indian Creek were placer -mined, leaving tailings in the riparian zone that persist to this day. Significant placer mining sites include Greens Creek, SF Indian Creek, and along the main stem of Indian Creek. Several other copper adit mines and open pit gold mines affected the riparian zone in smaller tributaries of Indian Creek.

The vegetation management activities GIS layer used in cumulative watershed effects modeling shows Forest Service and private timber harvest from 1936 to the present. Clearcut harvesting throughout the stream course RRs was permitted prior to the creation of the Forest Plan (USDA 1995a). Table 40 summarizes the acres of clear-cut stream course RRs between 1936 and 1995. Clearcut harvesting was steady from the 1950s until the 1990s with between 18 and 31 percent of the total clearcut RR acreage occurring each decade over the 40-year period. All of these areas are recovering and contain trees between 20 and 50 years old.

Table 40. Previously clear-cut stream course Riparian Reserves

Watershed	Watershed Area (acres)	Stream Course RR		Clear-cut Stream Course RR	
		Area (acres)	Fraction of Watershed Area (%)	Area (acres)	Fraction of Stream Course RR Area (%)
7th – Field Watershed					
Indian Creek Headwaters	8,550	1,915	22.4	319	16.7
West Branch Indian Creek	5,365	1,288	24.0	135	10.5
Indian/Mill Creek	6,247	1,326	21.2	252	19.0
Coon-Wagner	6,624	1,598	24.1	141	8.8
Upper South Fork Indian Creek	7,649	1,869	24.4	141	7.6
Twin Valley Creek	8,782	1,842	21.0	0	0.0
Little South Fork Indian Creek	6,112	1,469	24.0	224	15.3
Cole-Clauson	9,267	2,344	25.3	169	7.2
East Fork Indian Creek1	11,761	2,605	22.2	213	8.2
Luther-Ikes	7,816	1,850	23.7	69	3.7
Indian/Doolittle Creek	5,869	1,480	25.2	342	23.1
Perkins-Happy Camp	2,194	481	21.9	27	5.5
6th – Field Watershed					
Upper Indian Creek	26,786	6,127	22.9	847	13.8
South Fork Indian Creek	31,810	7,525	23.7	534	7.1
Lower Indian Creek	15,879	3,811	24.0	438	11.5
5th – Field Watershed					
Indian Creek	86,236	20,068	23.3	2,033	10.1

Water Quality

The intent of the Clean Water Act is met on National Forest System land by complying with water quality standards developed by the State of California, as authorized by the U.S. Environmental Protection Agency (EPA) pursuant to the Federal Clean Water Act of 1972. The Porter-Cologne Act, California's corresponding state law, assigns responsibility for protection of water quality within North Coast watersheds to the North Coast Regional Water Quality Control Board (NCRWQCB). The NCRWQCB implements and enforces the Porter-Cologne Act, and the Water Quality Control Plan for the North Coast Basin (Basin Plan). Water quality objectives are outlined in the Basin Plan. The primary purpose for maintaining water quality is to assure that the beneficial uses of water are not adversely affected. When water quality objectives are met, and beneficial uses protected, then the State considers that a project meets water quality standards.

The Forest Service entered into a Management Agency Agreement (1981) with the NCRWQCB and State of California requiring the Forest Service to institute a water quality management program to meet applicable water quality objectives and protect beneficial uses. Under the agreement, implementation of State-approved and EPA-certified best management practices (BMPs) are considered sufficient to protect water quality from non-point sources of pollution (USDA 2000b). As long as BMPs are implemented, the Forest Service can apply for an exemption from waste discharge requirements under the 2004 Categorical Waiver for Discharges Related to Timber Harvest Activities on Federal Lands managed by the USDA Forest Service in the North Coast Region (USDA 2004c). The 2004 waiver recently expired, but was extended during the development of a new waiver. On August 4, 2009, the State Water Resources Control Board unanimously approved a resolution directing their staff to develop a statewide waiver to cover all activities with potential for non-point source pollution on National Forest System land in California. The statewide waiver will be developed over the next 18 months to replace the 2004 waiver. This project would most likely fall under the 2004 Waiver.

Indian Creek is 303(d) listed as impaired for nutrients, organic enrichment/low dissolved oxygen, and water temperature. A total maximum daily load (TMDL) action plan for the Mid-Klamath River is currently in development with a foreseeable completion date of 2011. The Mid-Klamath Hydrologic Area (HA) was recently listed for sediment in 2008. A TMDL for sediment will not be developed until 2021.

Highest average of maximum daily temperatures over any seven day period (maximum weekly maximum temperature, MWMT) range from 13 degrees Celsius on West Branch Creek to 25 degrees Celsius in South Fork Indian Creek, as measured in various locations in the Indian Creek watershed since 1996 (Welsh et al. 2001). The MWMT recorded on the South Fork and main stem sampling locations exceed the theoretical maximum temperature for supporting anadromous fish species throughout their life cycle. The MWMT consistently occurs during the last two weeks in July. Unfortunately, the only water temperature data available for the smaller tributaries is from 1996. The MWMT of the tributaries shows the importance of thermal refugia

near the confluences with the warmer main stem. The smaller tributaries are still maintaining cold water temperatures despite the dense road system and legacy effects of logging and mining. The main stem portion in Upper Indian Creek is substantially colder than downstream locations. Below the confluence with the South and East Forks, the main stem has many wide sections with little shade to buffer solar loads. The wide alluvial sections are where the majority of the 1997 flood debris flows were deposited.

Sedimentation has only been measured through coarse stream surveys and through cumulative watershed effects modeling. Turbidity threshold sampling would need to be conducted to get an accurate estimate of sediment transport volumes and sediment concentrations during peak flow events.

Water Quantity

The USGS stream gage located approximately 3.5 miles upstream from the confluence of the Klamath River provides surface water data for 120 square miles of the Indian Creek watershed (89 percent of the watershed's area). The average annual runoff recorded at the stream gage from 1957 to 2008 is 302,500-acre-feet, or 47 inches. Annual evapotranspiration is approximately 28 inches, given the isobar-weighted average annual rainfall of 75 inches (Rantz 1964). An unknown portion of the 28 inches is drafted from Indian Creek for domestic water use. Minimum daily flows consistently occur during September, supporting the concept that the main stem's water temperature is more strongly related to air temperature and solar radiation than to low flow conditions.

3.6.3 Environmental Consequences

Alternative 1- No Action

Direct, Indirect and Cumulative Effects

The no-action alternative would not add any new management-related ground disturbance to the Indian Creek watershed in the short- or long-term. Appendix F summarizes existing conditions in the watershed based on CWE model results. Channel conditions would continue to recover from the 1997 flood event. Subsequent flood events could cause the conditions to worsen. Stream flows would not be affected by the no-action alternative.

Riparian vegetation in stream course RRs would continue to persist or recover from past harvesting activities (table 44). Areas where stream course RRs were planted with a tight spacing and/or did not receive follow-up non-commercial thinning would see trees die due to competition which could affect stream temperature due to loss of effective shade. Mortality due to snow breakage, insects and disease may occur in plantations where off-site pine was planted, which could cause large holes in the riparian canopy, therefore increasing solar loading. It would take 30-50 years for conifers to naturally regenerate and restore canopy cover in the stream course RRs with dead and dying off-site pine. Wildfire could cause high burn severity in

overstocked stream course RRs under the no-action alternative; high severity fire could result in adverse effects to water quality.

The no action alternative would not cause any negative effect to aquatic habitat conditions since actions would not be taken that could measurably affect the stream flow, temperature, or sediment regimes. Not treating RRs or decommissioning roads could prolong or cause an increase in the current effects to aquatic habitat.

Beneficial uses of water would continue to be supported in their current state under this alternative. The current state is considered to be impaired under the 303(d) list for temperature, nutrients, dissolved oxygen, and sediment. The no action alternative would not accelerate the possibility of delisting Indian Creek for sediment because no road decommissioning would be performed, or for temperature because dying densely-stocked and altered stream course RRs would not be treated.

Achievement of Forest Plan desired conditions within stream course RRs would take at least 100 years, especially in plantations with densely stocked stands with off-site pine. No change (increase or decrease) in the Forest System road density would occur.

Aquatic Conservation Strategy Objectives are described in detail in appendix D. Appendix D includes a summary of how alternative 1 addresses these objectives and compares this to implementation of the action alternatives.

Common to All Action Alternatives

There are 43 ephemeral and 50 intermittent streams adjacent to or within proposed treatment units. Four out of the 50 intermittent streams continue to flow into June contributing cold water during warm summer months. Eight perennial streams are adjacent to proposed treatment units (although this number is slightly less for alternative 3). The majority of the stream courses with proposed RR treatments are located on benches and are low-gradient, with weakly defined channels. A smaller portion of the stream courses with proposed RR treatments are high-energy, with well defined incised channels. No commercial treatments are located in fish-bearing stream course RRs. All of the landscape scale underburns outside of thinning units are adjacent to anadromous and/or resident fish-bearing stream course RRs.

Direct Effects from Road Decommissioning

The same level of road decommissioning is proposed for all action alternatives and the effects described here are common to alternatives 2, 3 and 4. Road decommissioning would cause short-term, negative effects to sedimentation, stream temperature and channel morphology. Removal of culverts on perennial stream crossings during road decommissioning would result in direct sedimentation effects. These are considered direct effects since the action would occur within the stream channel where water would be diverted around the construction site, or dammed, which could cause a minor increase in stream temperature. Groundwater inflow at the construction site would be hard to control on perennial crossings which may cause turbid water conditions.

Turbidity could be highest at the site, but would diminish as it extends through the reach (Foltz et al. 2008). If settling ponds were to be installed to lower turbidity from groundwater seepage, then an increase in water temperature might occur. All of these negative effects would be short-term, occur during construction and last for no more than a few days post-construction. Road decommissioning would not cause negative short- or long-term effects at the reach or watershed scale.

Excavation in the stream channel for road decommissioning might cause short-term sedimentation and channel incision which could occur during the following winter rain storms. These effects might last for up to two winters (depending on the magnitude of peak flow) and only be detectable at the site scale (Foltz et al. 2008, Madej 2001). The resulting channel incision and slope erosion would be a fraction of the total fill removed at the crossings. Two large perennial stream crossings (tributaries to Sutcliffe and Doolittle Creek), and seven intermittent stream crossings would be decommissioned.

The long term benefits of decommissioning these crossings far outweigh any short-term negative effects to water quality. Beneficial effects due to the proposed decommissioning also include a USLE model predicted reduction of 14 cubic yards per year of sediment and a GEO model predicted reduction of 2,079 cubic yards of sediment from a 10-year return period mass-wasting event. These beneficial effects are due to restoration of hill slope hydrology from removal of inboard ditches, cross-drain culverts and stabilization of the roads cut and fill slopes.

Meadow Enhancement

Meadow enhancement is proposed for all action alternatives and the effects described here are common to Alternatives 2, 3 and 4. The proposed meadow treatments would benefit meadows and wetlands by reducing conifer encroachment. Groundwater amounts may actually increase from these treatments, prolonging the duration of seasonal water inundation. Increasing the duration and extent of the groundwater table would favor plant species adapted to these environments. Ground disturbance would be minimal due to hand treatment. Shade would not decrease since only small diameter thinning by hand, followed by pile burning would occur.

Alternative 2 – Proposed Action

Direct/Indirect Effects

Activities within Stream Course Riparian Reserves

Roads and Landings

Re-opened temporary roads located in stream course RRs may cause short-term, negative effects to sedimentation and stream temperature. Reopened temporary road stream crossings may cause short-term, negative effects to sedimentation, stream temperature and channel morphology. Re-opened landings located in stream course RRs may cause short-term, negative effects to sedimentation and stream temperature.

Table 41 compares the miles and road density of reconstructed to decommissioned roads within stream course RRs. The increase in temporary road density is offset by the reduction due to decommissioning in the West Branch Creek 7th field watershed and the entire Indian Creek 5th field; there would be a net reduction in road densities following implementation of alternative 2.

The proposed reopened/reconstructed roads in the stream course RR are located in the outer half of the interim width (170 ft), meaning there would be at least 85 feet between the road and the stream course. Some of the reconstructed roads perpendicularly bisect stream course RRs at intermittent and ephemeral stream crossings. BMPs and project design features would ensure that reopened roads and decommissioned roads would not cause detrimental effects to beneficial uses of water. The reopening/reconstruction of existing roads might have less effect than the construction of new temporary roads, although some of the old roads may be located in undesirable locations. Reconstructed roads may already have an established road prism compared to newly constructed ones that would require more soil displacement. The vegetation removed on reconstructed roads may not have as substantial of a root system as what would be removed on a newly constructed road, so mass-wasting may have a greater effect on newly constructed roads. Any possible increase in surface erosion and peak flow from either newly constructed or reconstructed roads would be the same. After the temporary roads are used and hydrologically restored there would be no difference between newly constructed temporary roads and reconstructed roads.

Short-term, negative indirect effects at an existing temporary road stream crossing may occur following hydrologic rehabilitation. These activities would not cause detrimental effects to beneficial uses of water. Subsequent road closure may leave some of the reconstructed roads that were poorly designed originally in a more properly functioning hydrological state.

Table 41. Proposed action comparison of miles of reconstructed temporary roads to decommissioned roads located in stream course RRs by 7th –field watershed (percent change in parentheses)

Watershed	Reopened/Reconstructed Temporary Roads	Decommissioned Roads
Indian Creek Headwaters	0.04 (0.41)	
West Branch Indian Creek	0.16 (2.9)	0.49 (-8.9)
Coon-Wagner	0.14 (1.6)	
Little SF Indian Creek		0.24 (-4.1)
Cole-Clauson	0.11 (1.1)	
East Fork Indian Creek	0.11 (1.6)	
Indian/Doolittle Creek		0.98 (-7.9)
Total	**0.56 (0.64)**	**1.70 (-1.95)**

Acres of reconstructed landings located within stream course RRs are listed in table 42. Constructed landings would be located outside of stream course RRs. Landings would be hydrologically restored by actions such as removing berms, recontouring, and spreading slash or straw as needed. Therefore any negative effects on water quality would be insignificant, short-

term (3 years prior to revegetation), and only occur at the site scale. BMPs and project design features would ensure that landings would not cause significant effects to beneficial uses of water.

Table 42. Proposed action acres of reconstructed landings located in stream course RRs by 7th field watershed

Watershed	Reconstructed Landings in Stream Course Riparian Reserves (acres)
Indian Creek Headwaters	1.2
West Branch Indian Creek	1.1
Indian/Mill Creek	0.45
Coon-Wagner	0.34
Little SF Indian Creek	0.73
Cole-Clauson	1.59
East Fork Indian Creek	0.68
Luther-Ikes	
Indian/Doolittle Creek	0.75
Total	**6.84**

Thinning

Thinning treatments in stream course RRs may cause short-term, negative effects to sedimentation from skid trails and to stream temperature from canopy removal in plantations. Acres of commercial treatment and ground based equipment operations in steam course RRs are summarized in table 43.

These acres have already been adjusted by the stream course RR buffers prescribed in the project design features (Chapter 2).

These buffers, although not the entire steam course RR interim width, would be adequate to avoid substantial detrimental effects to beneficial uses of water. The Forest Service Best Management Practice Evaluation Program 2003-2007 Report (USDA Forest Service 2009a) indicated that Region 5 Forests were 94 percent effective in preventing sediment from entering stream channels. Any possible sediment delivery to streams due to these smaller buffer widths for treating previously clear-cut stream course RRs would be minor and at the site scale.

Table 43. Proposed action commercial treatment acreage located in stream course RRs by 7th field watershed[1]

Watershed	Total Stream Course RR (acres)	Stream Course RR treatment acreage with project design feature (percent of all RR)	
		Commercial Treatment	Ground-Based
Indian Creek Headwaters	1,915	59.9 (3.1)	42.5 (2.2)
West Branch Indian Creek	1,288	40.0 (3.1)	40.0 (3.1)
Indian/Mill Creek	1,326	9.8 (0.7)	9.8 (0.7)
Coon-Wagner	1,598	46.3 (2.9)	46.3 (2.9)
Little SF Indian Creek	1,469	13.4 (0.9)	13.4 (0.9)
Cole-Clauson	2,344	26.6 (1.1)	24.3 (1.0)
East Fork Indian Creek	2,605	11.1 (0.4)	11.1 (0.4)
Luther-Ikes	1,850		
Indian/Doolittle Creek	1,480	23.2 (1.6)	22.0 (1.5)
Total for Indian Creek 5th field Watershed	**20,068**	**230 (1 percent)**	**209 (1 percent)**

[1] Ground based treatment acres includes feller buncher, tractor endline and traditional tractor yarding.

Buffers and canopy retention project design features have been developed for perennial and large intermittent streams (intermittent streams which flow into the month of June) in natural stands to eliminate the possibility of stream shade reduction (Chapter 2). All of the perennial streams flow adjacent to, not through, treatment units. Therefore, any treatment to perennial stream course RRs would only occur on one side of the stream course. There would be no effects to stream temperature due to thinning natural stands in the RRs of perennial and large intermittent streams because canopy cover would remain above 85 percent in the inner portion and above 65 percent in the outer portion (see project design features in Chapter 2).

Even with the aggressive plantation treatment, the canopies of the young thrifty trees should regenerate previous stream shade within a decade. A review of research projects studying effects to stream temperature due to stream course RR treatments saw a general trend of onsite stream temperature recovery of 10 years, although many of these studies were of clear-cuts (Moore et al. 2005). The buffering capacity downstream due to stream shade, flow, and tributary and groundwater inflow could reduce stream temperatures to background levels a short distance downstream (Moore et al. 2005). Increased stream temperature in plantations may occur at the site and diminish at the reach scale, but would be undetectable at the 7th field watershed scale because of the small percentage, ranging from 0.2-3.1 percent, of stream course RR treatments relative to the intact stream course RRs in watersheds as a whole. Commercial treatment in plantation stream course RRs would not cause long-term detrimental effects to stream temperature.

Underburning

Prescribed fire treatments in stream course RRs could cause short-term, negative effects to sedimentation. The proposed landscape-scale underburn acres within stream course RRs are summarized in table 44. These underburns would be located in a larger portion of the stream

course RRs. Prescribed burning in stream course RRs should lower the risk of extreme fire behavior that might otherwise result in high soil burn severity during future wildfires. Recent high-severity wildfires in the Elk Creek watershed completely burned through and consumed much of the vegetation in stream course RRs. Although this was an extreme wildfire event, the pre-emptive use of prescribed fire might have limited the high-intensity effects in these often heavily fuel-loaded areas. Project design features and BMPs (Chapter 2) ensure effects from underburning are minimized. Possible negative effects to water quality due to prescribed fire would be short-term (1-2 years) and occur at the site scale. Prescribed fire would not cause substantial effects to beneficial uses of water.

Table 44. Proposed action prescribed burning acreage located in stream course RRs by 7th field watershed

Watershed	Total Stream Course RR (acres)	Steam course RR Rx burn acres (percent of all RR)
Indian Creek Headwaters	1,915	412.9 (21.6)
West Branch Indian Creek	1,288	266.1 (20.7)
Indian/Mill Creek	1,326	6.2 (0.5)
Coon-Wagner	1,598	168.0 (10.5)
Little SF Indian Creek	1,469	302.6 (20.6)
Cole-Clauson	2,344	143.1 (6.1)
Indian/Doolittle Creek	1,480	230.8 (15.6)
Total for Indian Creek 5th field Watershed	**20,068**	**1529.7 (7.6)**

Cumulative Effects

Changes in Sedimentation and Channel Morphology

For this analysis, all planned projects are analyzed as being completed; therefore, there are no other present or reasonably foreseeable actions considered. The CWE analysis is summarized in table 45 and in tables 74 and 75 in appendix F. The results indicate that the amount, intensity, and locations of the alternative 2 treatments relative to the watershed area have a small effect on CWE risk ratios; only small changes are seen when comparing the existing condition to the effects of the proposed action. The proposed decommissioning would cause a net decrease in the GEO risk ratio in the Indian/Doolittle Creek 7th field watershed and the greater Lower Indian Creek 6th-field watershed. Predicted increases in surface soil erosion (USLE) are greatest in Coon-Wagner at a 0.12 increase in risk ratio. The USLE model does not factor in the capacity of stream course RR buffers to filter sediment before reaching the stream course. Therefore, the actual amount of sediment that may enter the channel is a fraction of the predicted amount.

The indirect effects predicted by the USLE model may be realized from a 6-hour, 2-year rain event. Should this design storm not occur prior to revegetation, then the predicted sedimentation rates would not occur.

Predicted increases in sedimentation due to mass wasting were the greatest in Indian/Mill Creek and Coon-Wagner at a 0.03 increase in risk ratio. This increase is outside of the accuracy of the GEO models. The GEO model is an empirical model and provides a rough estimate of accelerated mass-wasting potential. The predicted mass-wasting might be triggered by a 10-year event if one were to occur. It is possible that a recovery of root strength from grass and brush species, as well as the retained trees' root systems extending into the gaps where trees were harvested, may promote recovery of the hillslope hydrology prior to the occurrence of the next 10-year event.

Table 45. Cumulative watershed effects risk ratios for the existing condition (alternative 1) and the proposed action (alternative 2)

Watershed	Model					
	USLE		GEO		ERA	
	Existing Condition	Proposed Action	Existing Condition	Proposed Action	Existing Condition	Proposed Action
7th – Field Watershed						
Indian Creek Headwaters	0.33	0.44	0.43	0.45	0.48	0.63
West Branch Indian Creek	0.68	0.78	0.36	0.36	0.70	0.84
Indian/Mill Creek	0.23	0.25	0.45	0.48	0.32	0.36
Coon-Wagner	0.52	0.64	0.79	0.82	0.67	0.85
Upper South Fork Indian Creek	0.09	0.09	0.22	0.22	0.26	0.26
Twin Valley Creek	0.00	0.00	0.00	0.00	0.00	0.00
Little South Fork Indian Creek	0.34	0.40	0.34	0.35	0.36	0.47
Cole-Clauson	0.18	0.23	0.55	0.55	0.49	0.54
East Fork Indian Creek	0.15	0.15	0.81	0.81	0.28	0.29
Luther-Ikes	0.39	0.39	0.75	0.75	0.60	0.61
Indian/Doolittle Creek	0.80	0.87	0.76	0.74	0.60	0.67
Perkins-Happy Camp	1.36	1.36	0.54	0.54	0.59	0.59
6th – Field Watershed						
Upper Indian Creek	0.43	0.52	0.51	0.52	0.50	0.63
South Fork Indian Creek	0.10	0.12	0.30	0.30	0.29	0.32
Lower Indian Creek	0.67	0.69	0.74	0.73	0.59	0.61
5th – Field Watershed						
Indian Creek	0.26	0.30	0.50	0.50	0.46	0.52

ERA modeling is used to provide an estimate of peak flow increase, but is hard to analyze since its outputs are simply in ERA percentages. Grant et al. (2008) reviewed the results of paired watershed studies to come to a consensus on forest harvesting effects on peak flow. The review found that forest harvesting in the transient snow zone had a greater influence on peak flows than forest harvesting in the rain-dominated zone. In the rain-dominated zone, the percent of a watershed's area that is harvested would have to exceed between 30 and 45 percent to reach the 10 percent peak flow increase prediction limit (Grant et al. 2008). In the transient snow zone, the percent of a watershed's area that is harvested would have to exceed between 15 and 20 percent to reach the 10 percent prediction limit (Grant et al. 2008). Openings in the forest canopy can collect more snow which could melt quickly during rain-on-snow events, causing a peak flow increase in clear-cut or heavily thinned areas (Moore and Wondzell 2005). This may be especially true of plantations located in the transient snow zone where heavy thinning is proposed. By converting percent ERA into percent Equivalent Clearcut Acres (ECA), the increase in ERA risk ratios of 0 to 0.18 (0 to 1 percent ERA increase or a 0 to 4 percent ECA increase) due to alternative 2 may be equal to a 0 to 2 percent increase in peak flow. The cumulative increase in peak flow may be 0 to 10 percent (with Coon-Wagner going from and 8 to 10 percent and Luther/Ikes remaining at 9 percent). This assumes that the entire Indian Creek watershed is in the transient snow zone. All of the 7th field watersheds in Indian Creek are larger than those of paired watershed studies in Grant et al. (2008), so the possible peak flow increase would be equal to or smaller than 0 to 2 percent. The treated smaller sub-watersheds within the greater 7th field may experience the 0 to 2 percent increase in peak flow, but this increase, when added to the remaining untreated sub-watersheds, would be attenuated and therefore undetectable at 7th field scale.

Neither summer low flows nor annual water yield would be affected due to the overall small amount of thinning in proportion to a particular 7th field watershed's drainage area. When treatment acres are scaled based on their respective treatment (50 percent for plantations and 25 percent for natural stands) the relative amount of acres being opened range from 0.2 to 2.6 percent of an entire 7th field watershed. Based on paired watershed studies, water yield and summer low flows may actually increase (Keppeler and Ziemer 1990, Stednick 2008), although the amount of basal area removed in these studies is far greater than what would occur on a watershed scale under the proposed action.

Modeled pre- and post-project cumulative watershed effects at the 7th field scale are all under 1.0, each model's threshold of concern in those watersheds where treatments are proposed. Although ERA, USLE and GEO model results are under the threshold of concern, they are elevated (any model's risk ratio greater than 0.75 and less than 1.00) in several watersheds (Coon-Wagner, East Fork Indian Creek, Luther/Ikes, and Indian/Doolittle Creek) with proposed treatments (table 49). The proposed action may cause a peak flow increase of 0-2 percent, which would cause the cumulative peak flow increases to range from 0-10 percent. The peak flow increase may be detectable in smaller sub-watersheds where treatments would occur, but not in

the greater 7th field watersheds. Annual water yields would remain unaltered, although low flows could have a short-term increase.

Conclusion

Alternative 2 would not change aquatic habitat conditions because only minor impacts to water quality are expected. All potential negative effects would be short in duration (1-10 years) and would occur at the site or reach scales. The negative effects would not measurably affect sedimentation, stream temperature, or channel geomorphology at the reach, the 7th field watershed scale, or greater.

Beneficial uses of water would continue to be supported in their current state under this alternative. The current state is considered to be impaired under the 303(d) list for temperature, nutrients, dissolved oxygen, and sediment. Alternative 2 would help accelerate the delisting of Indian Creek for sediment due to the reduction in road sediment sources from decommissioning.

Achievement of Forest Plan desired conditions within the stream course RRs would be accelerated (when compared to taking no action), especially in densely-stocked stands with off-site pine. While a reduction in road density would be realized across the Indian Creek 5th field watershed as a whole, three of the six 7th field watersheds with watershed concerns would have a net increase in road density within stream course RRs due to the proposed action. Newly constructed and reconstructed temporary roads would be hydrologically restored following use causing potential short-term adverse effects to diminish over time.

Aquatic Conservation Strategy Objectives are described in detail in appendix D. Appendix D includes a summary of how alternative 2 addresses these objectives and compares this to implementation of the action alternatives.

Alternative 3 – No New Temporary Roads

Alternative 3 differs from alternative 2 in the following ways: 1) no newly constructed temporary roads; 2) 0.8 fewer miles of re-opened/reconstructed temporary roads; 3) 270 fewer acres of commercial thinning; 4) 28 fewer landings; and 5) 70 more acres of underburning.

Direct/Indirect Effects

Activities within Stream Course Riparian Reserves

Roads and Landings

Alternative 3 includes fewer miles of reopened/reconstructed temporary roads in stream course RRs than alternative 2 and therefore, benefits of proposed decommissioning and net reduction in road density in stream course RRs would be greater under alternative 3 than alternative 2.

Table 46. Alternative 3 comparison of miles (percent) of reopened/reconstructed temporary roads to decommissioned roads located in stream course RRs by 7th field watershed

Miles in Stream Course RRs (percent change in stream course RR road density)		
7th -field Watershed name	**Reconstructed Temporary Roads**	**Decommissioned Roads**
Indian Creek Headwaters	0.04 (0.41)	None
West Branch Indian Creek	0.16 (2.9)	0.49 (-8.9)
Coon-Wagner	0.03 (0.34)	None
Little SF Indian Creek	None	0.24 (-4.1)
Cole-Clauson	0.06 (0.59)	None
East Fork Indian Creek	0.11 (1.6)	None
Indian/Doolittle Creek	None	0.98 (-7.9)
Total	**0.40 (0.46)**	**1.70 (-1.95)**

The same amount of reconstructed landings would be devegetated for use in alternative 3 as in alternative 2 and therefore impacts are the same as those previously described for alternative 2.

Thinning

Alternative 3 would include 27 percent less thinning and 28 percent less ground based treatments in stream course RRs than alternative 2 (table 47). Therefore, the potential indirect negative effects to water quality would be less. Substantial effects to beneficial uses of water would not occur since the same BMPs and project design features would be in place for all action alternatives.

Table 47. Alternative 3 commercial treatment acreage located in stream course RRs by 7th field watershed[1]

Watershed	Total Stream Course Riparian Reserve (acres)	Stream Course RR treatment acreage with project design feature (percent of all RR)	
		Commercial Treatment	Ground-Based
Indian Creek Headwaters	1,915	42.3 (2.2)	24.9 (1.3)
West Branch Indian Creek	1,288	36.3 (2.8)	36.3 (2.8)
Indian/Mill Creek	1,326	6.1 (0.5)	6.1 (0.5)
Coon-Wagner	1,598	21.6 (1.3)	21.6 (1.3)
Little SF Indian Creek	1,469	13.4 (0.9)	13.4 (0.9)
Cole-Clauson	2,344	15.3 (0.7)	15.3 (0.7)
East Fork Indian Creek	2,605	11.1 (0.4)	11.1 (0.4)
Luther-Ikes	1,850		
Indian/Doolittle Creek	1,480	22.0 (1.5)	22.0 (1.5)
Total for Indian Creek 5th-field Watershed	**20,068**	**168.1 (0.84)**	**150.7 (0.75)**

[1] Ground based treatment acres includes feller buncher, tractor endline and traditional tractor yarding.

Underburning

Prescribed burning in stream course RRs would lower the risk of extreme fire behavior that might otherwise result in high soil burn severity during future wildfires. Project design features and BMPs (Chapter 2) ensure effects from underburning are minimized. Possible negative effects to water quality due to prescribed fire would be short-term (1-2 years) and occur at the site scale. Prescribed fire would not cause substantial effects to beneficial uses of water. Slightly more (70 acres) underburning is proposed under alternative 3 than alternative 2; but this difference is considered negligible at the watershed scale and therefore, the effects are the same as those described for alternative 2.

Cumulative Effects

Changes in Sedimentation and Channel Morphology

Except for a few hundredths of a risk ratio less, the cumulative watershed effects modeling results are very similar for alternative 3 when compared to alternative 2 (table 52 and appendix F). Table 48 shows the change from the existing condition in the modeled results (existing conditions are shown in table 46 for alternative 2 and also in table 75 in appendix F). Changes in sedimentation at the watershed scale are the same as those described previously for alternative 2.

Table 48. Alternative 3 influence of cumulative watershed effects risk ratios (change in parentheses)

Watershed	Model		
	USLE	GEO	ERA
7th – Field Watershed			
Indian Creek Headwaters	0.44 (0.11)	0.45 (0.02)	0.61 (0.13)
West Branch Indian Creek	0.78 (0.10)	0.36 (<0.01)	0.82 (0.12)
Indian/Mill Creek	0.25 (0.02)	0.47 (0.02)	0.35 (0.03)
Coon-Wagner	0.63 (0.11)	0.81 (0.02)	0.81 (0.14)
Upper South Fork Indian Creek	0.09 (0)	0.22 (0)	0.26 (0)
Twin Valley Creek	0.00 (0)	0.00 (0)	0.00 (0)
Little South Fork Indian Creek	0.40 (0.06)	0.35 (0.01)	0.47 (0.11)
Cole-Clauson	0.23 (0.05)	0.55 (<0.01)	0.53 (0.04)
East Fork Indian Creek	0.15 (<0.01)	0.81 (<0.01)	0.29 (0.01)
Luther-Ikes	0.39 (<0.01)	0.75 (<0.01)	0.61 (0.01)
Indian/Doolittle Creek	0.87 (0.07)	0.74 (-0.02)	0.66 (0.06)
Perkins-Happy Camp	1.36 (0)	0.54 (0)	0.59 (0)
6th – Field Watershed			
Upper Indian Creek	0.52 (0.09)	0.52 (0.01)	0.61 (0.11)
South Fork Indian Creek	0.12 (0.02)	0.30 (<0.01)	0.32 (0.03)
Lower Indian Creek	0.69 (0.02)	0.73 (-0.01)	0.61 (0.02)
5th – Field Watershed			
Indian Creek	0.29 (0.03)	0.50 (<0.01)	0.51 (0.05)

Modeled pre- and post-project cumulative watershed effects at the 7th field scale are all under 1.0, each model's threshold of concern in those watersheds where treatments are proposed. Although, ERA, USLE and GEO model results are under the threshold of concern, they are

elevated (any model's risk ratio greater than 0.75 and less than 1.00) in several watersheds (Coon-Wagner, East Fork Indian Creek, Luther/Ikes, and Indian/Doolittle Creek) with proposed treatments (table 48). Alternative 3 may cause peak flow increase of 0 to 2 percent, which would cause cumulative peak flow increases to range from 0 to 10 percent. Peak flow increase may be detectable in smaller sub-watersheds where treatments would occur, but not in the greater 7th field watersheds. Annual water yields would remain unaltered, although low flows could have a short-term increase.

Conclusion

Alternative 3-No New Temporary Roads, would not change aquatic habitat conditions because only minor impacts to water quality are expected. All potential negative effects would be short in duration (1-10 years) and would occur at the site or reach scales. The negative effects would not measurably affect stream temperature at the site and reach scale, or sedimentation, and channel geomorphology at the site scale. All are not measurable at the 7th field watershed scale, or greater.

Beneficial uses of water would continue to be supported in their current state under this alternative. The current state is considered to be impaired under the 303(d) list for temperature, nutrients, dissolved oxygen, and sediment. Alternative 3 would help accelerate the delisting of Indian Creek for sediment due to the reduction in road sediment sources from decommissioning and would do so to a higher degree than Alternative 2 due to less temporary road construction.

Achievement of Forest Plan desired conditions within the stream course RRs would be accelerated (when compared to taking no action), especially in densely-stocked stands with off-site pine. While a reduction in road density would be realized across the Indian Creek 5th field watershed as a whole, three of the six 7th field watersheds with watershed concerns would have a net increase in road density within stream course RRs due to alternative 3. Newly constructed and reconstructed roads would be hydrologically restored following use causing potential short-term adverse effects to diminish over time.

Aquatic Conservation Strategy Objectives are described in detail in appendix D. Appendix D includes a summary of how alternative 3 addresses these objectives and compares this to implementation of the action alternatives.

Alternative 4 – Minimized Underburning

Alternative 4 differs from alternative 2 in the following ways: 1) 6,680 fewer acres (92 percent) of underburning and 2) mastication to treat slash following thinning would be used instead of or in combination with underburning/hand pile burning in 93 units, for a total of approximately 1,490 acres of mastication.

Direct/Indirect Effects

Effects described above for alternative 2 related to direct/indirect effects from roads and landings in stream course RRs and thinning in stream course RRs are the same as those previously described for alternative 2 since all of these treatments are the same for alternative 4.

Activities within Stream Course Riparian Reserves

Underburning and Mastication

Alternative 4 includes 92 percent fewer acres of underburning than alternative 2 and includes a substantial amount of site- preparation mastication following ground-based vegetation treatment. Proposed mastication in stream course RRs (table 49) could cause short-term negative effects to water quality due to ground disturbance that may cause sediment delivery from an extreme rain event (Hatchett et al. 2006). Most of the ground disturbance would be covered by masticated vegetation so any effects would be minor and have a low probability of occurring. Project design features and BMPs would minimize the potential for adverse effects at the site scale. Effects to sedimentation, stream temperature, and channel geomorphology would be undetectable at the reach, 7th field scale or greater.

There would be no substantial direct/indirect effects to water quality due to implementation of alternative 4.

Table 49. Alternative 4 proposed mastication acreage located in stream course RRs in 7th field watersheds

7th -field Watersheds	Total Stream Course RR (acres)	Total Stream Course RR mastication acreage with project design feature (% of all RR)
Indian Creek Headwaters	1,915	14.7 (0.77)
West Branch Indian Creek	1,288	3.5 (0.27)
Indian/Mill Creek	1,326	1.5 (0.12)
Coon-Wagner	1,598	5.2 (0.32)
Little SF Indian Creek	1,469	9.1 (0.62)
Cole-Clauson	2,344	9.9 (0.42)
East Fork Indian Creek	2,605	17.6 (0.67)
Luther-Ikes	1,850	2.4 (0.13)
Indian/Doolittle Creek	1,480	15.0 (1.01)
Total for Indian Creek 5th –field Watershed	**20,068**	**78.8 (0.39)**

Cumulative Effects

Changes in Sedimentation and Channel Morphology

For USLE, alternative 4 would have a lower effect on risk ratios since there would be less underburning and the model assumes that the use of mastication may actually increase soil cover.

GEO would remain unchanged when compared with the proposed action. ERA would increase from mastication, but would decrease due to less underburning treatments. When compared to the proposed action, some 7th field watersheds would experience greater increases and others would experience smaller increases in ERA risk ratios. There would be no measurable difference in ERA risk ratios at the 6th and 5th scale, except in South Fork Indian Creek, which would exhibit a risk ratio 0.01 less than the proposed action. Table 50 and appendix F display the results of modeling for alternative 4. Table 50 shows the change from the existing condition in the modeled results (existing conditions are shown in table 46 for alternative 2 and also in table 75 in appendix F).

Table 50. Alternative 4 influence of cumulative watershed effects risk ratios (change from existing condition in parentheses)

Watershed	Model		
	USLE	GEO	ERA
7th – Field Watershed			
Indian Creek Headwaters	0.37 (0.04)	0.45 (0.02)	0.63 (0.15)
West Branch Indian Creek	0.68 (<0.01)	0.36 (<0.01)	0.87 (0.17)
Indian/Mill Creek	0.25 (0.02)	0.48 (0.03)	0.37 (0.05)
Coon-Wagner	0.55 (0.03)	0.82 (0.03)	0.81 (0.11)
Upper South Fork Indian Creek	0.09 (0)	0.22 (0)	0.26 (0)
Twin Valley Creek	0.00 (0)	0.00 (0)	0.00 (0)
Little South Fork Indian Creek	0.34 (<0.01)	0.35 (0.01)	0.43 (0.07)
Cole-Clauson	0.19 (0.01)	0.55 (<0.01)	0.53 (0.02)
East Fork Indian Creek	0.15 (<0.01)	0.81 (<0.01)	0.29 (0.01)
Luther-Ikes	0.39 (<0.01)	0.75 (<0.01)	0.61 (0.01)
Indian/Doolittle Creek	0.85 (0.05)	0.74 (-0.02)	0.66 (0.06)
Perkins-Happy Camp	1.36 (0)	0.54 (0)	0.59 (0)
6th – Field Watershed			
Upper Indian Creek	0.46 (0.03)	0.52 (0.01)	0.63 (0.13)
South Fork Indian Creek	0.11 (0.01)	0.30 (<0.01)	0.31 (0.02)
Lower Indian Creek	0.69 (0.02)	0.73 (-0.01)	0.61 (0.02)
5th – Field Watershed			
Indian Creek	0.27 (0.01)	0.50 (<0.01)	0.52 (0.06)

Modeled pre- and post-project cumulative watershed effects at the 7th field scale are all under 1.0, each model's threshold of concern in those watersheds where treatments are proposed. Although, ERA, USLE and GEO model results are under the threshold of concern, they are elevated (any model's risk ratio greater than 0.75 and less than 1.00) in several watersheds (Coon-Wagner, East Fork Indian Creek, Luther/Ikes, and Indian/Doolittle Creek) with proposed treatments (table 50). Alternative 4 may cause a peak flow increase of 0-2 percent, which would cause the cumulative peak flow increases to range from 0-10 percent. The peak flow increase may be detectable in smaller subwatersheds where treatments would occur, but not in the greater 7th field watersheds. Annual water yields would remain unaltered, although low flows could have a short-term increase.

Conclusion

Alternative 4, Minimized Underburning, would not change aquatic habitat conditions because only minor impacts to water quality are expected. All potential negative effects would be short in duration (1-10 years) and would occur at the site or reach scales. The negative effects would not measurably affect stream temperature at the site and reach scale, or sedimentation, and channel geomorphology at the site scale. All are not measurable at the 7th field watershed scale, or greater.

Beneficial uses of water would continue to be supported in their current state under this alternative. The current state is considered to be impaired under the 303(d) list for temperature, nutrients, dissolved oxygen, and sediment. Alternative 4 would help accelerate the delisting of Indian Creek for sediment due to the reduction in road sediment sources from decommissioning.

Achievement of Forest Plan desired conditions within the stream course RRs would be accelerated (when compared to taking no action), especially in densely stocked stands with off-site pine. While a reduction in road density would be realized across the Indian Creek 5th field watershed as a whole, three of the six 7th field watersheds with watershed concerns would have a net increase in road density within stream course RRs due to alternative 4. Newly constructed and reconstructed temporary roads would be hydrologically restored following use causing short-term adverse effects to diminish over time.

Aquatic Conservation Strategy Objectives are described in detail in appendix D. Appendix D includes a summary of how alternative 4 addresses these objectives and compares this to implementation of the action alternatives.

Summary

The Indian Creek watershed has high concentrations of dormant and active landslide terrain with a dense road network, and a long history of mining and forest management. The residual effects of these past actions, in combination with the effects of past flood events, have led to a watershed whose sedimentation, stream temperature and channel geomorphology are not currently meeting desired conditions. Fire suppression has also created dense conditions in unmanaged stands, reducing diversity and increasing the risk for moderate to high severity wildfire.

Alternative 1, No Action, would not actively maintain or restore sedimentation, stream temperature or channel geomorphology. The no action alternative would passively maintain areas that are currently functioning within desired reference conditions and passively restore areas that are naturally recovering from past disturbances.

Alternatives 2, 3 and 4 would all result in short-term negative effects to stream temperature at the site and reach scale, and sedimentation, and channel geomorphology at the site scale only, and would not be measurable at the watershed scale. Adverse effects on stream temperature would only occur in treated plantations due to the removal of canopies in dense RRs in an effort

to improve tree growth and vigor and to promote future recruitment of large woody debris. All three alternatives would add very little to cumulative watershed effects within Indian Creek.

Except for road stream crossing decommissioning, the effects on sedimentation and channel geomorphology would only be realized from either intense thunderstorms or above-average rainfall events (greater than one inch per hour, or a ten year event) which would overwhelm soil infiltration capacities, resulting in overland flow and sediment transport. If such a storm event did not occur within the first few years following treatment, regrowth of vegetation would eliminate the risk of sediment transport to stream courses.

The long-term and short-term beneficial effects from implementing alternatives 2, 3 and 4 on sedimentation, stream temperature and channel geomorphology would outweigh all of the effects listed above. These beneficial effects include:

- Increased fire resilience of stream course RRs, reducing the risk of moderate- to high-severity wildfire causing negative effects to water quality.
- Plantation (and selected natural stand) stream course RRs moving towards desired conditions (future LWD recruitment, diverse understory, more stream shade, etc.).
- The removal of nine stream crossing culverts and fills (two perennial and seven intermittent), reducing the risk of catastrophic failures causing significant effects to water quality and aquatic habitat.
- Decommissioning 4.1 miles of chronic sediment producing system roads.
- Rehabilitation of re-used existing temporary roads and landings that may currently be contributing to sedimentation.

All action alternatives would meet clean water act (CWA) standards, Basin Plan and aquatic conservation strategy (ACS) standards and guidelines (appendix D) since there would be no measurable change to water quality or aquatic habitat at the watershed scale.

3.7 Geology

3.7.1 Methodology

Landslide potential, volume of landslide sediment produced, and hazards of naturally occurring asbestos were the key factors considered. Short-term effects were considered zero to five years, during which site conditions would be expected to recover from the proposed thinning and underburn activities. Long term effects were considered those greater than five years. The effects of high-severity wildfire would likely last up to 50 years. Even though proposed temporary roads and re-opened existing temporary roads would be hydrologically restored following use, for purposes of this analysis these roads were considered to be permanent fixtures, and would never fully recover because of the changes they create in mass balance (cuts and fills), and slope hydrology which are associated with roads in steep ground of the Klamath Mountains. Spatial context is the site level, 7th field watershed level, and 5th field watershed level (figure 7).

Each alternative was evaluated according to: (a) its potential direct, indirect, and cumulative effects, (b) the environmental indicators, and (c) how well it would meet the Forest Service's

geologic program goals for the Klamath National Forest. Direct, indirect, and cumulative effects were assessed through field and air photo assessments and GIS analyses using bedrock and geomorphology coverages. Aerial photos were used to identify geomorphic features in units and along roads, to develop a history of landslides and debris flows in the project area dating back to 1944, and to prioritize units for field visits. Units on unstable lands, as identified on the Forest geomorphology coverage or on air photos, were selected for field review. Klamath National Forest Sufficiency Standards for geologic investigations (USDA Forest Service 2003) were applied.

The geological cumulative watershed effects (GEO) model was used to estimate the potential volume of landslide sediment (in cubic yards) which would likely be delivered to the stream system under the variety of road, timber harvest, and fire conditions inherent in each alternative. Landslide production coefficients for this model were developed in the Salmon River basin, about 50 miles southeast of the project area. The GEO model also estimated a risk ratio that was used as an indicator of the potential for adverse cumulative watershed effects. The risk ratio was determined by comparing post project sediment production to that which would occur under background conditions in which there would be no roads, harvest, or fire. The relative change in sediment production (percent over background) was computed as the percentage change of post project sediment production compared to background sediment production.

When the modeled percent over background quantity approaches 200 percent, it is assumed that the risk for adverse cumulative watershed effects rises rapidly, and ratio value (1.0) is considered a management threshold. The risk ratio is computed by dividing the threshold value of 200 percent by the estimated post project percent over background. This analysis followed the procedure described in 2004 Cumulative Watershed Effects (CWE) analysis (USDA Forest Service 2004a). Appendix F contains a summary of the results of all models used as part of CWE for this project, including the GEO model.

Areas of ultramafic bedrock were derived through GIS overlay. Road areas were computed assuming a road corridor (prism) width of 50 feet. For purposes of this project, temporary roads are assumed to have a 10- to 20-foot-wide driving surface, with an average driving surface width of 12 feet and a 15- to 30-foot-wide road prism width, depending on steepness of slope. The road prism width for purposes of the geology analysis was increased to 50 feet just to ensure all disturbed areas were considered; actual disturbance would be less than that modeled, but the results would show a relative comparison between alternatives.

The alternatives are compared using the following indicators:

- Landslide potential measured by acres of activities proposed on unstable land in Riparian Reserves geomorphic terrains including active landslides, inner gorges, and toe zones of dormant landslides) or in cubic yards of landslide
- Naturally-occurring asbestos hazard measured by acres of activities proposed in ultramafic bedrock
- How alternatives meet geologic program goals as outlined in the Forest Plan (meeting Aquatic Conservation Strategy Objectives; maintaining water quality and quantity;

preventing geologic hazards to public health, safety, welfare and property; protecting geologic resources; and developing geologic resources in an environmentally sound manner)

- For cumulative effects, GEO model outputs for cubic yards of landslide sediment based on proposed activities combined with existing conditions and other planned activities
- For cumulative effects, GEO model outputs for risk ratios based on proposed activities combined with existing conditions and other planned activities

Project activities that would have the largest effect on model outputs per unit area are temporary road construction, re-opening of existing temporary roads, and road decommissioning. However, plantation thinning would be applied on many more acres than road actions, and as a result, this activity would contribute considerably to model outputs (see GEO Model output tables for each action alternative, under proposed actions, in the "Units 4/" column).

The information used in the preparation of this section, including detailed results of model runs, comes from detailed analysis in the Geology Report (De La Fuentes and Bell 2010) and is available in its entirety in the project record.

3.7.2 Affected Environment

Geologic Resources

This analysis considered potential effects to geologic resources from proposed activities. These resources included the following:

- Groundwater - Springs are common in the project area, particularly within landslide deposits. Since this project consists mostly of thinning and underburning, effects on the groundwater resource would be expected to be negligible because transpiration by the thinned stand is expected to return to pre-thinned conditions within a few years, and snow accumulation and melt rates would not likely change since no openings would be created in the canopy. As a result, groundwater is not addressed further in this analysis.
- Rock and Earth Materials - A number of rock quarries exist within the project area, and some of them are in ultramafic rock which could contain asbestos. Rock aggregate would be developed for use on roads from existing sources, so asbestos hazards could be affected by the project.
- Caves - No known caves occur within the project area; this resource is therefore not analyzed further.
- Geologic Special Interest Areas - The "West Fork Waterfall and Landslide" Geologic Special Interest Area (SIA) lies within the project area, and is located in the West Fork of the Little South Fork Indian Creek. It consists of two separate features about 0.7 miles apart, and is labeled "Little S Fake Indian Cr Geo Areas" on the 2007 Klamath National Forest recreation map, where it is shown as two polygons. A third Geologic SIA, "Elk Lick Pond," lies about two miles west of the project area along the South Fork of Indian Creek. It is identified as "Elk Lick Geological Area" on the Forest's recreation map. No activities are planned in the immediate vicinity of these SIAs. As a result, these areas are not considered further in this analysis.

Geologic Hazards

Landslide and Debris Flow Hazards

Landslides can adversely affect human life and property, watershed condition, and fish habitat. Management activities that can increase landslide rates include: (a) roads or landings that are improperly located designed or maintained; (b) removal of excessive vegetation from unstable areas through logging or prescribed fire, and (c) disturbances to soil in unstable areas associated with mechanized yarding of timber. Landslide hazards in the project area are categorized as follows:

1. Deep, Slow-Moving Landslides (Earth flows and Slumps) - A large proportion of the project area is underlain by dormant landslides characterized by earthflows and slumps. Within these deposits, there are numerous active earthflows up to 60 acres in size.
2. Shallow Rapid Landslides (Debris Slides) - Several large debris slides occurred in the headwaters of Green Creek during the 1964 flood, on steep (more than 65 percent) slopes. Smaller debris slides occurred in the sandy granitic soils of East Fork Indian Creek and are often very prone to debris slides, particularly where bedrock is deeply weathered and dissected. Debris slides are common in such areas of the Klamath National Forest.
3. Debris Flows - Debris flows are sediment-laden flows which usually develop in channels, and move rapidly downstream, mobilizing bed material, and stripping away vegetation. They can be triggered by landslides in the headwaters during winter storms or by high intensity short duration summer storms even if they do not trigger landslides.

Naturally Occurring Asbestos Hazards

Airborne asbestos is a human health hazard. There is a potential for asbestos fibers to be introduced into the air by vehicles traveling on unsurfaced roads in ultramafic areas, vehicles traveling on roads surfaced with ultramafic rock aggregate, rock removed from quarries in ultramafic rock, and yarding of timber in ultramafic areas, particularly tractor yarding. Ultramafic rock occurs in some portions of the project area.

Disturbance History

Past logging, road building, wildfires and managed fires have all contributed to the current conditions in the project area. Past logging included clear cutting and creation of plantations, many of which were revegetated by 1999. The majority of the road network was built by 1975 to support logging and other uses. Only minor fires have occurred in the project area within the past 50 years, as described in more detail in the fuels section of this chapter.

Landslide and Storm History

Large landslide-producing storms have been documented on the Klamath National Forest. The major events occurred in 1955, 1964, 1974, and 1997, with smaller events occurring in 1983 and 2006 (USDA Forest Service 1998). The 1964 flood triggered many landslides, mainly concentrated around stream gorges. However, the largest landslide in 1964 was a major debris

slide on the south flank of Spees Peak, known locally as the Spees Peak Landslide. This landslide initiated in a tributary, and then scoured Green Creek all the way to its junction with Indian Creek, removing a 170-foot wide swath of vegetation along the channel. It deposited a large volume of sediment into Indian Creek.

Other smaller debris slides about a mile to the northwest of Spees Peak occurred just beneath a forest road, with two adjacent point sources. The slides coalesced and deposited material into Green Creek, scouring the channel a distance downstream roughly equal to the length of the slide. Slides which showed up first on the 1975 photos occurred on slopes near stream gorges, such as in the Indian/Doolittle Creek watershed near the Doolittle Creek headwaters, but also off roads southwest of Slater Butte Lookout in the Luther-Ikes watershed, the latter of which were revegetated by 1999. Those slides that first appeared on the 1999 photos were in the East Fork Indian Creek watershed, and were concentrated beneath roads and in logging units. By the time the 1999 air photos were taken, both the Spees Peak slide and the smaller ones to the northwest were about 50 percent revegetated. The photos are in the project record.

Stream channel scour from the 1964, 1974, and 1997 floods was noted throughout the project area. Air photos show that most of Indian Creek, West Branch, East Fork Indian Creek and South Fork Indian Creek and its tributaries were stripped of vegetation by debris flows resulting from the 1964 flood. The width of the channel alteration on main Indian Creek was 300 feet a mile south of Granite Creek, and 1,000 feet about 0.75-miles east of Deadman Point. Indian Creek still showed scour in the 1975 photos from Green Creek down to its intersection with South and East fork. Those creek channels also showed scour one to two miles upstream from this intersection. The last two miles of both West Branch and Mill Creek, and the upper five miles of East Fork also showed scour in these photos. Scour from the 1997 flood occurred in tributaries into East Fork Indian Creek and along a segment of Indian Creek just above and below the South Fork/East Fork intersection (see the map attached to the Geology report (Two Bit Project Air Photo Analysis Results) which shows altered channels).

Revegetation Rates

Revegetation of previously altered channels and past logging units took about 20 years, though in some cases, new vegetation in channels was stripped again during later storms. Revegetation is defined as appearing in air photos to have been covered by new growth of ground covering vegetation since having been stripped or logged.

3.7.3 Environmental Consequences

Alternative 1 - No Action

Direct/Indirect Effects

Alternative 1 would not have any direct or indirect effects because no action would be taken in the project area. Current conditions would continue.

Cumulative Effects

There would be no cumulative effects associated with this alternative because there would be no direct or indirect effects to accumulate with the effects of other past, present, or reasonably foreseeable future activities. There are residual indirect effects that are the result of past timber harvest, road construction, and mining. Potential for adverse indirect watershed effects resulting from past or ongoing activities are greatest in Coon-Wagner, East Fork Indian, Luther-Ikes, and Indian-Doolittle 7th field watersheds, with risk ratios ranging from 0.74 to 0.81, while the 5th field watershed (Indian Creek) has a risk ratio of 0.50 (see appendix F for the CWE model summary). A risk ratio of 0.50 means that under existing conditions, the watershed would be expected to produce landslide sediment at a rate 2.0 times the rate it would produce if it had no roads, harvest or fire, in response to a 10 year storm. In summary, risk ratios for all 7th field watersheds within the project area are below the management threshold established by the Forest, which is 1.0. The highest is 0.81 (East Fork Indian).

Alternative 2 - Proposed Action

Direct/Indirect Effects

Thinning activities using ground-based and cable yarding logging systems can result in soil disturbance and compaction, decreased root support and decreased evapotranspiration, rerouting of surface runoff, potential disturbance to springs and wet areas if entered with mechanical equipment, and disturbance of soil underlain by ultramafic rock. Thinning would result in a small to negligible short term increase in landslide risk due to a reduction in root support and evapotranspiration. Thinning would result in a small to negligible short term increase in landslide risk due to a reduction in root support and evapotranspiration. Effects in thinned plantations would be larger than in natural stands because more trees would be removed there (greater than 40 percent of the basal area). This is the percent basal area reduction at which a measurable change may occur in the landslide potential. The cutoff of 40 percent basal area reduction is derived from professional judgment guided by the typical basal area removed during a variety of silvicultural treatments (CWE 2004). Although small, this increased potential could last for several years after thinning.

Prescribed underburning can result in the removal of low vegetation and the addition of ash to the soil. There would be a small risk of small isolated areas (a few acres in size) burning at high or moderate severity. If the fire were to burn at high or moderate severity on an unstable area, landslide potential would be increased; however, the likelihood of this is small and in general, underburning would be of low intensity and would not increase landslide risk.

Further development of existing rock quarriescould increase landslide potential due to changes in hydrology and mass balance on a slope, but this would be avoided with application of project design features (Chapter 2). Development of a rock source for road aggregate would generate dust and might alter drainage patterns, but these potential adverse effects would also be minimized with application of project design features (Chapter 2).

Any new roads or landing construction would remove vegetation, disturb soils (including in ultramafic rock), alter slopes through cuts and fills, and reroute surface runoff. Landslide potential due to these changes could increase due to changes in mass balance associated with cuts, fills, and alterations to the hydrology of the hillslope. These effects are minimized by design features that would avoid unstable areas, minimize cut and fills and dewatering measures if subsurface water is encountered. There would be a slight increase in landslide potential associated with temporary roads. Most of the proposed new temporary roads are short spurs scattered across the landscape, usually on gentle ground and often near ridge tops. None of the proposed new temporary roads cross unstable land in Riparian Reserves.

Maintenance and upgrading of existing roads would disturb the road surface and reroute surface runoff. The alteration of surface drainage patterns created by maintaining or upgrading existing roads would decrease the landslide potential where drainage problems exist and cut and fill stability is addressed. Reopening of existing temporary roads would remove trees and brush which in some cases might be up to 40 years old. This could locally increase landslide potential, but only in the short-term since these roads would be restored shortly after use including correction of any drainage problems.

Decommissioning of existing temporary roads would also involve removal of vegetation where they are overgrown but decommissioning would greatly reduce landslide potential by removing large fills at stream crossings and hydrologically stabilizing road surfaces. Specialized treatments and meadow enhancement treatments were not result in any measurable effects to landslide potential.

Specialized treatments and meadow enhancement treatments would not result in any measurable effects to landslide potential because sensitive areas would be protected from mechanical soil disturbance and only minor manipulation of vegetation would occur, and therefore are not considered further in this analysis.

Unstable Land in Riparian Reserves

A total of 1,042 acres of thinning and underburning would occur within unstable land in Riparian Reserves under alternative 2. Road reopening and road decommissioning would also occur, as shown below:

- 0.03 miles of existing road reopening
- 0.9 miles of road decommissioning
- 80 acres of plantation thinning
- 7 acres of natural stand thinning
- 955 acres of underburning

In general, thinning intensity within unstable land in Riparian Reserves would be reduced (see project design features in Chapter 2 and Riparian Reserve Decision Tree in Chapter 1) compared to areas outside of Riparian Reserves. In the long term, thinning would produce healthier stands and would reduce the risk of high intensity fire.

Thinning in plantations on unstable land in Riparian Reserves would result in short-term increases in landslide potential but these short-term increases are considered negligible due to the implementation of project design features which provide for limits on the type of activities and equipment used in these areas, as discussed above. Effects would be primarily due to thinning to less than 40 percent of the basal area in some plantations. This would only occur on 80 acres of unstable land in Riparian Reserve.

Thinning in natural stands on unstable land in Riparian Reserves would result in short-term increase in landslide potential as well, but these short-term increases are also considered negligible due to the implementation of project design features (Chapter 2). Effects would primarily be due to thinning to less than 40 percent of the basal area in some natural stands. This would only occur on about 7 acres of unstable land in Riparian Reserve.

Direct effects from roads and landings would include ground disturbance associated with 2.9 miles of new temporary road construction (0.0 miles on unstable land in Riparian Reserve), and 4.3 miles of existing temporary roads reopened (0.03 miles on unstable land in Riparian Reserve). New road/landing cuts and fills can trigger landslides. However, all new roads/landings avoid unstable land and steep slopes, and project design features would be applied so that the potential for landslides related to these roads is considered to be extremely low. The fact that such risks cannot be eliminated altogether is reflected in the GEO model outputs (table 51 and appendix F) that estimates 617 cubic yards, compared to 2,079 cubic yards reduced by decommissioning. The model applies Forestwide averages and assumes that all new roads would produce average levels of sediment. Similarly, the risk of sedimentation from the 0.03 miles of road in unstable land in Riparian Reserve would be negligible because of implementation of project design features. Most of the proposed new temporary roads are short spurs scattered across the landscape, usually on gentle ground and usually near ridge tops, far from streams. Field review by a geologist prior to use or construction (project design features) would prevent sediment production from these roads.

Road decommissioning would lower landslide potential by an estimated 2,080 cubic yards per decade, based on GEO model outputs for West Branch, Little South Fork and Indian/Doolittle 7th field watersheds (figure 7). This would be particularly noticeable in the 0.9 miles of road decommissioned on unstable land in Riparian Reserves.

Underburning would be of predominantly low severity and would not affect landslide production because all the larger vegetation would survive the fire and resource protection measures have been developed (project design features and BMPs in Chapter 2) to minimize severe fire on unstable lands.

Ultramafic Rock

Airborne naturally occurring asbestos (NOA) is a health hazard. NOA may be released into the air through the ground disturbing activities of ground-based and cable yarding, temporary road opening, and maintenance of existing roads underlain by ultramafic rock. Approximately 3,392

acres of treatment (including road work) would occur within areas underlain by ultramafic rock under alternative 2 as shown below:

- 35 acres of new temporary road construction and reopening of existing roads
- 12 acres of road decommissioning
- 820 acres of tractor yarding
- 5 acres of cable yarding
- 2,420 acres of underburning

Activities in areas underlain by ultramafic rock could introduce asbestos fibers into the air. However, the location of ultramafic bedrock bodies would be identified and provided to personnel and contractors working in the project area. All applicable state and agency regulations regarding NOA would be adhered to for this project (project design features in Chapter 2). Therefore, risk would be minimized.

Geologic Program Goals

Alternative 2 would have a high to moderately high probability of meeting all applicable geologic program goals. Those activities with the greatest potential for effects are tractor yarding, temporary road construction, road reopening and rock pit development. Because of the analysis presented above and the fact that detailed project design features have been developed to minimize the potential for adverse impacts to geologic resources, these effects are minimized.

Cumulative Effects

For this analysis, all planned projects are analyzed as being completed, and there are no other present or reasonably foreseeable actions considered. The GEO model outputs predict small increases in landslide production (19 to 125 cubic yards per decade) associated with temporary roads in all 7th field watersheds except for Upper South Fork Indian, Twin Valley, Luther-Ikes, and Perkins-Happy Camp (appendix F). Based on the effects described in the discussion of direct and indirect effects, none of the proposed roads are expected to cause landslides or produce sediment, with application of project design features. However, the model deals with basin averages, and assumes that all roads will produce landslides and sediment, and does not address the mitigating effects of all project design features. As a result, these 19 to 125 cubic yards would be attributable to the specific components of alternative 2 (roads).

The GEO model outputs also predict small increases in landslide production associated with plantation thinning ranging from 81 to 806 cubic yards per decade in all watersheds except for Upper South Fork Indian, Twin Valley, and Perkins-Happy Camp. The largest increase is in Indian Creek headwaters (806 cubic yards).

In addition, the GEO model outputs also predict reductions in landslide production per decade as a result of road decommissioning proposed under alternative 2 in West Branch (473 cubic yards less), Little South Fork (207 cubic yards less) and Indian/Doolittle (1,400 cubic yards less) 7th field watersheds (appendix F).

Risk ratios account for the offsetting of these alternative 2 effects described above. Four seventh field watersheds (Indian Creek Headwaters, Indian/Mill, Coon/Wagner, Little South Fork Indian) show small increases in risk ratio, ranging from increases of 0.01 to 0.03 and one watershed shows a small reduction of 0.02 in the risk ratio (Indian-Doolittle). At the 6th field scale, there is an increase in risk ratio from current conditions to that after alternative 2 is implemented (0.01 in Upper Indian). At the 5th field scale, there is no change in the risk ratio. These positive and negative changes associated with the project are extremely small in comparison to the effects of past activities (roads and timber harvest).

Therefore, the alternative would result in negligible to minor landslide production that would accumulate with the landslide production of past, other present or reasonably foreseeable future actions.

Alternative 3 - No New Temporary Roads

Direct/Indirect Effects

The general effects described for alternative 2 above associated with thinning activities, thinning activities in Riparian Reserves, prescribed underburning and rock quarry development are the same as those for alternative 2 since all of these actions are also proposed for alternative 3. There is a small reduction (270 acres) in the overall amount of thinning proposed for alternative 3 compared to alternative 2 and therefore reduces the amount of this disturbance across the project area.

Because no new temporary roads would be created under alternative 3, there would no associated vegetation removal, soil disturbance, slope alteration or surface runoff increases due to temporary road construction. However, maintenance and upgrading of existing roads would still occur and would disturb the road surface and reroute surface runoff. The alteration of surface drainage patterns created by maintaining or upgrading existing roads and landings would decrease the landslide potential where drainage problems exist and cut and fill stability is addressed. Reopening (temporarily) existing Forest System roads would remove trees and brush that in some cases might be up to 40 years old. This could locally increase landslide potential, but only in the short-term since these roads would be restored shortly after use, including correction of any drainage problems. Decommissioning of existing temporary roads would also involve removal of vegetation where they are overgrown, but decommissioning would greatly reduce landslide potential by removing large fills at stream crossings and hydrologically-stabilizing road surfaces.

Specialized treatments and meadow enhancement treatments would not result in any measurable effects to landslide potential because sensitive areas would be protected from mechanical soil disturbance and only minor manipulation of vegetation would occur. Therefore these activities are not considered further in this analysis.

Unstable Land in Riparian Reserves

Actions proposed under alternative 3 in unstable land are essentially the same as for alternative 2, except one less acre of natural stand thinning would occur on unstable land in Riparian Reserves. Road work and approximately 1,041 acres of thinning and burning would occur within unstable land in Riparian Reserves under alternative 3:

- 0.03 miles of existing road reopening
- 0.9 miles of road decommissioning
- 80 acres of plantation thinning
- 6 acres of natural stand thinning
- 955 acres of underburning

Because treatments in unstable land are essentially the same as proposed for alternative 2, the effects to landslide potential and sediment production are the same as those previously described for alternative 2; negligible short-term increases in landslide potential and sediment production, minimized through implementation of project design features.

Ultramafic Rock

As described for alternative 2 naturally occurring asbestos is a health hazard. Approximately 15 fewer treatment acres would occur in ultramafic rock areas under alternative 3 than alternative 2 since fewer existing roads would be reopened in these areas. A total of 3,277 acres would be treated as shown below:

- 20 acres of reopening of existing roads
- 12 acres of road decommissioning
- 820 acres of tractor yarding
- 5 acres of cable yarding
- 2,420 acres of underburning

Activities in areas underlain by ultramafic rock could introduce asbestos fibers into the air. However, the location of ultramafic bedrock bodies would be identified and provided to personnel and contractors working in the project area. All applicable state and agency regulations regarding NOA would be adhered to for this project (project design features in Chapter 2). Therefore, risk would be minimized.

Geologic Program Goals

Alternative 3 would have a high to moderately high probability of meeting all applicable geologic program goals. Those activities with the greatest potential for effects are tractor yarding, road reopening and rock pit development. Because of the analysis presented above and the fact that detailed project design features have been developed to minimize the potential for adverse impacts to geologic resources, these effects are minimized. The likelihood of meeting all applicable geologic program goals for alternative 3 are slightly greater than for alternative 2 because no temporary roads would be constructed and fewer acres would be thinned.

Cumulative Effects

The GEO model outputs predict small increases in landslide production (2-71 cubic yards/decade) associated with reopening of existing temporary roads in all 7th field watersheds except for Upper South Fork Indian, Twin Valley, Luther-Ikes, and Perkins-Happy Camp. Since no new temporary roads would be built, the GEO model predicts lower sediment production than quantities shown in alternative 2, as follows: Indian Creek Headwaters (reduction of 54 cubic yards per decade), West Branch Indian (reduction of 62 cubic yards per decade), Indian/ Mill (reduction of 31 cubic yards per decade), Coon-Wagner (reduction of 96 cubic yards per decade), Little South Fork Indian (reduction of 17 cubic yards per decade), Cole Clauson (no measurable change), East Fork Indian (no measurable change), Indian-Doolittle (reduction of 25 cubic yards per decade).

In summary, opening of temporary roads in alternative 3 would add 331 cubic yards of sediment per decade (no new construction of temporary roads), whereas alternative 2 would add 616 cubic yards for opening existing and building new temporary roads.

Risk ratios account for the offsetting of these alternative 3 effects described above. Based on GEO modeling, four 7th field watersheds (Indian Creek Headwaters, Indian/Mill, Coon/Wagner, Little South Fork Indian, (figure 7) would show small increases in risk ratio, ranging from 0.01 to 0.03, and one watershed (Indian-Doolittle) would show a small reduction of 0.02. These results are nearly identical to alternative 2; the only difference is in the Indian-Mill 7th field watershed, where the risk ratio in alternative 3 is 0.01 lower than in alternative 2 (appendix F).

As with alternative 2, the positive and negative changes associated with proposed activities are extremely small in comparison to the effects of past activities (roads and timber harvest).

Therefore, this alternative would not result in more than minor landslide production that would accumulate with the landslide production of past, other present or reasonably foreseeable future actions.

Alternative 4 - Minimized Underburning

Direct/Indirect Effects

Potential direct effects are very similar to alternative 2, except that underburning would be reduced considerably, and mastication would be added. The amount and location of thinning, new temporary roads, reopening of existing roads, decommissioned roads, and the area of ultramafic rock disturbed by temporary roads, tractor units, cable units, and decommissioned roads would be identical to alternative 2.

Specialized treatments and meadow enhancement treatments were not result in any measurable effects to landslide potential because sensitive areas would be protected from mechanical soil disturbance and only minor manipulation of vegetation would occur. Therefore, these actions are not considered further in this analysis.

Unstable Land in Riparian Reserves

Approximately 810 fewer acres of underburning would occur in unstable land for alternative 4 when compared to alternative 2. A total of 270 acres of treatments and road work would occur in unstable land, as shown below:

- 0.03 miles of existing road reopening
- 0.9 miles of road decommissioning
- 80 acres of plantation thinning
- 7 acres of natural stand thinning
- 145 acres of underburning
- 38 acres of mastication (within thinned stands)

Potential direct/indirect effects would be the same as alternative 2. Root support of large vegetation would not be reduced by mastication; therefore, landslide potential would not be measurably affected due to mastication and application of project design features (Chapter 2) would also contribute to minimizing effects. Underburning is greatly reduced compared to alternatives 2 and 3 and therefore, the potential for small areas of high intensity burning are greatly reduced which decreases the risk of landslide potential.

Ultramafic Rock

Airborne NOA is a health hazard. Fewer treatment acres would occur in ultramafic rock under alternative 4 than alternative 2 due to the reduction in the level of underburning. Approximately 2,190 acres of treatment would occur within areas underlain by ultramafic rock under alternative 4:

- 35 acres of new temporary road construction and reopening of existing roads
- 12 acres of road decommissioning
- 820 acres of tractor yarding
- 5 acres of cable yarding
- 508 acres of underburning
- 810 acres of mastication (within thinned stands)

Potential direct/indirect effects would be the same as alternative 2. Underburning is greatly reduced compared to alternatives 2 and 3 and therefore, the potential for small areas of high intensity burning are greatly reduced which decreases the risk of adverse effects associated with ultramafic rock. Activities in areas underlain by ultramafic rock could introduce asbestos fibers into the air. However, the location of ultramafic bedrock bodies would be identified and provided to personnel and contractors working in the project area. All applicable state and agency regulations regarding NOA would be adhered to for this project (project design features in Chapter 2). Therefore, risk would be minimized.

Geologic Program Goals

Alternative 4 would have a moderately high to high probability of meeting all applicable geologic program goals. Those activities with the greatest potential for effects are tractor yarding, road reopening, rock pit development and mastication. Because of the analysis presented above and the fact that detailed project design features have been developed to minimize the potential for adverse impacts to geologic resources, these effects are minimized. The likelihood of meeting all applicable geologic program goals for alternative 4 is the same as for alternative 2.

Cumulative Effects

For purposes of modeling, underburning and mastication do not have the potential to increase landslide potential because underburning is low severity and larger vegetation survives the fire. Mastication affects only the understory and downed woody material; mechanized equipment is restricted to gentler ground away from unstable lands, as shown in project design features (Chapter 2). Because of this assumption, there are no differences in the GEO model outputs for landslide potential or risk ratios; all other proposed activities are the same as that proposed for alternative 2. Alternative 4 would not result in more than minor landslide production that would accumulate with the landslide production of past, other present or reasonably foreseeable future actions.

Summary

Table 51. Summary of how alternatives address geologic measurement indicators

Indicator	Alternative 1 – No Action	Alternative 2 – Proposed Action	Alternative 3 – No New Temporary Roads	Alternative 4 – Minimized Underburning
Proposed treatment in unstable land in Riparian Reserves	None	1,042 acres plus 0.03 miles of reopened road and 0.9 miles of decommissioned road	1,041 acres plus 0.03 miles of reopened road and 0.9 miles of decommissioned road	270 acres plus 0.03 miles of reopened road and 0.9 miles of decommissioned road
Proposed treatment acres in ultramafic bedrock areas	None	3,292 total acres	3,277 total acres	2,190 total acres
How alternatives meet Forest Plan Geologic Program Goals	Not Applicable	Moderately high to high probability of meeting goals	Moderately high to high probability of meeting goals	Moderately high to high probability of meeting goals
Cumulative Effects: GEO model outputs (cubic yards of sediment, see appendix F)	Not Applicable	19-125 cubic yards per decade due to temporary roads in some (not all) 7th field watersheds: 81-806 cubic yards per decade in 7th field	2-71 cubic yards per decade in 7th field watersheds due to reopening of existing temporary roads in some (not all) 7th	Same as Alternative 2 because changes in mastication and underburning would not change sediment

Indicator	Alternative 1 – No Action	Alternative 2 – Proposed Action	Alternative 3 – No New Temporary Roads	Alternative 4 – Minimized Underburning
		watersheds due to plantation thinning in some (not all) 7th field watersheds; reduced in those watersheds that include road decommissioning	field watersheds	production
Cumulative Effects: GEO model outputs for risk ratios (see appendix F)	Not Applicable	Small changes only at the 7th field watershed level of 0.01 to 0.03 in some (not all) watersheds. No change in risk ratios at the 5th field watershed scale. All risk ratios below established threshold of 1.0	Small changes only at the 7th field watershed level: increase of 0.01 to 0.03 in two watersheds and a decrease of 0.02 in another. No change in risk ratios at the 5th field watershed scale. All risk ratios below established threshold of 1.0	Same as Alternative 2 All risk ratios below established threshold of 1.0

3.8 Soils

3.8.1 Methodology

This soils analysis focuses on how well the proposed alternatives maintain long-term soil productivity as defined in the Forest Plan; typically measured by soil cover. The amount, kind and distribution of soil cover necessary to avoid detrimental accelerated soil erosion is guided by the Region 5 Erosion Hazard Rating system (USDA Forest Service 1990) and locally adopted standard erosion models and measurements, such as those described in the following papers: Soil Cover Process Paper (Laurent 2000) and Soil Erosion Processes and the USLE (Laurent 2006a). The Forest Plan (USDA Forest Service1995) Standards and Guidelines are used on the Forest for protecting soil productivity and minimizing soil erosion.

Proposed harvest and fuel treatment units were surveyed in October 2008 and May 2009. Units were surveyed using a modified version of Region 1 soil quality monitoring protocol (Shovic et al. 2007) to determine existing detrimental disturbance percentage. Additional plots were established and measurements were taken for aerial extent of ground cover , number of large logs (greater than 20 inches diameter and 10 feet long), and coarse woody debris using a modified Brown's line intercept method (Brown 1974).

It was assumed that main skid trails would disturb 10 percent of each unit treated. Past timber harvest monitoring on the Klamath National Forest showed that 69 percent of skid trails used were old skid trails (Laurent 2009). Therefore, it was assumed that 69 percent of the 10 percent (or 7% of each unit) would occur on pre-existing skid trials. The remaining 3 percent was assumed to new detrimental disturbance; this was then added to the existing level of detrimental soil disturbance for each unit to calculate estimated detrimental soil disturbance.

It was also assumed that 5 percent additional disturbance would occur from cable logging corridors in cable logged units. The spatial area in yarding corridors has been measured as varying between 3 and 8 percent, depending upon the size of trees (Dyrness 1965; Wooldridge 1960; Klock 1975).

Literature reviews, field notes, geographic information system (GIS) data, and professional judgment were used to support conclusions. Sediment movement was modeled using the USLE values calculated for similar soils on the Klamath National Forest. Soil erosion hazard ratings were calculated for the project area based upon soil mapping units (USDA Forest Service1990).

The alternatives are compared using the following indicators:

- Soil erosion potential
- Detrimental soil disturbance
- How alternatives meet soil standards and guidelines as outlined in the Forest Plan (maintain soil productivity; minimize changes in the site's ability to cycle nutrients; retain course woody debris; minimize soil and litter disturbance; minimize consumption of litter and course woody debris during prescribed burning; and maintain the functionality of the soil ecosystem)

Effects to soil productivity are primarily through soil disturbance, redistribution of organic matter and changes in biological properties. Soil displacement, compaction, reduction and/or elimination of soil organisms can occur through tractor yarding and use of heavy equipment. Soil chemistry changes can result from high intensity wildfires. Increased surface erosion, reduced fertility and reduced vegetative growth are the most common indirect effects from mechanized disturbance and fire.

The information used in the preparation of this section comes from detailed analysis in the Soil Report (Walters 2010) and is available in its entirety in the project record.

3.8.2 Affected Environment

Soils in the project area are predominately metamorphic with some serpentine properties. The landscape is geologically active and prone to landslides. The area is dominated by both active and dormant landslide activity, steep slopes, and well incised main stream channels capable of sediment transportation. Soils range from a medium to high erosion hazard rating based upon Regional soil hazard mapping (USDA Forest Service 1990).

Soil Erosion

Soil erosion in undisturbed soils is mostly a result of chemical erosion from rainwater leaching through the soil. Natural disturbances such as tree windthrow create tip-up mounds when root wads pull up soil and expose the bare mineral component. This increases erosion. Another natural disturbance is landslides and/or debris torrents which cause erosion.

Surface erosion equal to the thickness of a single sheet of paper (0.004 inches) is equivalent to 0.63 tons/acre (1,260 pounds) of erosion. This is a low level of erosion and very difficult to observe. Average soil formation from bedrock as reported by Alexander (1988) is about 1.0 ton/acre/year. Sheet erosion equal to 2 sheets of paper in thickness, exceeds this reported soil formation rate, yet this is for the most part unobservable erosion. Most natural erosion on the Klamath National Forest is sheet erosion, which consists of raindrop splash displacement of soil particles and subsequent down slope deposition of this dislodged material. The average calculated soil erosion rates for existing conditions in the project area are 0.029-1.334 tons/acre and averages 0.1889 tons/acre. There were very few signs of active soil erosion in the units surveyed. There were some inclusions of units that had small soil creeps and landslides. There were also some areas with bare soil from road cutbanks that were actively eroding. It is postulated that during plantation establishment, much of the loose soil eroded when it was exposed postharvest.

Soil erosion hazard ratings were calculated for the project area based upon soil mapping units (USDA Forest Service 1990). These ratings were then cross referenced against units in the current project area. Forty-five of the 142 proposed treatment units were rated with a high soil erosion hazard. The remaining 97 have a moderate soil erosion hazard rating. Soils are generally deep with only eight units mapped at 20-60 inches, the remainder all being from 40 to 60 inches or greater.

Effective Soil Cover

With the exception of a few units that show signs of past mining activities or recent fires, soil cover was very good overall for the project area. Post project soil cover objectives range from 60-80 percent depending upon slope with at least 50 percent of the area covered by fine organics. The current conditions are such that only 10 of the surveyed units have less than 90 percent soil cover. One of the reasons there is little signs of erosion is because the soil is being held in place by the widespread effective soil cover.

Fine Organic Matter

The vast majority of the soil cover mentioned above is fine organic material in the form of litter and duff. Fine organic material includes plant litter, duff, and fine wood less than 3 inches in diameter. Of the effective soil cover, approximately 5-8 percent is basal vegetation, 2-5 percent rock cover, 2-3 percent coarse woody debris, and the rest is all fine organic matter. This is indicative of soils which have a high capacity for nutrient cycling. This does not however mean

that the soils are generally productive and cycling nutrients for tree growth. It is likely that the majority of the nutrients from the last 40 years of accumulation since plantation establishment are locked up in the biomass of the fine organic matter and not readily available for plants. Some of the organic matter as well as associated nutrients are beginning to decompose and accumulate in the mineral portion of the soil as humus. This humus accumulation is limited to the top 1-2 inches of topsoil and is variable across the landscape. This is indicative of a system that is in a recovery stage from plantation establishment and associated widespread disturbance.

Downed Large Logs

Downed woody material in the form of large logs (greater than 20 inches diameter, 10 feet long) has several beneficial soil attributes including, but not limited to, moisture retention, nutrient cycling, long-term soil formation, and sites for soil micro-organisms (Graham et al. 1994). There were very few large logs, with only five units meeting the regional standard of five logs per acre. Eighty-eight of the surveyed units had no measurable large logs. The beneficial soil attributes listed above are therefore not being realized.

Detrimental Soil Disturbance

Currently, the level of estimated detrimental disturbance from past activities (primarily landings, skid trails, and temporary roads) ranges from 0 to 25 percent and averages 7 percent across all proposed thinning and specialized treatment units (table 52). Fifteen percent detrimental soil disturbance is the acceptable threshold; detrimental soil disturbance below 15 percent is desired, based on Regional and Forest standards.

One of the main indices used to determine detrimental soil disturbance is soil compaction. Excessive soil compaction can alter key soil functions negatively such as: soil porosity, soil nutrient cycling capacity, and soil hydrology. Excessive compaction can also lead to increased runoff, which in turn will cause erosion of stream channel banks through increased flow into stream systems.

The findings for detrimental soil disturbance in the project area were relatively low in relation to the amount of widespread disturbance from past plantation development. In relation to the plantation stands, it was difficult to determine detrimental disturbance and the reported percentages are likely in relation to other stands in the project area, not natural baseline conditions for the area. In all likelihood, the majority of the plantation stands have some form of detrimental disturbance. However, in identifying the worst percentages of each stand, it allows land managers to not negatively alter the recovery path that plantation stands are on. While 7 percent was the average across proposed treatment areas, there were 23 stands that had a detrimental disturbance level greater than 12 percent. These are discussed in project design features at the end of Chapter 2.

Soil productivity is very low in the majority of the plantations. At the highest elevations, the project area receives an average of 62 inches of rain a year. Tree growth in the majority of the

plantation stands is well below what it should be for this amount of precipitation, all other things being equal. Past removal of the productive topsoil along with associated exposure of less productive lower soil layers, increased compaction, and historic removal of fine organic material and large logs are presumed to have all created unproductive soils that are on their way to recovery.

Table 52 shows existing conditions in the proposed treatment areas surveyed.

Table 52. Existing soil conditions in proposed treatment areas

Total Treatment (Thinning and Specialized Treatment) Acres	2,120
Average Ground Cover	96 percent
Average Logs/Acre	1
Average Detrimental Disturbance	7 percent
Total Acres Detrimental Disturbance	158

3.8.3 Environmental Consequences

Alternative 1- No Action

Direct, Indirect and Cumulative Effects

Under the no action alternative, no management activities would take place and therefore there would be no new soil disturbance. Existing conditions are described above. Without any management, a gradual recovery of existing disturbed areas would naturally occur over time and large logs and ground cover would increase over time. Nutrient cycling would be maintained as fine organic matter increased in the duff/litter layers. Soil fertility would be maintained in managed stands due to the increased organic matter on the soil surface and in the soil. Compacted soils (reduced porosity) in existing main skid trails would slowly increase their porosity due to biological activities and thereby regain lost soil productivity over the next 40-50 years. Existing old temporary roads would remain as they currently are.

Cumulative effects to soils are based upon the number and types of management activities occurring within an individual stand (or unit) over time and are measured by effects on soil productivity. Table 52 displays the existing detrimental disturbance data which represents current cumulative disturbances from past activities. Existing detrimental disturbance averages 7.4 percent. Currently 157 of 2,120 thinning acres within the project are detrimentally disturbed. This percentage is below the acceptable threshold of 15 percent, indicating that the criteria for maintaining surface organic matter in amounts sufficient to prevent short-and long-term nutrient cycling deficits and detrimental physical and biological conditions would be met with implementation of alternative 1. With no new disturbances, existing detrimental disturbances from past activities would slowly recover. Existing erosion processes would continue and soil biological functions and nutrient cycling would continue.

Overall, alternative 1 has a high probability of meeting the Forest Plan standards and guidelines for maintaining long-term soil productivity. However, taking no action to address the purpose and need would continue to contribute to the likelihood of high severity wildfire across the project area. The effects of wildfire on the soil resource are primarily dependent on conditions of the fuels, stand conditions, past fuel reduction actions, time of year, aspect and elevation. Klamath Forest soil burn severity data from 1977-2007 indicates that high burn severity ranged from 1-24 percent and averaged 9 percent. Moderate soil burn severity ranged from 6-53 percent and averaged 19 percent. Low soil burn severity ranged from 24-94 percent and averaged 69 percent. The 2008 soil burn severities showed that high burn severity ranged from 2-6 percent and averaged 4 percent. The moderate soil burn severity ranged from 11-24 percent and averaged 19 percent. The low soil burn severity ranged from 71-84 percent and averaged 76 percent (Laurent 2009).

A wildfire burning across the project area under current fuel and vegetation conditions would likely be similar to the 2008 soil burn severity data. It would therefore have about 70 percent low soil burn severity which roughly translates into the range of ground cover recommended for post prescribed burning activity. High and moderate soil burn severities have similar effects on nutrient cycling, changes in soil microbial communities but different amounts of soil erosion. The high burn severity has minimal post burn cover; mainly as surface gravels but moderate burn severity has more cover due to needle cast that falls to the ground within a few days after the fire. Cover can range up to 90 percent and has been averaged at 35 percent for erosion calculations. The erosion rate for moderate burn severity is much lower compared to high severity due to increased soil cover. Low soil burn severity has more cover due to a heavier than normal needle cast, which is generally higher than that under a moderate burn severity.

Alternative 2 – Proposed Action

Direct/Indirect Effects

Direct effects to soils result from disturbance and include redistribution of organic matter and changes in biological and physical properties. The soil properties that are affected are soil volume, soil porosity, soil water availability, soil chemistry and soil biology (Powers 1989). Indirect effects are secondary reactions to direct effects. The most common secondary reactions are increased surface erosion (from ground disturbance, soil cover removal), reduction in fertility (compaction, removal of fine organic materials), and reduced vegetative growth (compaction, loss of fine organic materials).

Ground-Based Harvesting

Ground-based harvesting would occur on approximately 1,866 acres and includes conventional log skidders, mechanical harvester operations and tractor endline operations. Of these, the tractor endline operations have the least impact and are generally used in steeper sections of units. These operations are all treated the same because one of the primary effects from them is

development and placement of skid trails. Ground-based harvesting would result in increased soil disturbance and reduced porosity. However, with proper layout of the skid trail pattern and reusing existing skid trails when appropriate (see project design features in Chapter 2), detrimental disturbance would be kept within allowable limits (15% of each unit). Some compaction would occur in areas outside of main skid trails where machinery makes one or two passes but this increased compaction would not exceed threshold values as documented by Powers et al. (2002) and Laurent (2006b). A recent study near the project area (Laurent et al. 2002) examined tractor yarding followed by tractor piling. This study concluded that tractor harvesting and mechanical slash disposal had no marked detrimental effect on the soil chemical properties. Relative to the other slash treatments, tractor piling seemed to result in low levels of nutrients and other soil properties important to nutrition—even if total levels were increased.

There is a possibility that the amount of post logging detrimental disturbance (reduction in soil porosity) could be greater than 15 percent of the area in units with existing detrimental disturbance greater than 12 percent (23 units). Main skid trails in these 23 units would be evaluated before the project using detailed transects as well as field compaction data to determine their need for subsoiling (project design features in Chapter 2). Subsoiling has been shown to be an effective method of reducing compaction and restoring porosity to the soil (Andrus and Froehlich 1983; Atzet et al. 1989).

Soil displacement and skid trail erosion from ground-based harvesting would result in some nutrient loss. Soil erosion on skid trails can vary from 1.1-4.1 tons/acre depending on soil cover, slope, and soil texture. This is equivalent to 26-98 pounds of soil erosion per 100 feet of skid trail. Loss of soil through erosion reduces growth of trees and other vegetation on skid trails after the harvest. Implementation of project design features such as installation of water bars on skid trails and application of slash would be very effective in controlling runoff and preventing off-site sedimentation and accelerating site recovery. The high amount of soil cover acts as sediment filters and prevents skid trail-derived sediment from reaching drainage channels.

Cable Harvesting

Cable harvesting would occur on approximately 167 acres and would cause small amounts of soil displacement from dragging logs in yarding corridors. The cable corridor can vary in width from 6 to 8 feet with an area in the center that is down cut 9-12 inches from log dragging. There would be a loss of nutrients and soil organic matter in the heavily disturbed portions of the corridor due to erosion. The amount of reduced soil productivity would be measurable within these heavily disturbed portions. However, the amount of area with reduced soil productivity would be within the regional and forest guidelines of a cumulative 15 percent.

Hand Work/Thinning

Hand thinning and piling slash would occur on approximately 87 acres. This activity would maintain sufficient fine soil cover and would not cause additional ground disturbance. Associated

burning of this piled material would meet the required soil coverage amounts. Recent data (Laurent 2007) collected on the Klamath National Forest shows that hand piles occupy from 4 to 25 percent of the total hand piled acres. The piles, which are composed of material generally less than 10 inches in diameter, is not compacted and therefore most of the material is not in contact with the soil. Most of the radiant heat then would not be focused on the soil but dispersed into the air. Field observations from other projects that had burned hand piles indicated that the duff layer beneath the pile is consumed and the soil surface blackened. This indicates that the burn intensity was in the range of low (higher end of low) to moderate (lower end of moderate). Damage to the soil occurs when the soil color changes to reddish orange (red brick color) which normally occurs under logs and in stump holes during wildfire or broadcast burn intensities of moderate and high. There would be minimal changes in soil characteristics within the burned pile areas (Dyrness and Youngberg 1957).

Plant-available soil nutrients would peak after burning and decrease to background levels within two years as nutrients become locked up in plant biomass (Choromanska and Deluca 2002). Soil erosion would be minimal (less than 0.8 tons per acre) due to the mosaic nature of the burn piles and intact duff layer in the remainder of the stands. The soil biota in the burned pile areas would be reduced by the effects of heat but would quickly recover as litter fall adds fine organic matter to the soil surface and soil micro-organisms re-establish on these sites (Borchers and Perry 1990).

Landings

Landings are central processing zones that are essential for logging operations. Landings are approximately 0.33 to 0.50 acres in size, and occasionally up to 0.75 acres in size to accommodate slash piles from tree tops. Landings are some of the most disturbed sites from logging activities. They have significantly lower site productivity due to compaction and loss of nutrients. Trees with stunted growth would slowly establish on these sites after more early successional vegetation such as shrubs and grasses. Existing landings would be reused where possible. Landings can produce erosion and sediment if not properly designed and maintained. Rehabilitation of non-road prism landings would minimize short- and long-term erosion. Erosion that moves off the landing would be filtered out by the high levels of soil cover retained in the areas immediately adjacent to the landings. Project design features (Chapter 2) provide for sufficient erosion control. Landings in the project area would be mapped and used for future logging operations.

Underburning

Proposed light underburning would not disturb additional soil. As long as underburning is not high severity and soil cover standards are met, erosion would be minimal to none according to recent monitoring on the Klamath National Forest (Laurent 2007). Low and moderate severity burns would show immediate plant availability of nutrients, spiking following the fire, but

decreasing quickly to background levels over the following two years (Choromanska and Deluca 2002). Afterwards, those available nutrients would be locked up in plant biomass. Project design features (Chapter 2) would ensure soil standards for prescribed burning are met.

Meadow Enhancement

Conifers encroaching on meadows would be hand thinned across 160 acres. There would be no mechanical entry. There would be no detrimental disturbances as long as ground cover standards are met. There would be pile burning of thinned conifers as well as some underburning. The effects will be the same as described above for hand thinning and underburning.

Coarse Woody Debris

Coarse woody debris (CWD) would be partially affected by mechanical yarding. Some of the more decomposed logs may be disturbed by heavy equipment operations and could therefore lose some of their effectiveness. If prescribed fire severity increases beyond low to moderate, some CWD may be consumed. Sufficient number of trees would remain on site in the project area so that CWD would increase over time by natural falling of standing trees and snags.

Existing Road Reopening/Reconstruction

Some existing temporary roads would be re-opened to access units with logging trucks and machinery. This would include blading and shaping of the road surface, installation of rolling dips, culvert replacement, and ditch cleaning and clearing of encroaching vegetation along the roadway. This work would disturb soil within the road prism but would also reduce road-related erosion by fixing road drainage problems such as rills and gullies and redirecting runoff to dips. Application of project design features and best management practices (Chapter 2) would ensure water quality and mitigate soil erosion potential.

Temporary Road Construction

Temporary road construction creates detrimental soil disturbance by bulldozing the surface layer aside and exposing nonproductive subsoil layers and substantially alters soil productivity. Temporary roads are typically 12-14 feet wide. On flat to gentle slopes, soil disturbance would be minimal (0.5-2 feet) but on steeper slopes where cut and fill techniques are required, cuts would be 4-8 feet high. Fill material is deposited on top of the existing soil, thereby increasing soil depth which in turn increases soil water holding capacity. Soil organic materials are also incorporated into the soil. Increased water holding capacity and organic matter has a positive effect on site productivity. The increased soil productivity does not necessarily equal the soil productivity lost in the cut portion of the road.

The road surface is compacted by equipment travel during the construction process as well as from log truck travel on the road. Road soil compaction is a long-term effect. All constructed temporary roads would be hydrologically stabilized after harvest activities. This would assist in

site productivity recovery from temporary roads. Soil health would gradually recover over the long-term as trees become established in the road bed and fill slopes.

Road Decommissioning

Road decommissioning would improve watershed health, stabilize soils and decrease soil erosion potential. This would increase long-term soil productivity in these areas.

Soil Erosion

Following implementation of alternative 2, post-project first-year calculated erosion rates (assuming that minimum recommended soil cover amounts of 60-80% are achieved) would range from 0.165-1.237 tons/acre and would average 0.6586 tons/acre. These rates are based upon Universal Soil Loss Equations calculated and field verified by the Klamath National Forest Soil Scientist. These calculated values are what is mobilized on site and does not represent what would actually reach a stream channel. The soil cover previous to prescribed fire is generally left in a mosaic pattern, somewhat like a checkerboard pattern. Soil that erodes from a bare area is immediately trapped in the first area of soil cover downslope. Any bare, actively eroding soil would quickly recover within two years following activities as litter accumulates and plants reestablish themselves.

Cumulative Effects

Cumulative effects are based on the number and types of management activities occurring within a unit over time and are measured by effects on soil productivity. These effects are measured by determining the spatial extent of detrimental disturbance within each unit.

Currently, the level of estimated detrimental disturbance from past activities (primarily landings, skid trails, and temporary roads) ranges from 0-25 percent and averages 7.4 percent across all units. Skid trails from ground-based harvesting are expected to cover a maximum of 10 percent of any unit. Of this 10 percent, 7 percent is assumed to be on existing skid trails and taken into account by calculations of current detrimental disturbance. The other 3 percent is added to the detrimental disturbance total.

Project design features (Chapter 2) including the use of subsoiling where needed would ensure that detrimental disturbance after harvest activities would be below the forest and regional 15 percent threshold. Table 53 displays the cumulative effects of alternative 2 across all treatment acres; detrimental soil threshold would be below 15 percent.

Table 53. Acreage of Detrimental Disturbance across the treatment units for alternative 2

Total Treated (Thinning and Specialized Treatment) Acres	2,120
Total Threshold Detrimental Disturbance Acres	318 (15%)
Total Detrimental Disturbance Acres Post Activity	236 (11%)

The hand piling and burning and broadcast burning would have no long-term cumulative effects on soil erosion, nutrient availability, and soil productivity. These types of fuel treatments would not expose excessive amounts of soil and would have minimal effects on the soil resource since existing down materials would not be treated. The combination of past and planned activities would have small short-term negative effects on soil productivity that would not be measurable on a stand basis (volume of biomass produced). Long-term soil productivity would be maintained.

Conclusion

The proposed action is expected to meet Forest Plan guidelines and Region 5 Soil Quality Analysis Standards (SQAS) for soil cover, porosity, soil organic matter content, surface organic matter levels, soil moisture regime, soil hydrologic function, buffering capacity and maintain a well functioning soil biological system.

Alternative 3 – No Temporary Roads

Direct/Indirect Effects

Direct/indirect effects to soil productivity are the same as those described above for alternative 2 because thinning and specialized treatments are very similar. Where there are differences, these are described below.

Overall, alternative 3 has a high probability of meeting the six soil standards and guidelines. Project design features and BMPs would minimize detrimental effects to soil productivity. The main soil concerns are the effects of ground based harvest activities (especially skid trails) on the soil resource. Increased soil erosion and reductions in soil productivity (compaction and soil displacement) would occur primarily in main skid trails, landings and new temporary roads. Units with existing detrimental disturbance above 10 percent (21 units) would be evaluated for the application of subsoiling (project design features in Chapter 2).

Alternative 3 would meet the LRMP and SQAS guidelines for soil cover, porosity, soil organic matter content, surface organic matter levels, soil moisture regime, soil hydrologic function, and buffering capacity and maintain a well functioning soil biological system.

No new temporary roads would be created under alternative 3 and thus ground disturbance from road construction would be less for alternative 3 than for alternative 2. However, when temporary roads are created, they typically alleviate the need for long skidding distances. Because no new temporary roads would be created under alternative 3, more skid trails would be needed in order to get cut trees to landings to be removed by logging trucks. Skid trails are often wider than temporary roads, used by ground-based equipment (and not just rubber-tired logging trucks as temporary roads are) and not specifically designed for drainage like temporary roads are. For these reasons, more skid trails would be created under alternative 3 and this would result in more short-term ground disturbance than would occur under alternative 2. However, because all skid trails would be hydrologically restored after use, just as temporary roads would be under

alternative 2, the long-term adverse impacts to soils would be essentially the same for Alternatives 2 and 3 because of the implementation of project design features.

Cumulative Effects

Table 54 displays the cumulative effects of alternative 3 on the soil resource across all treatment acres. This table shows that effects of the logging systems do not exceed the acceptable threshold of 15 percent. These percentages are the same as those discussed for alternative 2.

Table 54. Acreage of Detrimental Disturbance across the treatment units for alternative 3

Total Treated (Thinning and Specialized Treatment) Acres	1,850
Total Threshold Detrimental Disturbance Acres	278 (15%)
Total Detrimental Disturbance Acres Post Activity	208 (11%)

Alternative 4 – Minimized Underburning

Direct/Indirect Effects

Alternative 4 includes silvicultural treatments and road decommissioning as described in alternative 2. Fuels treatments would focus on thinned units, consisting of jack pot and pile burning and some limited underburning outside of thinned units, for a total of approximately 570 acres outside of treatment units. Mastication to treat slash following thinning would be used instead of or in combination with jack pot and pile burning in 93 units, for a total of approximately 1,490 acres of mastication.

Direct/indirect effects from alternative 4 are the same as those previously described for alternative 2 except for mastication.

Mastication

Mastication would have similar direct effects as mechanical harvesting. The effects of large machinery, in this case masticators, are the same as skidding equipment and harvesters. Proper skid trail pattern layout is essential in avoiding excessive soil disturbance. In units that have harvest and fuel treatments, care should be taken to ensure that the same skid trails are used for each treatment.

Mastication covers the forest floor with coarse wood chips that add protective groundcover. The primary purpose of mastication is to reduce fuel loading and decrease chances of future burning. A secondary benefit is increased ground cover, which reduces erosion potential and will help to stabilize actively eroding soils in the treated units.

Mastication additionally disturbs soils from the excavator turning and the masticating drum churning soil. The excavator has to make tight turns to maneuver between trees. These physical impacts are offset somewhat by the organic matter left on the soil surface that can protect churned soil from eroding and enhance recovery. Information on the long-term effects of

mastication on soil productivity is still sparse (Resh et al. 2007). For the current analysis, effects are considered similar to those with established skid trail systems in harvested stands (3 percent additional detrimental disturbance).

Overall, alternative 4 has a high probability of meeting the six soil standards and guidelines. Project design features and BMPs will minimize detrimental effects to soil productivity. The main soil concerns are the effects of ground based harvest activities (especially skid trails) on the soil resource. Increased soil erosion and reductions in soil productivity (compaction and soil displacement) would occur primarily in main skid trails, landings and new temporary roads. Units with existing detrimental disturbance above 10 percent (25 units) will have their main skid trails subsoiled in order to lower their detrimental cumulative effects to below the 15 percent detrimental disturbance threshold. The direction to maintain the soil organic layer intact will minimize negative effects on nutrient cycling.

Alternative 4 is expected to meet Forest Plan standards and guidelines for soil cover, porosity, soil organic matter content, surface organic matter levels, soil moisture regime, soil hydrologic function, buffering capacity and maintain a well functioning soil biological system.

Without the additional prescribed burning, alternative 4 would not realize the short term benefits of soil nutrient availability that the other action alternatives would. Additionally, alternative 4 will have a greater amount of ground-disturbing activity via the 1,490 acres of mastication. The effects in this acreage will be very similar to acreage of mechanical harvest.

Cumulative Effects

Cumulative effects are the same as those previously described for alternative 2; the estimates for detrimental soil disturbance shown in table 40 are the same for alternative 4.

3.9 Fisheries

3.9.1 Methodology

This fisheries analysis describes the current status of salmonid populations and salmonid habitat in the proposed treatment areas and how existing salmonid habitat condition relates to the desired condition as described in the Forest Plan, and the Table of Population and Habitat Indicators for use on the Klamath National Forest (USDA 2007a). The fisheries analysis focuses on determining how no action (alternative 1) and the action alternatives (alternative 2, 3 and 4) may affect coho salmon, Chinook salmon, and steelhead/rainbow trout (1) directly, (2) indirectly via 17 indicators of aquatic habitat and watershed condition, and (3) cumulatively.

Effects are analyzed in the context of short- and long-term. Unless otherwise noted, short-term effects are zero to five years. Long-term effects are greater than 5 years to 50 years (since the effects of high severity wildfire would likely last up to 50 years). The spatial context includes the site level, the 7th field watershed scale, and the 5th field watershed scale. Effects are evaluated by overlaying proposed activities on potentially affected salmon and steelhead/rainbow trout

habitat downslope and/or downstream of proposed activities; for this project, this includes nine 7th field watersheds (Cole-Clauson, Coon-Wagner, East Fork Indian Creek, Indian Creek Headwaters, Indian/Doolittle Creek, Indian/Mill Creek, Little South Fork Indian Creek, Luther-Ikes, and Westbranch Creek (figure 7)).

Units proposed for thinning with ground-based mechanical systems and/or thinning units with intermittent and perennial stream courses were top priority for field assessment because this activity has the most potential to cause ground disturbance, and to affect water quality and aquatic habitats. In 2008, most of these types of commercial thinning units were inspected in the field. The general locations of proposed temporary road segments were assessed. Project areas proposed for precommercial thinning and underburning were less intensely assessed in the field because these activities, if implemented as proposed, are expected to result in relatively minor ground disturbance and effects on watershed function.

Existing conditions of each indicator for each 7th field subwatershed were determined using a variety of sources including Klamath National Forest fish population censuses of juvenile and/or adult salmon and steelhead from 1989 to 2009; Klamath National Forest stream habitat assessment surveys from 1998 to 2009; California Department of Fish and Game fish population census surveys conducted prior to 1994; Klamath National Forest water temperature and flow monitoring from 1998 to 2006; Klamath National Forest Fish Passage Barrier Inventory (USDA Forest Service 2003); Klamath National Forest - 1997 Flood Assessment (USDA Forest Service 1998); Site visits in 2009 to the Two Bit commercial thin units proposed for treatment that are near intermittent and perennial streams; Klamath National Forest GIS data layers needed to run the three Forest cumulative watershed effects models (includes roads, historic timber harvest and salvage disturbances, historic wildfires, historic mining, reasonably foreseeable future actions, slopes, streams, and geomorphic terrains); Salmon, steelhead trout, and resident rainbow trout population status reports; Indian Creek Watershed Analysis (USDA Forest Service 1997); and professional judgment of fish populations and fish population habitat condition from 15 years of working in the project area as fisheries biologist.

There are 17 indicators for assessing the existing fish habitat condition and the potential for changes based on implementation of all alternatives. The indicators are:

- Water temperature
- Turbidity
- Chemical contamination
- Fish passage
- Substrate character
- Amount of large woody debris in stream channels and potential for future LWD recruitment
- Pool frequency and quality
- Off-channel habitat
- Refugia
- Width to depth ratio

- Streambank condition
- Floodplain connectivity
- Change in peak and base flows
- Drainage network increase
- Road density and location
- Disturbance history/regime
- Riparian Reserves

The information used in the preparation of this section comes from detailed analysis in the Fisheries Report (Grunbaum 2010) and is available in its entirety in the project record.

3.9.2 Affected Environment

Coho salmon, Chinook salmon, steelhead trout and resident coastal rainbow trout are the focus of this analysis. Project effects on other fish species listed as Sensitive on the October 2007 Forest Service Region 5 Sensitive Species list (USDA c) and/or listed as Proposed, Threatened, or Endangered by the Arcata Office of the US Fish and Wildlife on December 10, 2009, were not assessed because these species do not occur in or near the Two Bit project area. There are approximately 22 miles of habitat for coho salmon, 19 miles of habitat for Chinook salmon, 47 miles of habitat for steelhead trout, and 49 miles of habitat for rainbow trout In the Indian Creek watershed downstream/downslope of proposed actions.

Southern Oregon/Northern California (SONCC) Coho Salmon –Federally Listed as Threatened

The SONCC coho salmon species or Evolutionary Significant Unit (ESU) includes coho salmon in the Klamath River and all tributaries to the Klamath River downstream of certain dams. The number of tributaries used by coho salmon in the Klamath-Trinity System has significantly declined, and estimated numbers of coho salmon in the Klamath basin has decreased precipitously since the early 1900s. The life history, habitat requirements, and status of SONCC coho salmon is thoroughly outlined in Moyle 2002 and in Moyle et al. 2008 (see Moyle et al.2008 at: (www.caltrout.org/SOS-Californias-Native-Fish-Crisis-Final-Report.pdf). SONCC coho salmon were listed as “threatened” under the federal Endangered Species Act in 1997 (62 FR 24588) and Critical Habitat (CH) was subsequently designated (64 FR 24049). Essential Fish Habitat (EFH) was designated for SONCC coho salmon by the Pacific Fishery Management Council in 1999.

Upper Klamath-Trinity Rivers (UKTR) Chinook Salmon – Forest Service Sensitive

The UKTR Chinook salmon species ESU includes Chinook salmon in the Klamath River and all tributaries to the Klamath River upstream of an including the Trinity River. In the Klamath River basin, there are two distinct Chinook salmon populations: the spring run and the fall run. UKTR Chinook salmon are a Forest Service Sensitive species because the spring run is very limited in

current range compared to historical distribution. Spring Chinook are currently extirpated from much of their historical range in the Klamath Basin because of dam construction and/or poor water quality conditions. The Salmon River supports the only spawning population of any significance in the Klamath River above the Trinity River confluence, and this population has experienced wide fluctuations of returning adults ranging from under 100 to over 1400. For the fall-run, a minimum escapement goal of 35,000 adult Chinook salmon to natural spawning areas in the Klamath Basin has not been met for the last four years (2004 to 2008). The Klamath River fall Chinook population has been so depressed that Chinook salmon fishing along the west coast has had to be severely restricted since 2006. The life history, habitat requirements, and status of summer and winter runs of UKTR Chinook salmon is thoroughly outlined in Moyle 2002 and in Moyle et al. 2008 (www.caltrout.org/SOS-Californias-Native-Fish-Crisis-Final-Report.pdf). Essential Fish Habitat was designated for UKTR Chinook salmon by the Pacific Fishery Management Council in 1999.

Klamath Mountains Province (KMP) Steelhead Trout and Resident Coastal Rainbow Trout – Forest Service Sensitive Species and Management Indicator Species

The boundary between anadromous steelhead trout and resident coastal rainbow trout is fuzzy. Many different populations of rainbow trout presumably had independent origins from steelhead trout (Moyle et al. 2008). The Klamath Mountains Province (KMP) steelhead trout species or ESU includes steelhead trout in coastal basins from Cape Blanco to just south of the Klamath River in California. In the Klamath River basin, there are two distinct steelhead trout populations: the summer run and the fall run. KMP steelhead is a Forest Service Sensitive species because the summer run is very limited in distribution, and numbers of summer-run steelhead in remaining populations are depressed. Resident rainbow trout are found in virtually every coastal stream (including tributaries to the Mid-Klamath River) where habitat is accessible. The life history, habitat requirements, and current status of summer and winter runs of KMP steelhead trout, and of resident coastal rainbow trout, is thoroughly outlined in Moyle 2002 and Moyle et al. 2008 (www.caltrout.org/SOS-Californias-Native-Fish-Crisis-Final-Report.pdf).

Water Temperature

Water temperature meets desired conditions in all 7th field watersheds except for the Luther Ikes subwatersehd where water temperature in mainstem Indian Creek is categorized as ‘at risk’ according to the habitat indicator criteria. As state previously in the Water section of this chapter, the entire mid-Klamath River and tributaries including Indian Creek are on the EPA 303(d) list as impaired for water temperature, nutrients, organic enrichment, and low dissolved oxygen.

Turbidity

Turbidity is low to moderate in project area streams. Turbidity is slightly elevated or "at risk" in the following watersheds that have high road density and/or high hydrologic connectivity between roads and the stream network and/or highly elevated modeled surface erosion risk: Coon-Wagner, Indian Creek Headwaters, Indian/Mill Creek, Little South Fork Indian Creek, Luther-Ikes, and Westbranch Creek. None of these 7th field subwatersheds are rated "not properly functioning" for the Sediment-Turbidity Indicator. The California State water quality requirements are that "the suspended sediment load and suspended sediment discharge rate shall not be altered in such a manner as to cause nuisance or adversely affect beneficial uses" (beneficial uses in project area streams are salmon and steelhead habitat, and domestic or municipal water supply). This is hard to measure so the Forest Plan and Table of Habitat Indicator proxy for turbidity is that "average percent fine (less than 2mm) sediment should not exceed 15 percent".

Chemical Contamination

There are no known point sources of chemical contamination in most 7th field watersheds except Coon-Wagner and Luther Ikes. The Classic Hill mine occurs in the Coon-Wagner watershed and the Gray Eagle mine occurs in the Luther Ikes watershed.

Runoff from the Gray Eagle Mine and surrounding area contaminates streams. Heavy metals were detected in high concentrations in surface water of a side channel of mainstem Indian Creek in 2008 (Soto, pers. comm. 2008). Much of the flow of Luther Gulch is treated in a facility to remove heavy metals and other contaminates that drains the now inoperative Gray Eagle Mine. Tailings from the Gray Eagle Mine that were placed on a 20-acre site (former lumber mill) on the valley floor of Indian Creek were capped in a restoration project in the late 1990s; however, heavy metals and other pollutants still leach into mainstem Indian Creek in wet years when there is significant lateral groundwater movement under the cap. Contamination of mainstem Indian Creek from the tailing dump is evidenced by metal plating on the rocks at and downstream from the tailings dump. There are small areas along mainstem Indian Creek upstream from Luther Gulch that do not support fish due to heavy metal contamination in water coming from the Gray Eagle Mine; however, most of mainstem Indian Creek is not contaminated to the point where salmonids are adversely affected.

Contamination from the Classic Hill Mine has not been documented but is suspected. Chemical contamination from other private lands is unknown but suspected to be insignificant at the 7th field watershed scale because there is little to no private land in most of the project watersheds, private lands in the project watersheds are generally not industrial and generally have light to moderate residential and/or ranching development, and there are no large disposal areas. Although water quality of Klamath River tributaries is generally "properly functioning", the entire mid-Klamath River is on the EPA 303(d) list for excessive concentration of the following pollutants: temperature, dissolved oxygen, and nutrients/algae.

Fish Passage

Fish passage was assessed, inventoried, and prioritized for barrier modification or removal at all road-stream crossings on National Forest System land in the project area (USDA Forest Service 2003); one low priority and four high priority sites were documented. Two of the high priority sites have been remedied and the Forest Service is in the process of securing funds to restore passage at the other three barrier sites.

Substrate Character

The substrate quality indicator is rated "properly functioning" in the Cole-Clauson and East Fork Indian Creek 7th field watersheds but is rated either "at risk" in Coon-Wagner, Indian Creek Headwaters, Indian/Doolittle Creek, Indian/Mill Creek, Little SF Indian, and Luther-Ikes 7th field watersheds and "not properly functioning" in Westbranch Creek watershed. This is due to: (1) high road density in watersheds where there has been little road maintenance or stormproofing, (2) high fines and/or embeddedness in stream surveys, (3) low pool frequency and pool depth indicating excessive course sediment delivery to the stream, (4) history of numerous major road failures and altered stream channels from the 1997 Flood, and/or (5) highly elevated CWEs.

Large Woody Debris

Levels in stream channels are well below desired condition in all watersheds and the large woody debris indicator is rated as either at risk or not properly functioning in all nine project 7th field watersheds.

Pool Frequency and Quality

One of the nine 7th field watersheds meets the Forest Plan and habitat indicator pool frequency/quality criteria for "properly functioning". It is likely that the pool frequency/quality criteria are not a good fit for many of the smaller streams in the project area. However, it is likely that pools are filled in or partially filled in with course sediment in many of the 7th field watersheds that have high road density and that have had extensive past stand replacement forestry because the rate of mass wasting in these watersheds has been accelerated by these types of management actions (USDA Forest Service 1998). Excessive fine sediment from elevated mass wasting is transported out of the stream systems relatively quickly (a few years) whereas the excessive course sediment from mass wasting can take decades to transport out. Based on field data and/or level of watershed disturbance, the pool frequency/quality indicator is "properly functioning" in the Little South Fork Indian Creek 7th field watershed, is "at risk" in the Cole-Clauson, Indian Headwaters, Luther-Ikes, and Westbranch 7th field watersheds, and is "not properly functioning" in the Coon-Wagner, East Fork Indian Creek, Indian/Doolittle Creek, and Indian/Mill Creek 7th field watersheds.

Off Channel Habitat and Floodplain Connectivity

Off-channel habitats provide refugia from high flows and increase habitat diversity. Off-channel habitat development and floodplains is not characteristic of many of the highly entrenched channel types in the Two-Bit Project area (primarily Rosgen A-, B-, C-, and G-channel types), consequently, there are few floodplains or areas where off-channel habitats can develop, and most of the project 7th field watersheds do not have potential for off-channel habitat development. The off-channel habitat and floodplain indicators are not applicable in seven of the nine project 7th field watersheds. Unconstrained reaches where off-channel habitat and floodplain have potential for development occur only along the lower gradient reaches of mainstem Indian Creek in the Coon-Wagner and Luther-Ikes HUC 7 watersheds. The off-channel habitat and floodplain connectivity indictors in the Coon-Wagner and Luther-Ikes watershed are “at risk”.

Refugia

The most important components of refugia for salmonids in project area streams is primarily cool clear water and secondarily cover in the form of deep pools and/or large woody debris and/or boulders. Water temperature is suitable to optimum in all project 7th field watersheds except Luther-Ikes where summer water temperatures often increase to suboptimal levels in mainstem Indian Creek. Cover in the form of deep pools is lacking in all project watersheds except for Little SF Indian Creek. Cover in the form of large woody debris is lacking in all watersheds. Refugia is properly functioning in the Cole-Clauson, Indian Headwaters, Indian/Doolittle Creek, Indian/Mill Creek, and Little SF Indian Creek watersheds. The Refugia indicator is “at risk” in the Coon-Wagner, EF Indian Creek, Luther-Ikes, and Westbranch Creek watersheds.

Width to Depth Ratio

The effects of past floods combined with high concentration of landslides overlain by a dense road system are the main factors that have contributed to poor channel characteristics in the Indian Creek watershed (Bousfield 2010). Filling of pools and deep spots in the streambed from increased erosion (see Pool Frequency section above) has resulted in a shallowing and widening of the stream channel. The Width to Depth Ratio indicator is “properly functioning” in only the Little SF Indian Creek project watershed; is “at risk” in the Cole-Clauson, East Fork Indian Creek, Indian Headwaters, Indian/Doolittle Creek, Indian/Mill Creek, and Westbranch Indian Creek watersheds; and is “not properly functioning” in the Coon-Wagner and Luther-Ikes watersheds.

Streambank Condition

Streambanks along mainstem Indian Creek are impacted by roads (some in the inner gorge), past mining, private property development, berming to prevent flooding, and numerous accesses to the stream buffer. Streambanks in tributaries to Indian Creek are generally stable and in good condition except: (1) at the numerous road-stream crossings, (2) where roads are within the inner

gorge of streams, and (3) where channels have been recently altered by floods and/or debris flows. Streambank conditions are “properly functioning” in the Little SF Indian Creek and Westbranch Creek HUC7 watersheds, and is “at risk” in the remaining seven project watersheds, based on Forest Plan and habitat indicator criteria.

Change in Peak and Base Flows

The Change in Peak/Base Flow indicator is “not properly functioning” in the Coon-Wagner, Indian Creek Headwaters, Indian/Doolittle Creek, Indian/Mill Creek, Luther-Ikes, and Westbranch Creek 7th field watersheds and is “at risk” in the other project 7th field watersheds. This is primarily due to the relatively high road density in the project area and the fact that between 5 percent and 26 percent of the road system (not including Indian Creek Road and Grayback Road) in the project 7th field watersheds are hydrologically connected to the stream network.

Drainage Network Increase

The primary cause of drainage network increase in the Indian Creek watershed is hydrologic connectivity between the road system and the stream network. As stated above, road density is relatively high in the project area. For these reasons, the drainage network is “not properly functioning” in the Coon-Wagner, Indian Creek Headwaters, Indian/Doolittle Creek, Indian/Mill Creek, Luther-Ikes, and Westbranch Creek watersheds, and “at risk” in the Cole-Clauson, EF Indian Creek, and Little SF Indian Creek watersheds.

Road Density and Location

Based on GIS data to determine road density and location, the Road Density and Location Indicator is “not properly functioning” in the Coon-Wagner, Indian Creek Headwaters, Indian/Doolittle Creek, Indian/Mill Creek, Luther-Ikes, and Westbranch Creek watersheds, and is “at risk” in the Cole-Clauson, EF Indian Creek, Little SF Indian Creek watersheds. Desired conditions include less than 2 miles of roads per square mile of watershed and no roads in valley bottoms. Road density in the Indian Creek watershed is estimated at 3.1 miles per square mile.

Disturbance History/Regime

All of the project 7th field watersheds and the entire Indian Creek 5th field watershed have moderate to high levels of watershed disturbance from past road construction, stand-replacement forestry, and/or large-scale industrial mining. All of the 7th field watersheds except for East Fork Indian Creek and Little South Fork Indian Creek have high watershed disturbance from roads.

There were 92 major road failures and other management related landslides in the Indian 5th field watershed during the 1997 Flood, and about 12 percent of the channels were altered by debris flows and are still recovering. Rate of recovery from the 1997 Flood and the 2005 Flood is slow.

The cumulative effect of past management in the Indian Creek 5th field watershed has resulted in poor watershed function and poor channel conditions in mainstem Indian Creek and many of the tributaries (see Water section earlier in this chapter). Vegetation attributes have been significantly altered from their historical range (see Fire and Fuels section earlier in this chapter) in riparian and upslope areas due to stand-replacement forestry and fire suppression. Consequently, fire frequencies have departed from historical frequencies by multiple return intervals and the risk of losing key ecosystem components due to altered vegetation characteristics is high. The precarious condition of vegetation in the Indian Creek watershed could result in a large high intensity fire that would further degrade watershed function.

Based on the above factors, the Disturbance History/Regime indicator is “at risk” in all 7th field watersheds except Luther-Ikes where the Disturbance History/Regime indicator is “not properly functioning”.

Riparian Reserves

All of the project 7th field watersheds have some level of disturbance within stream buffer and geologic RRs from past road construction, stand-replacement forestry, and/or large-scale industrial mining. All of the watersheds except for East Fork Indian Creek and Little South Fork Indian Creek have high watershed disturbance from roads within stream buffer RRs. The Cole-Clauson, Coon-Wagner, Indian Creek Headwaters, Indian/Mill Creek, and Luther-Ikes watersheds have significant disturbance in stream buffer RRs from past large-scale industrial mining. The Coon-Wagner and Luther-Ikes watersheds have significant disturbance within stream buffer RRs from ground compaction, development, and vegetation removal on private lands. There were 92 major road failures and other management-related landslides in the Indian 5th field watershed during the 1997 Flood and about 12 percent of the channels were altered by debris flows and are still recovering, however, the majority of riparian vegetation was left intact. The 2005 Flood caused additional road failures and riparian vegetation downstream of the bridge to the Westbranch campground was lost due to fluvial erosion. The road system in the is generally in poor condition due to lack of road maintenance and stormproofing, and is still susceptible to failures that could trigger debris flows damaging to riparian vegetation. Between 5and 26 percent of the road system (not including Indian Creek Road and Grayback Road) in the project 7th field watersheds is hydrologically connected to the stream network and road density within stream buffer RRs ranges from 0.4 to 1.4 mile of road per square mile of stream buffer. See the Geology and Water sections of this chapter for more details on existing watershed conditions in the project area. Based on the above factors, the Riparian Reserves indicator is “at risk” in all watersheds except Luther-Ikes where the Disturbance History/Regime indicator is “not properly functioning”.

3.9.3 Environmental Consequences

Alternative 1- No Action

Direct/Indirect and Cumulative Effects

Under the no action alternative, there would not be any direct or indirect effects because no action would be taken. Therefore, there would be no cumulative effects. However, the potential for high intensity fire would continue and subsequent loss of riparian areas and loss of aquatic habitat would continue. At the same time, vegetation would recover in previously disturbed areas and riparian/aquatic conditions would improve until or unless another disturbance results.

Alternative 2 – Proposed Action

Direct/Indirect Effects

Direct effects on fish are possible only where there are instream activities. Water drafting is the only project activity that would occur in-stream. Water drafting in streams that support salmon and steelhead would be performed in accordance with NMFS water drafting specifications (USDC 2001) designed to prevent adverse direct and indirect effects to anadromous salmonids by requiring intakes to be screened to prevent entrainment of fish, and by limiting rate of water drafting. Existing water drafting sites would be used and no new water drafting sites will be constructed. Therefore, the proposed action is not likely to have any direct adverse are affect on salmon and steelhead. Individual resident rainbow trout could be killed or injured because fish screening is not required upstream of the range of salmon or steelhead; however, there would be few drafting sites in resident rainbow trout habitat because the range of rainbow trout is just slightly greater than the range of steelhead trout in most project area streams and most of the drafting sites upstream of the range of steelhead would be in non fish-bearing reaches. However, a few individual rainbow trout could conceivably be entrained at water drafting sites that are within the range of resident trout, but this loss would not jeopardize the populations of rainbow trout in project streams given that rainbow trout are not listed as a threatened or endangered species and are ubiquitous in project area streams large enough to support trout.

Indirect effects to salmon, steelhead, and rainbow trout are assessed using habitat indicators as described in detail in table 55.

Table 55. Salmonid habitat indicators, primary environmental factors determining condition of salmonid habitat indicators, and appropriate measures for determining effects of proposed action on salmonid habitat indicators

Salmonid Habitat Indicators	Primary Environmental Factor(s)	Measures for Determining Affects on Salmonid Habitat Indicators via Affects on the Primary Environmental Factors
Water Temperature	Stream Shading	Change in stream shading
		Change in rate of landsliding (debris flows)
	Channel morphology	Change in rate of landsliding (mass wasting and debris flows)
		Change in magnitude of peak flows
	Base stream flow	Change in base flow (see measures for Change in Peak/Base Flow indicator below)
Substrate - Turbidity	Rate of fine sediment delivered to streams	Change in rate of landsliding
		Change in amount of disturbed, denuded, and/or compacted ground that is hydrologically connected to the stream system
		Change in rate of surface erosion as estimated by CWE modeling (USLE model)
Chemical and/or Nutrient Contamination	Amount of toxic or nutrient substances entering surface waters	Change in amount of toxic or nutrient substance entering surface water
Physical Barriers	Stream reached made impassable by construction of road-stream crossings, impoundments, diversion dams, or other obstructions	Change in status of fish passage due to construction of road-stream crossings, impoundments, diversion dams, or other obstructions
Substrate Character	Rate of fine and course sediment delivered to stream	Change in rate of landsliding.
		Change in amount of disturbed, denuded, and/or compacted ground that is hydrologically connected to the stream system
		Change in rate of surface erosion and mass wasting as estimated by CWE modeling (USLE and GEO models)
Pool Frequency/Quality and Width to Depth Ratio	Rate of course sediment delivery to stream	Change in rate of landsliding
	Rate of debris flows	Change in rate of landsliding
	Magnitude of peak flows	Change in magnitude of peak flows
	Amount/character of existing LWD in stream channels, and potential for future LWD recruitment to the stream channel	Direct removal or addition of LWD to the stream channel.
		Change in potential for future recruitment of LWD to the stream channel via trees falling. (see Measures for LWD Indicator below)
		Change in rate of LWD delivered to the stream channel via landsliding (see Measures for LWD

Salmonid Habitat Indicators	Primary Environmental Factor(s)	Measures for Determining Affects on Salmonid Habitat Indicators via Affects on the Primary Environmental Factors
		Indicator below)
Off-Channel Habitat and Floodplain Connectivity	Freedom of stream channels to move laterally without obstruction by roads, culverts, dams, berms, or other obstructions	Change in potential for streams to move laterally without restriction due to in-channel activities or developments
	Amount of disturbance or development in off-channel areas or floodplains that reduces habitat availability or suitability	Change in disturbance levels in off-channel and floodplain areas.
Large Woody Debris	Amount/character of existing LWD in stream channels	Direct removal or addition of LWD to the stream channel.
	LWD recruitment potential via trees falling into the stream channel	Change in potential for future recruitment of LWD to the stream channel via trees falling from within stream buffers
	LWD recruitment potential via trees landsliding into the stream channel	Change in rate of landsliding
		Change in amount and character of ground or vegetation disturbance on unstable or highly erodible ground (geologic RRs)
Streambank Condition	Direct ground disturbance of streambanks	Amount of direct ground disturbance on streambanks
	Channel alteration from increased rate of debris flows	Change in rate of landsliding
	Channel alteration from increased peak flows	Change in magnitude of peak flows
Refugia	Water temperature	Same Measures as for Water Temperature Indicator
	Cover	Change in amount of cover from LWD, undercut banks, unembedded cobbles and boulders, and deep pools (see Measures for Substrate, LWD, and Pool ... Indicators)
Change in Peak/Base Flows	Peak Flow: Amount of disturbed, denuded, and/or compacted ground that is hydrologically connected to the stream network (includes roads, landings, skid trails, etc)	Change in amount of disturbed, denuded, and/or compacted ground that is hydrologically connected to the stream system
		Change in amount of watershed disturbance from commercial thinning, underburning, and road and landing construction as estimated with CWE modeling (ERA/TOC model)
	Peak Flow: Increased runoff from increased area of clearings in the snow zone and snow transition zone	Change in number and total area of clearings that are 1.5 acres or greater in size

Salmonid Habitat Indicators	Primary Environmental Factor(s)	Measures for Determining Affects on Salmonid Habitat Indicators via Affects on the Primary Environmental Factors
	Base Flow: Amount of water diversion	Change in amount of water diverted from streams
	Base Flow: Net stand evaporation	Change in net stand evapotranspiration rate
Increase in Drainage Network	Amount of disturbed, denuded, and/or compacted ground that is hydrologically connected to the stream network (includes roads, landings, skid trails, etc)	Change in amount of disturbed, denuded, and/or compacted ground that is hydrologically connected to the stream system
Road Density and Location	Number of miles of road and the road locations. Duration of road before it is decommissioned	Change in number of miles of upslope and valley bottom road and how long new roads will be used before being decommissioned.
Disturbance History and Disturbance Regime	Amount and location of vegetation clearing and/or ground disturbance	Change in amount of watershed disturbance from commercial thinning, underburning, and road and landing construction as estimated with CWE modeling (USLE, GEO, and ERA models)
	Deviation from historic fuels conditions	Change in fuels conditions from proposed thinning and underburning
	Frequency and/or magnitude of stochastic events such as intense fires, floods, and large and/or widespread landslides	Change in rate of landsliding
		Change in magnitude of peak flows (see Change in Peak/Base Flow indicator)
		Change in fuels conditions from proposed thinning and underburning
Riparian Reserves	Amount of ground disturbance and/or vegetation removal in stream buffers (hydrologic RRs)	Change in amount of ground disturbance and/or vegetation removal in stream buffer (hydrologic RRs)
	Disturbance of stream buffer from debris flows or debris avalanches	Change in rate of landsliding
	Amount and character of ground disturbance and vegetation removal on unstable and/or highly erodible ground (geologic RRs)	Change in amount and character of ground or vegetation disturbance on unstable or highly erodible ground (geologic RRs)

Indirect effects to salmon, steelhead trout, and rainbow trout from implementation of alternative 2 are shown in table 56.

Table 56. Alternative 2 - Effects on salmonid habitat condition measures

Measures of Project Effects to Salmonid Habitat Condition	Effects of Proposed Action Project Elements on Measures of Salmonid Habitat Condition for Alternative 2
Change in stream shading	The proposed action would kill and/or consume brush and small trees within stream buffer RRs. However, PDFs would maintain adequate stream shading where needed. At least 85% canopy cover would be maintained (where that much currently exists) over perennial and intermittent streams in all natural stands and most plantations (the only exception to this is in plantations with offsite ponderosa pine; in these stands, more aggressive thinning would occur and canopy cover could be reduced below 85%). Field research has shown that water temperatures did not increase when taken upstream and downstream of a stream reach with 80% canopy cover (McGurk 1988), although other research suggests that the impact of past forest harvest activities on stream temperatures cannot be entirely mitigated through the reestablishment [or retention] of riparian buffers (Pollock et. al., 2009). Thinning and underburning is unlikely to cause significant changes in stream shading or microhabitat conditions, therefore, risk of Project-related change in stream temperature due to changes in canopy cover of vegetation density is negligible.
Change in rate of landsliding	The proposed action would slightly increase landslide potential due to: (1) short-term (up to ten years) reduction in evapotranspiration and root strength in thinned, underburned, and cleared areas (roads, landings, skid trails) and (2) to increased and/or altered runoff from compacted and/or disturbed ground. These effects would not measurably affect landslide rates and would be offset in the long-term (10+ years) by increasing vigor of the stands associated with thinning, and by reduction in wildfire hazard due to fuel treatments (Geology Report).
Change in number and total area of clearings that are 1.5 acres or greater in size	Research has shown that canopy openings greater than 1 ½ to 2 acres must be created in order to change rain-on-snow dynamics (Christner and Harr, 1982). The proposed action would create openings where all vegetation is removed; however, none of the openings would be larger than the 1.5 acres that could lead to changes in magnitude of peak flows from rain-on-snow events.
Change in amount of disturbed, denuded, and/or compacted ground that is hydrologically connected to the stream system	The proposed action would increase area of disturbed, denuded, and/or compacted ground in each Project watershed, however, there would be negligible or no measurable increase in the amount of disturbed, compacted or cleared ground that drains overland to a stream system because: (1) roads, landings, skid trails, and yarding corridors would be designed and used with drainage control, and generally be located well enough away from the nearest channel or ditch to provide adequate infiltration, (2) underburning implemented to prescription has negligible risk of increasing overland flow or measurably altering runoff because low intensity underburning treatments do not typically affect the permeability of soil underneath the protective duff and litter layer, and little to none of the existing canopy cover over the stream is removed, (3) new areas of disturbance would generally be less than one acre - research has shown that canopy openings greater than 1.5 to 2 acres must be created in order for a change in runoff from rain-on-snow to be measurable (Christner and Harr, 1982), and (4) Grant et al (2008) review of paired watershed studies indicated that a 1% increase of harvested [clearcut or cleared] areas in a watershed relates to a 0.5% increase in peakflow, however, all the clearing (for temporary roads, landings, meadow enhancement, etc) caused by the proposed action amounts to less than 0.5% clearing of the total area in any of the project HUC7 watersheds or within the entire Indian Creek HUC5 watershed.
Change in amount of watershed disturbance from commercial thinning, underburning, and road and landing construction as estimated with CWE modeling (USLE,	The proposed action would not significantly increase modeled mass wasting (GEO) rate in any of the Project watersheds but would slightly increase modeled surface erosion (USLE) and modeled runoff risk (ERA/TOC) rates in many of the Project watersheds. All Project watersheds would remain below model inference points in all three CWE models.

Measures of Project Effects to Salmonid Habitat Condition	Effects of Proposed Action Project Elements on Measures of Salmonid Habitat Condition for Alternative 2
GEO, and ERA/TOC models)	
Change in amount of toxic or nutrient substance entering surface water	Borax treatments are expected to have neutral effect on water quality because: (1) application of Sporax® (borax) to fresh cut true fir stumps would be done in compliance with all label directions and Forest Service requirements, (2) borax is not particularly toxic and is relatively environmentally benign (USDA Forest Service 1995a), and (3) borax would be used only on the freshly-cut stumps of white fir or Shasta fir in treatment units that are at high enough elevation (about 4000 feet) to support true fir which means that use would be limited. In the Project area, true fir trees grow at higher elevations where there are few perennial streams and where perennial streams are usually non fish-bearing or support just resident trout but not salmon or steelhead. The Borax Pesticide Fact Sheet (USDA-FS 1995) concludes that borax is adsorbed by the mineral portion of the soil and borax remains unchanged in the soil for varying lengths of time, depending on soil acidity and rainfall. The average persistence is one year or more. Borax is less persistent in acid soils and in areas with high rainfall, under which conditions it may leach rapidly. The Dost Report further reports that plant uptake would probably scavenge any boron moving through the soils and that dilution over a watershed would hide even a significant spill. The proposed action could cause drips or spills of oil, hydraulic fluid, and grease from use of vehicles and equipment, and/or spray of bar oil from chainsaw use, but streams would be protected from this type of contamination through application of PDFs, particularly stream buffers, and through enforcement of Forest Service contract obligations, such as restricting equipment use in stream buffers and forbidding the use of poorly maintained or “leaky” vehicles and equipment in the Project. The prescribed burns would be ignited with drip torches or through aerial ignition. Most but not all of the fuel from drip torch and aerial ignitions is consumed in the prescribed fire. Total amount of petroleum products entrained into surface or ground waters from lubricants, hydraulic fluids, and drip torch fuels combined is expected to be insignificant and it is unlikely that such Project-related chemicals would be detectable in perennial streams.
Change in status of fish passage due to construction of road-stream crossings, impoundments, diversion dams, or other obstructions	The proposed action has no causal mechanism to affect passage for fish and aquatic organisms because there would be no in-channel disturbances in fish-bearing streams or reductions in streamflow that could affect passage for fish or other aquatic organisms.
Direct removal or addition of LWD to the stream channel	The proposed action would not remove LWD from a stream channel except in infrequent situations of where a piece of large woody debris or fallen hazard tree is blocking a drainage structure or presenting a safety hazard. Therefore, little to no LWD would be removed from stream channels. Wood could be added to a stream channel if a hazard tree was felled into the channel and left there - but this would occur infrequently if at all.
Change in potential for future recruitment of LWD to the stream channel via trees falling into the channel	The proposed action would have neutral short term effect on potential for LWD to be recruited by trees falling from the stream buffer because no large qualifying trees would be felled or burned up within stream buffers (except for trees hazardous to operations which are generally left on site in stream buffers if felling is necessary) and the largest and healthiest trees would be retained in stream buffers. The proposed action would have slight positive long term effect on potential LWD recruitment from stream buffers because thinning, fuel treatments, and underburning would improve the health, vigor, and growth rate of retained vegetation, and because the treatments would reduce risk of a future stand-replacing wildfire that could kill living trees before they are large enough to qualify as LWD. No thinning would take place in aquatic influence zones (FEMAT 1993) of ephemeral channels where the sediment retaining function of

Measures of Project Effects to Salmonid Habitat Condition	Effects of Proposed Action Project Elements on Measures of Salmonid Habitat Condition for Alternative 2
	live vegetation and woody debris is critical to moderating erosion.
Change in potential for streams to move laterally without restriction from roads, levies, berms, or other development	The proposed action has no causal mechanism to affect the potential of streams to move laterally because the Project would not cause any significant new ground disturbance within stream channels, off-channel areas, or floodplains.
Change in disturbance levels in off-channel areas and floodplains	The proposed action has no causal mechanism to cause any significant new ground disturbance within stream channels, off-channel areas, or floodplains.
Amount of direct ground disturbance on streambanks	Only the skidding and water drafting components of the proposed action have causal mechanism to affect streambanks. Streambanks would not be disturbed except: (1) in infrequent circumstances where logs may have to be skidded across a dry intermittent channel – in these instances the channel shape would be restored immediately after skidding, and before any precipitation and runoff, and (2) in infrequent circumstances where a new water drafting site needs to be created – in these instances new water drafting sites would be temporary, would not use fill without approval by a fisheries biologist and an earth scientist, and would not be constructed on fish-bearing stream reaches, and if fill is used, it would be removed and the channel shape restored after use.
Change in amount of cover from LWD, undercut banks, substrate, deep pools	The proposed action would not significantly affect the amount of instream cover because: (1) there would be no instream activities other than water drafting which would not affect quantity of fish cover, (2) potential for LWD to be delivered to stream channels via trees falling from the stream buffer or via landslides from upslope areas would not be significantly decreased in the short term and may increase in the long term due to proposed action (see LWD measures above), and (3) rate of course sediment delivery from mass wasting that can fill pools or provide cover in the form of large boulders would not be significantly changed (see Landsliding measures above).
Change in net stand evapotranspiration rate	The proposed action would slightly increase area of denuded ground and/or slightly decrease vegetation density. These actions would eliminate evapotranspiration in the short term in areas where there is new road, landing, skid trail, and yarding, and would reduce evapotranspiration in the short term in areas where trees are thinned and/or ladder fuels treated, however, these Project disturbances are not expected to affect net evapotranspiration rate in any drainage to the point where ground water balance is significantly affected in the long term or short term because: (1) the only semi-permanent clearing of vegetation is associated with new short temporary road segments and landings - in these areas all vegetation would be removed during Project implementation and post-project regrowth would likely be slow and stunted due to loss of top-soil and ground compaction, however, these new disturbances are very small in area relative to the HUC7 project watersheds and are widely distributed across the project watersheds and (2) in the short term, thinning would slightly reduce net evapotranspiration in treated stands but the thinning would also cause the rate of evaporation to increase in the treated stand thereby compensating for the slight reduction in ground water use - so that ground water balance would be approximately the same as pre-treatment in the short term. In the long-term, the residual canopy would expand and evapotranspiration would increase, while forest floor evaporation would decrease due to the expanding shade. Total evapotranspiration would again return to near pre-harvest level.

Measures of Project Effects to Salmonid Habitat Condition	Effects of Proposed Action Project Elements on Measures of Salmonid Habitat Condition for Alternative 2
Change in amount of water diverted from streams	Water drafting is the only proposed action with causal mechanism to affect this measure. Water would be drafted for dust abatement and to manage underburns. Water drafting would follow NMFS Water Drafting Specifications (USDOC 2001) that limits the rate of water drafting so that anadromous salmonids are not adversely affected. Drafting rate is limited to 350 gallons per minute and no more than 10% of the streamflow. Therefore, total amount and rate of water drafted from streams during Project implementation would be negligible.
Change in number of miles of upslope and valley bottom road and how long new roads will be used before being decommissioned	The proposed action would construct about 2.9 miles of temporary road in 26 segments, and would decommission 4.1 miles of road in 6 segments. There would be a slight increase in road miles in the short-term due to construction and use of the temporary roads but most temporary roads would be constructed, used, and stormproofed or decommissioned in the same year and dry season. Temporary roads leave a long-term imprint on the landscape even if decommissioned but the long term increase in disturbance due to temporary roads in the Two Bit Project would be minor because Project temporary road segments would be constructed on stable ground or ridgetop locations outside of hydrologic and geologic RRs. In the long-term, after road decommissioning, there would be a slight reduction in non self-maintaining road density in the Indian Creek 5th field watershed but a slight increase in density of self-maintaining temporary roads.
Change in fuels conditions from proposed thinning and underburning	The proposed action would reduce flame length and crown fire potential in treated areas in the long term (Fuels Specialist Report). Wildfire risk would be slightly increased in treated areas in the short-term because thinning would increase ground fuels, and underburning is delayed for several years after thinning so residual trees can recover from thinning shock before underburning.
Change in amount of ground disturbance and/or vegetation removal in stream buffer riparian reserves	The proposed action would increase area of disturbed ground and slightly decrease vegetation density in stream buffers in the short term, but would increase the vigor and growth rate of residual vegetation in the long term. Buffer width would be determined by site condition so that stream bank integrity, sediment filtering and nutrient spiraling functions, temperature regulation, large wood delivery, and other watershed processes are protected in the short term, and improved in the long term. Approximately 234 acres within stream buffer RRs are proposed for commercial thinning to reduce density, which is about 1.2% of the total stream buffer RR acreage in the Indian Creek 5th field watershed. There would be no commercial thinning or other ground-disturbing activities within stream buffers of fish-bearing streams. Short term increase in disturbance and decrease in vegetation density in stream buffer RRs would not be significant at the 7th field or 5th field watershed scale because: (1) there would be only 234 acres of commercial thinning in stream buffers across the entire Project area and no more than 60 acres would be commercially thinned in stream buffers in any one 7th field watershed, (2) the prescriptions in stream buffer RRs retain much of the vegetation and nearly all of the overstory, and (3) no road or landings would be constructed within stream buffer so there would be minor disturbance legacy.
Change in amount and character of ground or vegetation disturbance on unstable or highly erodible ground (geologic RRs)	The proposed action would not cause significant ground disturbance and/or result in excessive vegetation removal in geologic RRs. Project design features for activities in geologic RRs (see project design features in Chapter 2) would guide project activities in these sensitive areas. No commercial harvesting would occur in inner gorges; ground-based equipment would not operate within extremely unstable areas (as designated by a geologist), inner gorges or areas with highly erosive soils (as designated by a soil scientist); no new roads or landings would be constructed in geologic RRs; mastication and tractor yarding would not be used in unstable lands in geologic RRs; careful review of any proposed roads or landings in particularly sensitive areas (unit numbers are identified in Table 12) would occur; full suspension cable yarding would be used in geological RRs; specific guidance on use of prescribed fire in geologic RR's

Measures of Project Effects to Salmonid Habitat Condition	Effects of Proposed Action Project Elements on Measures of Salmonid Habitat Condition for Alternative 2
	would be implemented to ensure fire would be low severity; and all treatments in geological RRs would meet ACS objectives. Therefore, increase in ground disturbance and vegetation removal on geologic RRs is expected to be insignificant at the HUC7 and HUC5 watershed scales in the short and long term.

Alternative 2 would not directly adversely affect salmon or steelhead trout because water drafting is the only in-channel activity proposed, and because water would be drafted according to NMFS 2001 Water Drafting Specifications designed to prevent adverse affects to anadromous fish. Upstream of the range of anadromy, a few individual rainbow trout could be killed or injured at a few drafting sites but this loss would not result in a trend toward federal listing or a loss of viability. Rainbow trout are ubiquitous in project area streams and not federally listed. Proposed activities would not measurably affect these populations. Alternative 2 may impact individual Chinook salmon, steelhead trout and resident rainbow trout; but would not result in a trend toward federal listing or a loss of viability. Indirect effects are minimized because none of the measures for determining indirect effects of proposed action on salmon and steelhead/rainbow trout habitat indicators would be significantly affected.

For purposes of Section 7 of the Endangered Species Act, implementing alternative 2 may affect but is not likely to adversely affect Coho salmon.

Cumulative Effects

Since there are no significant effects to salmon and steelhead trout at the stream segment or 7th field watershed scale, the proposed action would not increase cumulative effects at the 5th field watershed or larger scales. Since loss of a few individual resident rainbow trout would not jeopardize the trout populations in any of the project streams, the effects of the proposed action on resident rainbow trout would not be cumulative at the 7th field watershed or larger scales.

Alternative 3 – No New Temporary Roads

Direct/Indirect Effects

Alternative 3 includes 12 percent less thinning, fewer landings, and slightly fewer acres (70 acres) of underburning than alternative 2. Alternative 3 would not construct new temporary roads. The direct effects of alternative 3 would be slightly less than alternative 2 because less water would be drafted since no new temporary roads would be constructed—there would be less chance of injuring or killing a rainbow trout during water drafting, however, the chance of injuring or killing a resident rainbow trout is already low under alternative 2.

Alternative 3 would cause slightly less watershed disturbance than alternative 2, and result in slightly less watershed benefit; however, at the 7th field watershed scale, both alternatives would have minimal effects on the measurement indicators that serve as proxy for effects to coho and

Chinook salmon, steelhead trout, and rainbow trout. Therefore, alternative 3 and the proposed action would have similar effects on these fish species. Effects from implementation of alternative 3 are the same as those described above for alternative 2 and summarized in table 56.

Alternative 3 may impact individual Chinook salmon, steelhead trout and resident rainbow trout but would not result in a trend toward federal listing or a loss of viability. Indirect effects are minimized because none of the measures for determining indirect effects on salmon and steelhead/rainbow trout habitat indicators would be significantly affected.

For purposes of Section 7 of the Endangered Species Act, implementing alternative 3 may affect but is not likely to adversely affect Coho salmon.

Cumulative Effects

Since there are no significant effects to salmon and steelhead trout at the stream segment or 7th field watershed scale, alternative 3 would not increase cumulative effects at the 5th field watershed or larger scales. Since loss of a few individual resident rainbow trout would not jeopardize the trout populations in any of the project streams, the effects of alternative 3 on resident rainbow trout would not be cumulative at the 7th field watershed or larger scales. Therefore, alternative 3 would have similar cumulative effects as the proposed action.

Alternative 4 – Minimized Underburning

Direct/Indirect Effects

Alternative 4 includes 92 percent less burning than alternative 2 and unlike both alternative 2 and 3, includes 1,490 acres of mastication. The direct effects of alternative 4 would be slightly less than alternative 2 because less water would be drafted since substantially less underburning would occur—there would be less chance of injuring or killing a rainbow trout during water drafting, however, the chance of injuring or killing a trout is already low.

Based on the analysis presented in the hydrology and geology sections of this chapter, the indirect effects to fish (based on habitat indicators) of alternative 4 would be approximately the same as alternative 2. Both alternatives would have insignificant effects on the measures of effects to salmonid habitat indicators that serve as proxy for effects to coho and Chinook salmon, steelhead trout, and rainbow trout. Therefore, alternative 4 and alternative 2 would have similar effects on these fish species. Effects from implementation of alternative 4 are the same as those described above for alternative 2 and summarized in table 56.

Alternative 4 may impact individual Chinook salmon, steelhead trout and resident rainbow trout but would not result in a trend toward federal listing or a loss of viability. Indirect effects are minimized because none of the measures for determining indirect effects of alternative 4 on salmon and steelhead/rainbow trout habitat indicators would be significantly affected.

For purposes of Section 7 of the Endangered Species Act, implementing alternative 4 may affect but is not likely to adversely affect Coho salmon.

Cumulative Effects

Since there are no significant effects to salmon and steelhead trout at the stream segment or 7th field watershed scale, alternative 4 would not increase cumulative effects at the 5th field watershed or larger scales. Since loss of a few individual resident rainbow trout would not jeopardize the trout populations in any of the project streams, the effects of alternative 4 on resident rainbow trout would not be cumulative at the 7th field watershed or larger scales. Therefore, alternative 4 would have similar cumulative effects as alternative 2 and alternative 3.

Summary

Under the no action alternative, there would not be any direct or indirect effects. Therefore, there would be no cumulative effects. Under the no action alternative, potential for severe wildland fires would not be abated and the current risk of intense wildfire that could degrade watershed processes and aquatic habitats would continue.

Under the three action alternatives, there would be no direct effects to salmon and steelhead trout, and there would be no significant indirect effects to salmon, steelhead, and resident rainbow trout via effects to habitat indicators. A few individual rainbow trout could be entrained (killed or injured) at a few drafting sites under all action alternatives but this loss would not jeopardize the populations of rainbow trout in project streams. The action alternatives would not increase cumulative effects on salmon, steelhead trout, or resident rainbow trout. The action alternatives would slightly reduce the potential for severe wildfire effects that could degrade watershed conditions and aquatic habitats.

3.10 Botany and Noxious Weeds

3.10.1 Methodology

This section discusses effects on botanical species of interest, including special status species (federally listed, sensitive, other species of interest, rare plants) and noxious weeds. An office prefield review and a preliminary field review were conducted to determine if this project is within the range of any federally listed Threatened, Endangered or Proposed species, any Klamath National Forest Sensitive Species or other botanical species of interest, or if suitable habitat for any of these species is present within the proposed project area (USDA Forest Service 2009g). The objective of this review was to determine if suitable habitats were present and if further surveys would be required. Surveys are not required for species for which suitable habitat is not present, and for which the project area is outside of the currently known range of the species. Past surveys for other projects within the project area, GIS layers, California Natural Diversity Database and past field visits in the project area were used to develop the list of species of concern for this project.

The Klamath National Forest has a list of noxious weeds that are being tracked and managed. A high priority weed species is one that is of important local management concern

because of its currently limited distribution on the Klamath National Forest, highly invasive nature, and demonstrated potential to displace large geographic areas of native plant communities. Inadequate funding does not allow for treatment of all nonnative species, so emphasis is given primarily to high priority weed species. Information on weed presence and abundance was documented with field surveys for sensitive plants.

Numerous past field surveys have been conducted within portions of the Two Bit project area since 1980. Project-specific field surveys were conducted for Forest Service Sensitive Species during June - September of 2009 and are discussed in the affected environment section below. A qualified botanist familiar with the identification of the target species and their habitats conducted the surveys. Documentation included traverse routes marked on topographic maps. For all surveys, forms were completed which included the location of the unit, date of survey, seral stage and vegetation series, other habitat information, and a list of associated species. Project surveys and populations, if located, were documented on survey and site report forms. Field surveys conducted within the general area, and specifically for this project, were adequate to determine the presence of TES plant species.

Ground disturbance and alterations of light, moisture, and nutrient regimes within forest and associated plant environments can affect sensitive plants and their habitats through direct destruction of individual plants or through modification of habitat. Effects can be both long-term and short-term. Proposed activities may have cumulative effects on species viability if individually insignificant effects occur over a wide geographic range or on large numbers of sensitive plant populations.

The significance of management activities upon sensitive plant species viability depends upon many factors, including the size of known populations, the wider geographic range of known sensitive plant populations outside of the project area, and the degree of species sensitivity to short-term and long-term habitat modification.

Special Interest Areas (as defined in the Forest Plan) will also be described in this section.

The alternatives are compared using the following indicators:

- Changes in sensitive species (sensitive plants, fungi and bryophytes) population viability
- Changes in occurrence of high priority noxious weeds
- Special Interest Areas

The information used in the preparation of this section comes from detailed analysis in the Botany and Noxious Weed Report (Rentz 2010a) and is available in its entirety in the project record. A Biological Assessment/Evaluation has also been prepared for this project (Rentz 2010b) that provides additional detailed evaluation of sensitive plant species and is also available in the project record.

3.10.2 Affected Environment

Sensitive Species

There are no known populations or suitable habitat for plant species federally listed as Threatened, Endangered, or those proposed for federal listing within or near the project area. Therefore, federally listed and proposed species were not considered further for this analysis. Suitable habitat and/or confirmed populations of 13 sensitive species are present in the project area (table 57). Other species of concern are those angiosperms, bryophytes, lichens and fungi that were previously surveyed following the Survey and Manage standards and guidelines of the Northwest Forest Plan (USDA and USDI 1994). These survey and manage species are also listed as Sensitive Species on the Region 5 Sensitive Species List and are therefore included in the list below.

Table 57. Sensitive Species in the Two Bit Project Area, based on known occurrences or presence of suitable habitat

Species	Code	Common Name	Known to Occur in Project Area?	Field Survey Recommended	Habitat
Vascular Plants					
Cypripedium fasciculatum	CYFA	Clustered Lady's Slipper	Yes – 5 known populations	Yes	Moist sites on northern aspects in understory of mixed conifer forests
Cypripedium montanum	CYMO2	Mountain Lady's Slipper	Yes – 1 known population	Yes	Moist sites on northern aspects in understory of mixed conifer forests
Eriogonum hirtellum	ERHI7	Klamath Mountain Buckwheat	Yes – 20 known populations	Yes	Open serpentine barrens and rocky outcrops
Eucephalis vialis	EUV18	Wayside Astor	No	Yes	Forest openings and meadow edges; roadsides and other disturbed areas
Pedicularis howelli	PEHO	Howell's Lousewort	Yes – 26 known populations	Yes	Partial shade or forest openings on northern aspects in montane mixed conifer forests
Thermopsis robusta	THRO4	Robust False Lupine	Yes – 2 known populations	Yes	Openings within forests

Species	Code	Common Name	Known to Occur in Project Area?	Field Survey Recommended	Habitat
					and shrublands often found in disturbed areas along roads
Bryophytes					
Ptilidium californicum	PTCA5	Pacific Fuzzwort	Yes – 43 known populations	Yes	Moist, mature mixed conifer forests on shaded aspects of host trees
Buxbaumia viridis	BUVI2	N/A	No	No, habitat evaluation only	Occurs on decaying stumps and logs in shady, humid locations
Fungi					
Boletus pulcherrimus	BOPU4		No; low potential in project area		Found on roots in humus of mixed conifer and hardwood trees in older coastal forests
Cudonia monticola	CUMO2		No; low potential in project area		Found on coniferous needles and debris in older forests
Dendrocollybia racemosa	DERA5		No; low potential in project area		Found on rotting remnants of other fungi or in leaf mulch in forests
Phaeocollybia olivacea	PHOL		No; moderate potential in project area		Older mixed forests
Sowerbyella rhenana	SORH		No; low potential in project area		Duff, litter, mineral soil, woody debris or roots

Noxious Weeds

There are three high priority weed species within the proposed project area; Scotch broom (3 known populations), meadow knapweed (14 known populations), and spotted knapweed (1 known population). There are two moderate priority weeds, dyer's woad (14 known populations) and star thistle (3 known populations).

Special Interest Areas

There are four botanical special interest areas located within the project boundary.

- The Indian Creek Brewer Spruce area is a 310 acre stand located in the northwest end of the project area and represents a healthy stand of Brewer Spruce, *Picea breweriana*, a species endemic to the Klamath Region. This special interest area is not within or adjacent to areas where ground disturbing activities are proposed and therefore will not be discussed further.
- The Rhododendron Patch is the westernmost presence of a large patch of Rhododendron occidental. This special interest area is not within or adjacent to areas where ground disturbing areas are proposed and therefore will not be discussed further.
- Poker *Flat is* a 100-acre are containing mid-elevation (4200 feet) serpentine meadow. Several sensitive/rare species are located in this meadow including *Castilleja elata*, *Pedicularis howellii*, and *Epilobium luteum*. Proposed treatment in this area includes the removal of encroaching conifers and reduction of fuels. Proposed treatments are designed to maintain an open habitat and to promote plant diversity in the meadow
- Port-Orford Cedar Management Area is a 29-acre area located north of Kelly Lake on road 18N30. This area contains old growth Port-Orford cedar that differs from other populations due to its distance from the ocean and its higher elevation (4000 feet). There are two proposed treatment units that overlap the management area. Unit 22 is a plantation unit within the management area that would be thinned and Port-Orford cedar seedlings resistant to root rot would be planted. Unit 24 is a plantation with two small ends overlapping the management area that would also be thinned. A more detailed discussion of treatment in this area is discussed in the Vegetation section of this Chapter. Proposed project activities in this area are designed to enhance old growth characteristics and promote future health of the stand.

3.10.3 Environmental Consequences

Alternative 1- No Action

Direct, Indirect and Cumulative Effects

Sensitive Plants

There would not be direct effects from the no action alternative because no treatments would occur. Not implementing the proposed action could increase the possibility of the project area experiencing high intensity wildfire, which could result in indirect adverse impacts to habitat for sensitive plants. These plant communities have evolved in a fire-dependent ecosystem (Sawyer and Thornburgh, 1977) so species would likely survive and respond positively to low or moderate intensity wildfire. High intensity wildfires were not typical in the Klamath Mountains of California historically and many native plant species are not resilient to impacts of high intensity wildfire. There is a higher chance of death of native species individuals or populations from lethal soil temperatures that can kill underground reproductive structures. Indirectly, severe modifications in the forest canopy could be great enough to eliminate necessary habitat characteristics, such as shade, necessary for native and rare plant species to survive after high intensity wildfire has occurred.

The cumulative effect of increased potential for a high intensity fire with other past, present and future actions would be negligible to minor to sensitive species. Changes in species viability are not expected due to the distribution of habitats throughout each species' range.

Noxious Weeds

The no action alternative would not increase suitable habitat for noxious weeds from project related activities. Suitable habitat for weeds decreases with full canopy closure. Lack of disturbance and maintenance of the canopy would continue to discourage the establishment of weeds, allowing native species to occupy the majority of habitat in the project area. Other factors that contribute to introduction and establishment of weeds would continue, such as offroad vehicle use, transport on vehicles traveling through the Two Bit project area, spread of existing roadside noxious weeds. Invasive plant susceptibility may be increased by wildfires.

Alternative 2 – Proposed Action

Direct, Indirect and Cumulative Effects

Sensitive Species

The potential for effects to sensitive species are summarized in table 58 below.

Table 58. Direct, indirect and cumulative effects to Sensitive Plants from implementation of alternative 2

Species	Common Name	Proximity to Treatment Areas	Effects	Sensitive Species Determination
Cypripedium fasciculatum	Clustered Lady's Slipper	1 site near pole harvest unit; would be flagged and avoided	No direct/indirect effect due to harvest	No impact
Cypripedium montanum	Mountain Lady's Slipper	3 miles from nearest treatment	No direct/indirect effect due to harvest	No impact
Eriogonum hirtellum	Klamath Mountain Buckwheat	3 sites near underburn units; would be flagged and avoided by handline construction	Minor direct/indirect/cumulative effect due to underburning	May impact individuals but is not likely to cause a trend toward federal listing or a loss of viability
Eucephalis vialis	Wayside Astor	May be present in project area; surveys will be completed prior to implementation	No or minor direct/indirect effects due to harvest	May impact individuals but is not likely to cause a trend toward federal listing or a loss of viability
Pedicularis howelli	Howell's Lousewort	1 site near meadow enhancement unit; species favors	Minor direct/indirect/cumulative effect due to hand thinning and underburning	May impact individuals but is not likely to cause a trend toward federal listing or a

Species	Common Name	Proximity to Treatment Areas	Effects	Sensitive Species Determination
		disturbance for germination		loss of viability
Thermopsis robusta	Robust False Lupine	0.5 miles from nearest treatment	No direct/indirect effect due to harvest	No impact
Ptilidium californicum	Pacific Fuzzwort	Several sites within or adjacent to treatment units; project design features would minimize effects	Minor direct/cumulative effects due to timber harvest in occupied units; no indirect or cumulative effects	May impact individuals but is not likely to cause a trend toward federal listing or a loss of viability
Buxbaumia viridis	N/A	All habitat outside of harvest units; project design features for riparian reserves would protect habitat	No direct/indirect/cumulative effect due to underburning in riparian reserves, minimized through project design features	No Impact
Fungi				
Boletus pulcherrimus		Fungi habitat is present within thinning units; project design features for other resources would protect habitat	Minor direct/indirect/cumulative effects due to commercial thinning and underburning; no change in population viability	May impact individuals but is not likely to cause a trend toward federal listing or a loss of viability
Cudonia monticola				
Dendrocollybia racemosa				
Phaeocollybia olivacea				
Sowerbyella rhenana				

Project design features (see Chapter 2) have been developed to minimize the potential for adverse effects to sensitive species. Based on implementing these design features, effects would be minimal and would range from no impact to minor adverse direct/indirect and cumulative impacts, as shown in the table above.

Cumulative effect determinations considered the number of sites affected in the project area in context with the known population size on the Forest and within the range of the species, to the extent possible.

Noxious Weeds

Overall, the proposed action would have limited risk of weed spread due to implementation of project design features (Chapter 2). However, alteration of habitat in the short- and long-term, and presence of known weed occurrences in the project area could provide opportunities for weeds to spread or become established.

Weeds are commonly found on roadsides, in urban developments, in early-seral forested habitats and in open valleys. The presence of known weed occurrences in the project area could

provide opportunities for weeds to spread or to become established. Noxious weed habitat is created when soil is disturbed, competing vegetation is removed and bare soil is exposed. Noxious weeds have developed strategies that allow them to out-compete native species by germinating and occupying land faster than native species under environmental conditions that are not as well tolerated by native species. Project activities that result in ground disturbance may promote the spread of noxious weeds and increase the potential for noxious weed establishment. Commercial thinning would create openings under dense canopies; however, shade and duff levels would be retained and would inhibit germination of weed seeds. Weeds generally do not invade or persist in areas with moderate to high vegetative cover, which is expected to be retained as part of the project design.

Some soil disturbance would occur through tractor yarding, skid trail development, road and landing construction and decommissioning, pile burning, and machine piling near landings. Construction of temporary roads causes the greatest habitat alteration that can allow invasion by weeds. Decommissioning these roads afterwards, and permanently closing or decommissioning other roads is likely to offset the increase in risk from the temporary road construction. The ground disturbance from reopening old landings or constructing new landings can create additional suitable habitat where introduced noxious weed seed can become established. Landings, however, represent a small area of the total proposed for project activities. Project design features have been developed (see Chapter 2) that would minimize these effects.

Underburning can affect the introduction of noxious weeds by reducing protective duff and making bare mineral soil available or by releasing seeds. Studies have found that canopy cover is an important factor in the establishment of nonnative plant species as high canopy cover reduces available light. All the proposed treatment units would retain adequate overstory, understory, shrub and forb layers and area likely to suppress noxious weed invasions. Handpile and underburn fuels treatment methods pose a low risk since the treatment prescriptions are designed to retain adequate soil cover to prevent erosion. Retaining adequate soil cover will reduce the likelihood that new infestations can occur.

Design features have been developed that would minimize the potential for direct and indirect effects. The potential for new weed site introduction through project activities would be reduced through equipment washing measures and the use of weed free seed and straw. This is expected to greatly reduce the amount of weed seed introduction into the site. Heavy equipment would be excluded from the existing weed sites or would be washed prior to leaving an infested site. This would prevent the transfer of seed into other areas in the project by equipment. Also, treatment of existing populations prior to ground disturbing activities would reduce the number of seeds within the soil seed bank and may also reduce the potential for vegetative spread.

The post-project implementation weed monitoring and treatment would detect any new sites that may become established within the project area. Quickly treating these sites has a high probability of preventing new weed site establishment.

Alternative 3 – No Temporary Roads

Direct, Indirect & Cumulative Effects

Sensitive Species

The primary difference between alternative 2 and 3 is the construction of temporary roads. Locations of sensitive plants or habitats occur in/near thinning treatment units and are not specifically affected by road construction. For this reason, the effects to sensitive species are the same as that described for alternative 2.

Noxious Weeds

Changes in noxious weed distribution would be somewhat less for alternative 3 as that described for alternative 2 since no new temporary roads would be constructed; road construction and subsequent restoration can increase the presence and distribution of noxious weeds.

Alternative 4 – Minimized Underburning

Direct, Indirect and Cumulative Effects

Sensitive Species

With the substantially less underburn treatments in alternative 4, there would be no ground disturbing activities within or adjacent to Klamath Mountain Buckwheat populations. Therefore, there would be no direct, indirect or cumulative effects to this species and no change to the species' viability within the project area. Effects to all other sensitive species would be the same as those described for alternative 2 because project design features would minimize effects. Mastication would occur under alternative 4 and not under the other alternatives, but mastication would occur within thinned units only; areas that are treated by mastication followed by underburning may result in greater impacts to fungi species. Concentrated fuels close to the soil surface would produce higher temperatures that could damage mycelium within the soil. Design features developed for specific units would also apply to alternative 4.

Noxious Weeds

Mastication fuel treatment methods (or mastication in plantations) cause greater levels of ground disturbance; greater ground disturbance often results in an increase in nonnative species. However, mulch levels increase with mastication and this would reduce the germination of invasive species that require open, disturbed ground.

Summary

If alternative 1 were implemented, indirect impacts to sensitive plants could occur, associated with the effects of high intensity fire, if a wildfire were to start in the project area. Impacts would range from determinations of 'no impact' to 'may impact individuals but is not likely to cause a

trend toward federal listing.' Suitable habitat for noxious weeds would not increase under alternative 1, although invasive plant susceptibility may increase with high severity fire.

The impacts to sensitive species from implementation of alternative 2, 3 and 4 would range from determinations of 'no impact' to 'may impact individuals but is not likely to cause a trend toward federal listing.' Klamath Mountain Buckwheat would not be affected by implementation of alternative 4; this is the only difference in effect to sensitive species among the alternatives. The overall level of risk related to noxious weeds, given the existing condition and proposed activities for alternatives 2, 3 and 4 is low. Project design features would limit the spread of noxious weeds under any of the action alternatives.

3.11 Terrestrial Wildlife

3.11.1 Methodology

This section includes discussion of terrestrial wildlife species federally listed as Threatened, Endangered, or species proposed for federal listing, and Sensitive terrestrial wildlife species, species of interest, late-successional reserves (LSR), Management Indicator Species (MIS), migratory birds and Forest Plan Management Area (MA) 6 (Managed Wildlife Area). Effects analysis is based on habitat changes and the potential for direct disturbance from proposed treatments.

Field reviews, literature and research review, GIS analysis (forest MIS layer, NSO layers and others) and local expertise for the consideration of the direct, indirect and cumulative effects from implementation of proposed alternatives were used. Onsite project area field trips and review of forest service management indicator species habitat typing was used to analyze effects on forest sensitive species and management indicator species. NSO habitat was analyzed using the Klamath NSO habitat layer derived from the Habitat Land Management Plan Timber Type crosswalk for analysis done on the landscape scale (i.e. LSR, Management Area 6, Project Area and 7th field watershed areas). NSO habitat in the 0.5 mile radius core area and the 1.3 mile radius home range for all existing and new spotted owl activity centers were habitat typed by Timothy D. Burnett (USFS Biologist) using 1-meter resolution digital color imagery, GIS data and field confirmation. Field reviews of proposed treatment units were conducted in 2009 by biologists of the Yreka Fish and Wildlife Office and USFS. Suitable NSO within 0.5 mile of proposed treatment units was surveyed in 2009. Talus habitats in proposed treatment units were searched in 2009 for Siskiyou mountain salamanders and mollusks by multiple Forest Service specialists (biologist, soils, hydrology, and silviculture) while conducting field reviews of proposed units. No suitable talus habitat within the range of the Siskiyou salamander was identified. Goshawk surveys were conducted in 2009 in areas with historic Goshawk sightings. Sensitive species habitat was assessed using the NSO layer as a basis with field verification of habitat components.

The terrestrial wildlife analysis area consists of the Two Bit project boundary plus MA 6, a peregrine falcon territory and five NSO territories that extend beyond the project boundary. In total the wildlife analysis area comprises approximately 77,822 acres and is larger than the project area.

Short term effects are those that occur within ten years of project implementation and long term effects are those that occur more than 10 years after project implementation.

The alternatives are compared using the following indicators:

- Changes in TES species and species of interest habitat, trend toward federal listing or loss of population viability, and Critical habitat
- MA 6 and LSR habitat changes
- Changes in MIS and migratory bird habitat

The information used in the preparation of this section comes from detailed analysis in the Wildlife Report (Burnett 2010a) and is available in its entirety in the project record. A separate Biological Assessment/Evaluation has been prepared for this project (Burnett 2010b) which provides additional detailed evaluation of TES species as well as a separate MIS and migratory bird report; these reports were all used in preparation of this section and are all available in the project record.

3.11.2 Affected Environment

TES Species and Species of Interest

The Region 5 TES species list (USDA 2007) includes two terrestrial wildlife species federally listed as Threatened (NSO and marbled murrelet). The Fisheries section of this chapter discusses TES fish species with potential to be affected by proposed actions and the Botany and Noxious Weed section of this chapter discusses TES plant species with potential to be affected by proposed actions. The two Threatened wildlife species, NSO and marbled murrelet occur or have the potential to occur (based on available habitat) in the Two Bit analysis area and are discussed in more detail below. The Region 5 TES list (USDA Forest Service 2007a) also includes 19 additional wildlife species designed as sensitive by the Forest Service. These species as well as other species of concern were evaluated for the Two Bit project to determine which ones occur or have the potential to occur (based on available habitat) within the project area; several were excluded from detailed analysis. Table 59 includes all TES species with the potential to occur in the Two Bit project area.

Table 59. Sensitive Species/Other Species of Concern in the Two Bit Project Area, based on known occurrences or presence of suitable habitat

Species	Status	Known to Occur in Project Area?	Habitat
Birds			
Northern spotted owl	Threatened	Yes; 14 confirmed territories and designed Critical Habitat (CH) in the eastern portion of the project area; no treatments proposed in CH, so CH not considered further[1]	Old, forested habitats with multilayered canopies, large overstory trees, snags, and downed wood
Marbled murrelet	Threatened	No, but designated Critical Habitat and Northwest Forest Plan Zones 1 and 2 overlap the project area; no suitable nesting habitat occurs within 0.25 miles of proposed treatments	Nests primarily in coniferous forests from coastline to 52 miles inland
Bald eagle	Sensitive	No known nest sites but have been observed feeding at Kelly Lake	Nests in old-growth components of forests within 1 mile of water
Northern goshawk	Sensitive	Two historical nests sites that have not been confirmed in recent years; no designated goshawk management areas would be treated	Nests in dense, old forests in conifer trees
Willow flycatcher	Sensitive	No known locations but potential habitat occurs along Indian Creek and its tributaries	Nests in river valleys or lush meadows in willows or other riparian tree/shrub species
Great grey owl	Sensitive	No historic detections have been reported within the project area; suitable habitat occurs near the Klamath Siskiyou crest and Dry Lake Mountain	Mixed conifer and true fir forests adjacent to large montane meadows
Peregrine falcon	Species of Interest (removed from list in 2007 but analyzed here due to known presence)	Yes; one management area (nesting territory) occurs within the project area; thinning and burning treatments are proposed within this area	Prominent cliffs for nesting and perching, often near water
Mammals			
Wolverine	Sensitive	No, but home range overlap with project area is suspected based on available habitat and large home range size	Use meadows, forests, riparian habitats and montane chaparral; often select dens in den logs, rocky outcrops and burrows in dense forests
Fisher	Sensitive	No, but suitable denning/resting habitat	Mature, structurally complex conifer and

Species	Status	Known to Occur in Project Area?	Habitat
		is present	mixed conifer/hardwood forests; require multiple rest sites that are often tree cavities, squirrel and raptor nests or brush piles
American marten	Sensitive	No; habitat potential is low in the project area	High elevation true fir stands; use large logs, snags and live trees for denning/resting
Townsend's big-eared bat	Sensitive	No, but occurrence is likely based on available habitat	Variety of wooded habitat often in association with caves for roosting; will use caves, large trees, mines, buildings and bridges for roosting
Red tree vole	Species of Concern	Surveys conducted in general area with no detections; habitat potential is low in the project area	Older growth conifer forests with multi-layered canopies
Reptiles and Amphibians			
Northwest pond turtle	Sensitive	No, but potential habitat occurs along Indian Creek and its larger tributaries and in small ponds adjacent to project area	Aquatic habitats of ponds, lakes, streams; require emergent basking sites; use adjacent terrestrial habitat for overwintering and nesting
Foothill yellow-legged frog	Sensitive	No, but potential habitat occurs along Indian Creek and its larger tributaries	Streams in a variety of vegetation types; requires shallow, slow moving water for breeding
Siskiyou Mountains salamander	Sensitive	No, but potential habitat is suspected in proposed underburn treatment areas	Forested slopes with rocky soils and talus outcrops
Southern Torrent salamander	Sensitive	No, but potential habitat is present	Springs, seeps, and headwater streams and streamside forests
Invertebrates			
Blue-gray taildropper (slug)	Sensitive	Yes; surveys within suitable habitat will occur prior to project implementation to ensure treatment areas avoid any known sites	Forests with late-successional characteristics often with hardwoods; prefers moist, shady sites below leaf litter and duff

1 NSO CH applies to the 1992 and 2008 designation

Management Indicator Species

The full list of Klamath National Forest MIS was evaluated for applicability to this project. Table 60 below is a subset of the larger Forest list and displays those MIS that have habitat within the Two Bit project area with potential to be affected by proposed activities. Fourteen of the 25 Forest MIS were not considered further due to a lack of habitat within the project area.

Table 60. Management Indicator Species relevant to the Two Bit Project

MIS	Forest Plan Habitat Association	Forest Plan Recommended Level of Analysis	Reasons for Selection as MIS
Hardwood Species Association			
Acorn woodpecker	Oak woodlands with associated large conifers	Forest Plan and Project	Indicator for diversity of oak species and large conifers
Western gray squirrel	Mature hardwood and mixed hardwood/conifer	Forest Plan and Project	Indicator for mature hardwood and mixed conifer/hardwood
River/Stream Species Association			
Tailed frog	Perennial montane streams with dense vegetation	Forest Plan and Project	Indicator for water quality, in stream woody debris, bottom substrate, flows and channel condition
American dipper	Cold, swift, perennial streams	Forest Plan and Project	Indicator for water quality, instream woody debris, bottom substrate and flows
Northern water shrew	Riparian w/dense grass-forb cover	Forest Plan and Project	Indicator of riparian vegetation including canopy, deciduous veg, and grass/forb.
Long-tailed vole	Mesic habitats, dense riparian vegetation	Forest Plan and Project	Indicator of riparian vegetation including canopy, deciduous veg, and grass/forb.
Snag Species Association			
Red-breasted sapsucker	Mid- to late-seral mixed conifer and riparian deciduous	Forest Plan and Project	Indicator of snags as a habitat element and of other species which depend on sapwells for food.
Hairy woodpecker	Riparian deciduous habitats with large trees for cavities	Forest Plan and Project	Indicator of snags as a habitat element and of other species which depend on woodpeckers for cavities or as prey.
Vaux's swift	Late-successional forests with large hollow snags	Forest Plan and Project	Indicator of large snags as a habitat element
Downy woodpecker	Riparian deciduous habitats	Forest Plan and Project	Indicator of snags as a habitat element and for other species which depend on woodpeckers for cavities or as prey.
Pileated woodpecker	Late-successional coniferous forests	Forest Plan and Project	Indicator of snags as a habitat element and for other species which depend on woodpeckers for cavities or as prey.

Migratory Birds

On December 12, 2008, a Memorandum of Understanding was signed by the U.S. Department of Agriculture Forest Service (USFS) and the U.S. Fish and Wildlife Service (FWS) to promote the conservation of migratory birds (MOU). Section D, 3 of the MOU says, “Within the NEPA process, evaluate the effects of agency action on migratory birds, focusing first on species of management concern along with their priority habitats and key risk factors.” For the Klamath National Forest, the migratory bird species of management concern are those bird species listed under the Endangered Species Act as Threatened or Endangered, those species designated by the Regional Forester as Sensitive Species and those species listed under Standard and Guideline 8-21 through 8-34 of the Forest Plan as Management Indicator Species for project level assessment. Because several birds are included above as management indicator species and special status species, this section focuses primarily on those bird species not previously addressed in this document.

In the early 1990s, habitats along portions of the Klamath River were systematically surveyed for songbirds. These surveys detected over 70 avian species including 31 neotropical migratory species. The Seiad Valley long-term MAPS station is located 12 miles east from the project area and has captured 25 species of neotropical migratory birds (Cuenca personal communication).

Studies of mixed conifer forests in the western United States indicate that structural diversity—habitat patchiness, layered canopy, well developed understory—are positively related to richness (a measure of species diversity) and abundance of avian species (Beedy 1981; Hagar et al. 1996; Siegel and DeSante 2003). Hardwood species, even small patches within a mixed conifer community can also positively influence the density of some species (Morrison and Meslow 1983).

The specific nesting and foraging requirements of the resident and neotropical migrants in the project area are diverse. Due to these diverse requirements, any management activities or wildfire would likely benefit some species while negatively affecting others. Therefore, impacts to avian communities or assemblages would be expected to vary by species, type of treatment, wildfire intensity, and time since disturbance.

Management Area 6 (Managed Wildlife Area)

MA 6 is approximately 6,600 acres in size and is located on the west side of Indian Creek on the Happy Camp Ranger District; a portion of which occurs within the Two Bit project area. MA 6 was established to provide habitat for a broad range of species dependent on structural features common to late-successional vegetation. This area includes one Sensitive wildlife species, fisher (*Martes pennanti*). Within the Two Bit project area, open to dense stands of mid- to late-seral stage conifer habitat is present with inclusions of early seral stage vegetation. Approximately 30 percent of MA 6 currently provides habitat that is suitable for fisher denning/resting (KNF LRMP). Management guidelines for MA 6 include 1) manage the area to provide for late-

successional habitat; 2) manage habitat attributes, compatible with ecological processes, to provide moderate to high quality habitat conditions on the Forest as defined in the Fisher Habitat Capability Model (appendix I of the Forest Plan EIS1995), and; test and demonstrate the effectiveness of treatments for use in LSRs in an adaptive management approach. Underburning and one acre of roadside pole thinning is proposed within MA 6.

Late-Successional Reserves

Late Successional Reserves (LSRS) are land allocations established in the Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents within the Range of the northern spotted owl (NSO), also known as the Northwest Forest Plan (NWFP) (USDA Forest Service and USDI Bureau of Land Management 1994a). LSRs in combination with other land allocations and associated standards and guidelines were established to maintain a functional, interactive, late-successional and old-growth forest ecosystem. They were designed to serve as habitat for late-successional and old-growth-related species including the NSO. Specific to NSOs, LSRs primary function is to support NSO population clusters. The Two Bit project area contains the Runaway LSR and six 100-acre LSRs, three of which have treatments proposed in portions of them.

Runway LSR

The Runway LSR is about 3,030 acres in size and encompasses portions of West Fork and Little South Fork of Indian Creek. The Runway LSR is also designated Marbled Murrelet Critical Habitat. Late-successional and mid-successional conditions account for about 68 percent of the area and plantations account for about 27 percent. Because many of the early- and mid-successional stands within the LSR are young and healthy, they are expected to respond favorably to silvicultural treatments that reduce stand density. Some legacy late-successional components exist in mid-successional stands but generally large-diameter trees, snags, and downed woody debris are lacking. The dominant plant series in the LSR is mixed conifer – pine. Twelve percent of the Runway LSR has burned historically. This has allowed fuels to build up creating heavier fuel loadings and denser stands; fire risk is currently considered moderate. Based on the Klamath NSO GIS habitat layer, the Runway LSR is 43 percent nesting/roosting habitat and 37 percent nonhabitat for NSO. Plantation thinning and underburning are proposed within the Runway LSR.

100-Acre LSR

The 100-acre LSRs represent a network of stands of late-successional habitat that are to be retained in their natural condition with natural processes, such as fire, allowed to function to the extent possible (USDA Forest Service 1995b). Within the Klamath Province, past management practices have decreased the abundance of some types of old growth that are dependent on low intensity fires. Vegetation that is less fire resistant or less desirable for long term sustainability of late-successional habitat has become more widely distributed. Within and adjacent to the 100-

acre LSRs within the Two Bit area, the potential for stand replacing events has greatly increased. There are six 100-acre LSRs within the Two Bit project area, and they total approximately 570 acres (one is less than 100 acres). Plantation thinning and underburning are proposed within three 100-acre LSRs.

3.11.3 Environmental Consequences

Alternative 1- No Action

Direct, Indirect and Cumulative Effects

Northern Spotted Owl, Marbled Murrelet and Critical Habitat, LSR, and MA 6

These effects were combined under alternative 1 because all are expected to be similar under the no action alternative. All are associated with late-seral conditions and habitat characteristics.

Under alternative 1, no direct effects would occur because no proposed activities would occur in the project area. Activities designed to promote late-successional habitat would not occur. The indirect effects of alternative 1 include slow development of habitat for late-successional dependant species; tree density related mortality would continue and this would increase surface fuels over time. As described in the Forest Vegetation and Fuels section of this chapter, tree densities and basal area mortality would increase over time, crown fire potential would remain constant or would increase over time under both moderate and severe weather conditions, and surface fire intensity would increase under alternative 1. Therefore, alternative 1 does little to promote the development of habitat for late-successional species and increases the potential for stand-replacing fire that would remove existing late-successional habitat.

Other Forest Sensitive Species/Species of Concern

Bald eagle

There are no direct, indirect or cumulative effects on bald eagles from the no action alternative because there are no know bald eagle nest sites located within the project boundary and no management activities would occur under alternative 1 to directly alter existing conditions.

Goshawk

Under the no action alternative no activities would occur and there would be no direct effects to goshawks. Indirect effects of increasing stand density and increasing wildfire risk (as described above and also in the Forest Vegetation and Fuels section of this chapter) increases the potential to remove existing and future goshawk habitat in the event of a high intensity wildfire start within the analysis area. With no thinning within the project area, suitable goshawk habitat would take longer to develop in the proposed treatment units than if thinning treatments were implemented. Thus, the no action alternative does little to promote the development of goshawk habitat and increases the potential for wildfire to remove habitat in the long term.

Willow flycatcher

Under the no action alternative no activities would occur and there would be no direct effects to Willow flycatcher. It is unlikely that the amount of willow flycatcher habitat in the project area would substantially change in the short-term under alternative 1. However, in the event of a high intensity wildfire, many riparian areas could lose riparian shrub habitat that provides willow flycatcher habitat. Without treatment of meadows, meadows would eventually be replaced with conifers, reducing the habitat availability for willow flycatchers

Great grey owl

In the absence of large scale natural disturbance, it is unlikely that the amount of great grey owl habitat would change substantially in the short term. Nesting structure would continue to be recruited as winter storms in the higher elevation fir stands create broken-topped trees and snags. Foraging habitat may decline as conifer encroachment continues to reduce the size of natural meadows. Crown fire potential and expected tree mortality would increase over time with alternative 1 and this could degrade habitat over the long-term.

Peregrine Falcon

There will be no direct, indirect or cumulative effects from the no action alternative because no changes would occur to peregrine falcon habitat.

Wolverine

There would be no direct effects to wolverine under the no action alternative because no management actions would be taken. It is unlikely that the amount of wolverine habitat in the project area would substantially change in the short-term. Fire behavior is expected to change in the long term, increasing the potential to remove existing habitat in the event of fire starts within the project area. Thus, the no action alternative does little to promote the development of or maintenance of wolverine habitat and increases the potential for wildfire to remove habitat in the long term. Wildfires that burn with mixed severity levels in a mosaic pattern could benefit wolverines by improving habitat for deer and elk. Increase in ungulate numbers could benefit wolverine especially in winter when more carrion would be available.

Pacific Fisher

Under the no action alternative thinning and fuel reduction activities would not occur and thus there would be no direct effects to the Pacific fisher under this alternative. However, high quality fisher habitat would be slow to develop and density related mortality would continue under the no action alternative. As described above, the likelihood of a high intensity fire would increase over time with alternative 1. Therefore, the no action alternative does little to promote the development of fisher habitat and increases the potential for high intensity wildfire to remove existing fisher habitat.

American Marten

There are no historical records of marten in the analysis area. There have been no detections of marten in proximity of the project area and there have been only two detections in one area of

marten within the known range. The probability of martens occurring in the area is very low. Thus there are no direct or indirect effects to American Marten

There are no cumulative effects from the no action alternative because there are no other known or reasonably foreseeable future projects that will occur within the project area.

Townsend's big-eared Bat

Under the no action alternative there would be no direct effects to Townsend's big-eared bats. The no action alternative would not promote development of late-successional habitat. Large roost trees would be slow to develop and density related mortality would continue, increasing surface fuels over time. The no action alternative does little to promote the development of large tree/roost habitat and increases the potential for fire to remove existing large snags.

Red Tree Vole

Under the no action alternative there would no direct effects to red tree voles and existing habitat conditions would persist over the short-term. Preferred habitat (older growth mixed conifer forests with multi-layered canopies) would not be promoted and would be slow to develop over the long-term; density-related mortality would continue and surface fuels would increase over time, increasing the potential for wildfire.

Northwestern Pond Turtle

Under the no action alternative there would be no direct or indirect effects to northwestern pond turtles because habitat is expected to remain under the no action alternative.

Foothill yellow-legged frog

Under the no action alternative there would be no direct effects on foothill yellow-legged frogs. Existing habitat conditions is expected to remain under the no action alternative. In the absence of large scale natural disturbance it is unlikely that the amount of foothill yellow-legged frog habitat in the project area would substantially change in the near future. However, in the event of a high intensity wildfire, fire would burn through many riparian areas, potentially removing riparian habitat and high severity fires would increase sediment in the streams. Increase temperatures and sediment could adversely affect foothill yellow-legged frogs.

Siskiyou Mountains Salamander

There will be no direct effects to Siskiyou Mountains/Scott Bar Salamanders from the no action alternative. In the absence of large scale natural disturbance it is unlikely that the amount of Siskiyou Mountains/Scott Bar Salamander habitat in the Project Area would substantially change in the near future. However, in the event of a fire, fire would burn through many of the talus areas, potentially removing overstory habitat. The effects of such a fire on Siskiyou Mountains Salamanders are unclear, as they have survived these types of fires in the past. In areas where the talus is shallow the lack of an overstory may cause heating and drying of the talus leading to the loss of the salamanders at those sites; however in areas with deep talus the salamanders would be expected to survive high severity fires and the loss of the overstory vegetation.

Southern torrent salamander

There will be no direct effects on southern torrent salamanders as a result of the no action alternative. Southern torrent salamander habitat in the action area would not change substantially in the short-term. However, in the event of a fire, fire would burn through many riparian areas, potentially removing riparian habitat and high severity fires would increase sediment in the streams. Increase temperatures and sediment could adversely affect southern torrent salamanders.

Blue-gray taildropper

There would be no direct effects to the blue-gray taildropper as a result of the no action alternative. Indirect effects of the no action alternative could result in a high intensity wildfire that could burn through much of the habitat areas, potentially removing overstory habitat. The effects of a fire on blue-gray taildropper are unclear, as they have survived these types of fires in the past. In areas where the talus is shallow, the lack of an overstory may cause heating and drying of the talus leading to the loss of the mollusks at those sites; however, in areas with deep talus or other refugia the mollusks would be expected to survive high severity fires and the loss of the overstory vegetation.

Management Indicator Species

Hardwood species association (Acorn woodpecker and Western gray squirrel)

There would be no direct effect to the hardwood species association as a result of the no action alternative because no management actions would be taken. In the absence of large scale natural disturbance it is unlikely that the amount of hardwood habitat in the Project Area would substantially change in the near future. However, in the event of a fire, fire would burn through many of the hardwood areas, potentially removing hardwood habitat.

River/stream species association (Tailed frog, Cascade frog, American Dipper, Northern Water shrew and Long-tailed vole)

There would be no direct effects on the river/stream species association with the no action alternative because no management actions would be taken. The no action alternative would not result in changes to the amount or quality of habitat for these river/stream associated species in the near future. As fuels continue to accumulate with increasing tree mortality wildfire behavior is expected to increase with wildfires of higher severity and intensity. Following high intensity fire, surface erosion is expected to occur and the potential for landslides increases. These processes would contribute sediment to streams potentially impacting turbidity and stream substrate. High intensity fire also has the potential to remove riparian vegetation and structure such as downed logs. A reduction in riparian vegetation has the potential to increase stream temperatures. The extent of these impacts is dependent upon fire intensity and size.

Snag associated species (Red-breasted sapsucker, Hairy woodpecker, White-headed woodpecker, Vaux's swift, Downy woodpecker, Pileated woodpecker, Black-backed woodpecker)

There would be no direct effects created by the no action alternative because no management actions would be taken. Under the no action alternative indirect effects could result in several general patterns regarding fire behavior and fire induced tree mortality over time including constant or increased crown fire potential, increased surface fire intensity and constant or increased basal area mortality (see Fire and Fuels section in this chapter). These patterns may have some benefit to snag associated species by creating nesting and roosting structure and by increasing foraging opportunities in the short-term. However, uncharacteristic wildfire has the potential to remove existing habitat components such as large snags and down wood, to impact recruitment of these components over the long-term, and to substantially reduce or create large gaps in the canopy. The actual extent of these effects, whether beneficial or adverse, is dependent upon fire intensity and size. Fire behavior that is expected to continue to increase in severity and intensity over time would likely result in long-term impacts that would exceed short-term benefits for the snag associated species habitat.

Migratory Birds

Under the no action alternative, change in forest structure and composition at the landscape scale would be slow in developing. Thus, no significant changes in avian communities would be expected. In the event of a fire start within the project area, a high severity is likely (see Fuels section of this chapter).

Several studies have shown that some avian species respond favorably to wildfire events while the abundance of other species declines (Hutto 1995: Kotliar et al. 2002: Smucker et al. 2005). Even following high severity fire, Smucker et al. (2005) found that an approximately equal number of forest birds increased in abundance as decreased. Thus, under the expected fire behavior described above, it is likely that there would be a shift in avian communities but not necessarily a decrease in forest bird abundance. Cavity nesting species and species that forage on insects and seeds would likely increase in abundance immediately following a fire event. Species such as western tanagers and hermit warblers that nest in the foliage of live trees and whose foraging strategy includes gleaning insects from foliage would likely decrease following moderate to high intensity fire. Over time, as the vegetation regenerates, the avian community would likely shift to species that nest in shrubs or are associated with grass understory, eventually becoming dominated by species associated with early-successional forests.

Alternatives 2, 3 and 4

The three action alternatives (alternatives 2, 3, and 4) would have similar effects to NSO, Marbled Murrelet, Marbled Murrelet Critical Habitat, LSR, MA 6, Forest Sensitive Species, MIS and migratory birds because all three alternatives involve management of habitat and include similar implementation methods and project design features for terrestrial wildlife (see Chapter 2). The alternatives vary primarily in the amount of treatment and not in the type of treatment, with a few exceptions. Therefore, all three alternatives are discussed together; where there are differences among the effects by alternative, these are noted.

Direct, Indirect and Cumulative Effects

Project design features have been developed for terrestrial wildlife to minimize the potential for adverse effects; these would apply to any action alternative selected and are described in detail at the end of Chapter 2.

Northern Spotted Owl

There are 14 historical NSO activity centers in the analysis area. All suitable NSO habitat and sites within 0.5 mile of treatment units were surveyed to protocol in 2009. Proposed activities that were within 0.5 miles of the historic sites were surveyed and NSOs were located at three of these sites in 2009.

Approximately 62 percent of the project area contains NSO habitat (dispersal, foraging and nest/roost); of this, 49 percent is suitable (foraging and nest/roost, table 61). In general, nesting/roosting habitat occurs in small, widely scattered patches. Foraging habitat is more widely distributed and occurs in somewhat larger blocks. Of the NSO habitat available in the project area, approximately 12-13 percent would be treated under Alternatives 2 and 3 and only approximately 1 percent would be treated under alternative 4 (table 61). The vast majority of this treatment would be underburning (table 62).

Table 61. Northern spotted owl habitat in the Two Bit project area

Habitat	Total Acres in Project Area	Percent in Project Area	Alt 2 Percentage of Available Habitat Treated	Alt 3 Percentage of Available Habitat Treated	Alt 4 Percentage of Available Habitat Treated
Dispersal	8981	13	8	8	2
Forage	15578	23	11	10	2
Nest/Roost	17354	26	16	16	Less than 1
Total Available NSO Habitat	**41913**	**62**	**13**	**12**	**1**
Nonhabitat	23483	35	18	18	9
Off-Forest (land in Oregon outside of Klamath NF)	2236	3	0	0	0
Total All Acres	**67632**	**100**			

Combining all proposed treatment acres (underburning and silvicultural), approximately 55 percent of total treatment acres would occur in NSO habitat for Alternatives 2 and 3 and 24 percent for alternative 4, due to the limited amount of underburning under alternative 4.

Table 62. Treatment types in northern spotted owl habitat, all action alternatives

Treatment	Alternative 2	Alternative 3	Alternative 4
	Percent of Total Treatment Acres	Percent of Total Treatment Acres	Percent of Total Treatment Acres
Dispersal Habitat			
Silvicultural Treatments (thinning and specialized treatments)	2	2	7
Underburning Only	6	6	Less than 1
Percent of Total Treatment	*8*	*8*	*7*
Foraging Habitat			
Silvicultural Treatments (thinning and specialized treatment)	3	2	11
Underburning Only	15	16	3
Percent of Total Treatment	*18*	*18*	*14*
Nest/Roost Habitat			
Silvicultural Treatments (thinning and specialized treatment)	0	0	0
Underburning Only	29	29	3
Percent of Total Treatment	*29*	*29*	*3*
Percent of Total Treatments in NSO Habitat	*55*	*55*	*24*
Nonhabitat			
Silvicultural Treatments (thinning and specialized treatments)	17	16	75
Underburning Only	28	29	Less than 1
Percent of Total Treatment	*45*	*45*	*76*
Percent of Total Treatment	*100*	*100*	*100*

Proposed thinning and underburning treatments are considered activities that would degrade NSO habitat. Habitat degradation is a term used to describe the reduction in NSO habitat attributes (i.e. down woody debris, trees with mistletoe) but not elimination of these attributes to the extent that the habitat cannot be used by NSO. Degrading habitat still retains the quality (stand diversity, canopy cover etc.) so that it can continue to be used by NSO. There will be no NSO habitat downgrading (habitat removal or habitat category change) from treatments proposed in alternatives 2, 3, or 4. For the purposes of this analysis, degraded NSO habitat is separated by treatment type; degradation via underburning compared to degradation via thinning. These treatments result in different effects: commercial thinning would result in reduction in canopy cover and stand density of trees greater than 10 inches and tends to result in stands that are more uniform; underburning would result in much more variation and is less likely to result in a reduction in canopy closure and/or tree density of trees greater than 10 inches. Therefore, underburning, though still considered degrading, would have minimal effects to NSO habitat. No thinning is proposed for suitable nesting/roosting habitat; thinning would occur in foraging and dispersal habitat only.

Most plantation units proposed for treatment (except 103, 104, and 108-11) and natural stands proposed for treatment (except units 208, 234, 237 and 254) were considered suitable NSO foraging habitat; Units 208, 234, 237 and 254, 400, 300 and 301 were considered dispersal habitat. All pine plantation units and meadow treatment units were not considered suitable NSO habitat.

Effects of Thinning

Thinning is designed to promote the development of NSO habitat and would not remove important structural habitat components such as large diameter trees, hardwoods, snags, or downed wood. Trees infected with mistletoe may be removed, but prescriptions have been designed to ensure that this structural component will remain on the landscape.

The prescriptions in stands that are suitable foraging habitat are designed to retain all NSO foraging habitat postharvest (i.e. 50 percent or greater canopy cover, thinning from below and retention of snags, down woody debris, hardwoods, variable density thinning, and tree species diversity). Table 63 displays units in foraging habitat proposed for thinning and how they would be treated.

Table 63. Proposed thinning in NSO foraging habitat

Unit#	Silvicultural Treatment	Yarding System	Acres	NSO Habitat Type	Basal Area Pre-Harvest AVG	Basal Area Post-Harvest AVG	Canopy Closure AVG	Effect Post
103	Thin Plantation	Conventional Log Skidder/Tractor Endline	9	Foraging	188	120	>60	Degrade
104	Thin Plantation	Conventional Log Skidder/Tractor Endline	7	Foraging	180	120	>60	Degrade
108	Thin Plantation	Mechanical Harvester	11	Foraging	200	130	>60	Degrade
109	Thin Plantation	Mechanical Harvester	5	Foraging	180	120	>60	Degrade
110	Thin Plantation	Mechanical Harvester	13	Foraging	175	120	>60	Degrade
111	Thin Plantation	Mechanical Harvester	17	Foraging	200	120	>50	Degrade
200	Thin Natural Stand	Conventional Log Skidder/Tractor Endline	14	Foraging	240	160	>60	Degrade
201	Thin Natural Stand	Mechanical Harvester	17	Foraging	300	160	>50	Degrade
203	Thin Natural Stand	Mechanical Harvester	3	Foraging	160	120	>50	Degrade
205	Thin Natural Stand	Cable	7	Foraging	400	190	>60	Degrade
209	Thin Natural Stand	Mechanical Harvester	9	Foraging	240	180	>60	Degrade
212	Thin Natural Stand	Mechanical Harvester	3	Foraging	380	180	>60	Degrade
213	Thin Natural Stand	Cable	6	Foraging	420	240	>70	Degrade
214	Thin Natural Stand	Cable	19	Foraging	280	160	>60	Degrade
216	Thin Natural Stand	Cable	7		340	160	>60	Degrade

Unit#	Silvicultural Treatment	Yarding System	Acres	NSO Habitat Type	Basal Area Pre-Harvest AVG	Basal Area Post-Harvest AVG	Canopy Closure AVG	Effect Post
				Foraging				
217	Thin Natural Stand	Conventional Log Skidder/Tractor Endline	3	Foraging	220	140	>50	Degrade
218	Thin Natural Stand	Conventional Log Skidder/Tractor Endline	3	Foraging	340	170	>60	Degrade
219	Thin Natural Stand	Cable	15	Foraging	260	140	>50	Degrade
220	Thin Natural Stand	Conventional Log Skidder/Tractor Endline	12	Foraging	240	140	>50	Degrade
225	Thin Natural Stand	Mechanical Harvester	6	Foraging	220	140	>50	Degrade
226	Thin Natural Stand	Conventional Log Skidder/Tractor Endline	8	Foraging	320	150	>50	Degrade
227	Thin Natural Stand	Mechanical Harvester	10	Foraging	230	150	>60	Degrade
228	Thin Natural Stand	Mechanical Harvester	9	Foraging	320	150	>50	Degrade
229	Thin Natural Stand	Mechanical Harvester	5	Foraging	240	140	>60	Degrade
236	Thin Natural Stand	Conventional Log Skidder/Tractor Endline	2	Foraging	260	160	>60	Degrade
238	Thin Natural Stand	Mechanical Harvester	10	Foraging	360	190	>60	Degrade
243	Thin Natural Stand	Cable	4	Foraging	280	120	>50	Degrade
253	Thin Natural Stand	Mechanical Harvester	28	Foraging	240	140	>50	Degrade
255	Thin Natural Stand	Mechanical Harvester	9	Foraging	240	160	>60	Degrade

Dispersal habitat would be retained postharvest. Prescriptions are designed to increase growth in mid-seral and younger trees left after treatment, increasing the development of late-seral conditions sooner than untreated stands.

Thinning may affect NSO prey species during and immediately following treatment; However, where thinning treatments similar to those proposed in this project have been applied, effects to small mammal species diets and small mammal biomass have been shown to be insignificant or of short duration (Monroe and Converse 2006; Manning and Edge 2008; Suzuki and Hayes 2003).

Thinning plantations is expected to open stands to allow foraging habitat conditions to develop sooner than if no treatment took place. Many plantations are currently too dense to allow for NSO foraging. By thinning stands, NSO would have more accessible habitat to forage in and move through. Prey populations may increase due to the creation of openings and burn treatments that would increase grasses and forbs for prey species. The majority of plantations within the project area have little to no snags, coarse woody debris or trees over 20 inches dbh; what is intact would remain so following treatment and in some cases may increase these components.

A home range analysis for all NSO home ranges in the analysis area was done to evaluate the proximity of treatments to known nest sites. Activities within 0.5 miles and 1.3 miles of NSO activity centers were calculated. Many of the home ranges do not contain recommended sufficient amounts of suitable nesting/roosting habitat. However, this project would not thin any existing nesting/roosting habitat; underburning only is proposed for nesting/roosting habitat and is not expected to reduce the quality of the habitat for nesting/roosting. In addition, in the long-term, both thinning and underburning treatments proposed for foraging and dispersal habitat would also contribute to the development of future suitable nesting/roosting habitat. Short term effects on prey species within home ranges are expected to minimal with small mammal populations recovering in 6 months to 1 year from the date of treatment (Manning and Edge 2008; Suzuki and Hayes 2003).

Operational trees are those that are cut for road and landing construction and clearing for yarder corridors. Placement of yarding corridors would be such that patches of large trees and snags would be avoided whenever possible; however in some cases due to yarder anchors and or geographical conditions corridors may need to be placed where the cutting of an individual large tree may be required. Large trees felled for safety or operational reasons may be removed. The removal of large trees for this reason would be uncommon and incidental and therefore, effects to NSO would not be measurable. Down wood greater than 20 inches diameter averaged 4.9 pieces per acre across units surveyed (Walters 2010). Amounts of down wood vary greatly by units surveyed ranging for 0 to 14 pieces per acre. Additionally, where stand conditions permit, incorporation of recommendations for snags and down wood would ensure that these components are retained in the landscape (USDA Forest Service 1994, pgs 4-25 & 4-39).

Alternatives 2 and 4 propose the same level of NSO foraging habitat degradation via thinning. Alternative 3 proposes somewhat fewer acres of thinning in foraging habitat. Underburning in NSO nest/roost would be approximately the same for alternatives 2 and 3 but substantially less under alternative 4. Underburning would have minimal impact to suitable NSO nesting/roosting habitat. Alternative 4 is the only alternative that proposes mastication. Mastication however would not result in any additional impacts to NSO habitat because it would occur in postharvest thinning units only; it would not further reduce canopy cover or stand density.

Temporary Road Construction, Existing Road Reopening and Landings

Approximately 0.5 miles (or 1 acre) of temporary road is proposed for construction under alternative 2 in NSO foraging habitat. All other temporary road construction and reopening would not occur within NSO habitat. Openings created by road construction would be linear and at most 20 feet wide. Existing canopy in mid-and late-seral forest would cover all or most of the openings. Road clearings may have short term effects on small mammal movements and occupation of the road surfaces. All temporary roads would be hydrologically restored after use and should be covered by leaf and needle drop and start accumulating down wood within one year of their closure. Openings of this size are common in NSO habitat and would have minimal short-term negative effects.

New landings proposed within tractor-thinned units are expected to average approximately 0.33 to 0.50 acres in size, and occasionally up to 0.75 acres in size to accommodate slash piles from tree tops, while landings for cable units are expected to average 0.1 acre. Landings in tractor units would remove approximately 18 acres of NSO foraging habitat. Landing for cable units would remove approximately 6 acres of foraging habitat. Six new landings would be constructed within 0.5 miles of a known NSO activity center. Of these, three are proposed in plantations and therefore would not be removing suitable NSO habitat. Three cable landings are within the same NSO 0.5 mile activity center (core area) and are expected to remove approximately 0.3 acres of foraging habitat from that activity center’s core area.

Prescribed burning

Prescriptions for underburns are designed to minimize damage to the existing habitat. To ensure the distribution of northern spotted owl prey will not be significantly impacted by fuel reduction treatments, project design features will limit the amount of northern spotted owl habitat that can be burned annually to less than 50 percent of the suitable habitat within a northern spotted owl core area and home range. However, the area within a fire perimeter that actually burns is highly variable (Sugihara et al. 2006). Unburned areas within the fire perimeter may act as refugia for some small mammals (Lyon et al. 2000).

Underburn monitoring data collected by the Forest Service from 1998 to 2005, indicates that an average of 31 percent of the area within an underburn remains unburned post treatment (USDA Forest Service 2005b). Therefore, the actual number of acres burned within a northern

spotted owl core area or home range is expected to be considerably lower than 50 percent of the core and home range.

Prescribed fires can influence prey communities via consumption and creation of snags and down wood and effects on understory vegetation. Several important prey species are associated with decaying standing and down wood structures, including flying squirrels and voles. Prescribed fires typically consumes some of the existing dead wood in a stand, which could negatively affect these species; however, low intensity burns do not normally burn all areas within the fire and are expected to leave hard down wood and snags in place, providing refugia for small mammals. A number of studies have found strong support for positive low severity prescribed fire affects on deer mouse densities (Kaufman et al. 1990; Jones 1992) an important prey species for northern spotted owls. However, in a study conducted in mixed conifer forest of the Sierra Nevada Mountains, deer mice densities did not change significantly as a result of prescribed fire and overall small mammal biomass did not change significantly for three years following spring and fall prescribed burns (Monroe and Converse 2006). Other effects described as, year effects, (weather and food availability), had a greater influence on deer mice and total small mammal biomass than did the prescribed fire effects (ibid). Therefore, it is expected that low severity and intensity prescribed fires will have minimal short tern negative effects on small mammal biomass.

In the long term, fuel reduction treatments are expected to have benefits to northern spotted owls by reducing fuels to a level that would result in an acceptable fire behavior and post fire stand condition. Fuels treatments will generally reduce crown fire potential and maintain a surface fire type and reduce predicted stand mortality in the event of a wildfire start. The area susceptible to some type of crown fire in the project area would be reduced and the area that would have control problems (flame length greater than 8 feet) would be reduced (Fuels section).

These factors indicate that stands will be more resistant to large scale fires but will burn with sufficient intensity to create small openings within forested habitat. This type of pattern, would create a mosaic of stands in different successional stages, and be consistent with patterns under historic fire regimes. This pattern of successional stages would likely benefit northern spotted owls by creating horizontal diversity of habitat across the landscape.

Additional projects that are ongoing that are within the project area would not remove NSO habitat. These projects are generally small and were evaluated for NSO effects and project design features were developed to minimize the likelihood of adverse effects. Cumulative effects are considered minor for this reason.

NSO Summary

For purposes of Section 7 of the Endangered Species Act, implementation of alternatives 2, 3 or 4 may affect, but is not likely to adversely affect NSO. This determination is based on the above detailed analysis and the following key points: 1) suitable (foraging and nest/roost) NSO habitat would only be degraded; no habitat would be removed or downgraded; 2) none of the existing dispersal habitat within the project area would be removed; 3) effects to prey species would be

minimal and of short duration; and 4) project design features would minimize the likelihood that NSOs would be killed or injured during project implementation or that normal breeding behaviors would be disrupted by noise or smoke. Critical Habitat would not be treated and therefore would not be affected by implementation of either alternatives 2, 3 or 4.

Marbled Murrelet and Critical Habitat

No nesting habitat for marbled murrelet was identified in or within 0.25 miles of any proposed thinning units under alternatives 2, 3 or 4, based on multiple site visits. At inland sites (12 to 37 miles from the coast) in southwestern Oregon and northern California, murrelets were absent from dry stands where platforms were abundant but moss was scarce (Dillingham et al. 1995, Hunter et al. 1998). In the Two Bit project area, most of the treatment units are located in the Klamath mixed conifer vegetation association; this is drier and is less likely to contain moss-covered limbs. Moss-covered limbs are the primary nesting substrate used by marbled murrelets. Some units have large trees with large limbs but no moss- covered limbs were observed. Units are also in the upper third of the slope and away from major creeks and rivers where marbled murrelets generally are found nesting.

The Runway LSR is designated Marbled Murrelet Critical Habitat Unit CA-10a. Only approximately 4 percent (120 acres) of the 3,000 acre Critical Habitat Unit (Runway LSR) would be thinned under alternatives 2, 3 and 4 and this thinning would be in existing plantations. These plantations do not provide the primary constituent elements for Critical Habitat and thus primary constituent elements would not be removed or affected by proposed treatments. All of these plantations are approximately 50 years old. None of the thinning is in marbled murrelet nesting habitat. Thinning is designed to increase growth of trees creating trees with large limbs that could provide suitable nest structure for marbled murrelets in the long-term. Thinning would reduce the probability of stand-replacing fires.

In alternatives 2 and 3, underburning is planned for approximately 40 percent (1,200 acres) of the Critical Habitat Unit. Under alternative 4, no underburning would occur in Critical Habitat. For alternatives 2 and 3, this area would not be underburned in one year and is expected to take several years to completely burn the designated area. Underburning would decrease the probability of stand replacing fires and is expected to create a more fire resilient ecosystem. Underburns would not remove or affect any of the primary constituent elements for MAMU critical habitat.

There are no cumulative effects because there are no foreseeable future projects within Critical Habitat.

Marbled Murrelet Summary

For purposes of Section 7 of the Endangered Species Act, implementation of alternatives 2, 3 or 4 would have no effect on marbled murrelets or marbled murrelet Critical Habitat. This determination is based on the analysis above and the following key points: (1) no marbled murrelet nesting habitat would be removed or downgraded; (2) no marbled murrelets have ever

been found nesting in the project area; (3)marbled murrelets are unlikely to be found nesting in the project area due to the lack of suitable nesting habitat; (4) there is no suitable nesting habitat within ¼ mile of proposed treatments; (5) Proposed treatments would not remove primary constituent elements of marbled murrelet Critical Habitat; and (6) proposed thinning and underburning would be beneficial to marbled murrelet Critical Habitat.

Other Sensitive Species/Species of Concern

Bald Eagle

There are no direct, indirect or cumulative effects from action alternatives 2, 3 or 4 because there are no known nest sites, and therefore no potential to affect bald eagle habitat or individuals.

Northern Goshawk

No goshawk management areas are proposed for treatment within the project area. There are two historic “nest” locations within the project area. These two areas were surveyed in 2009 with no detection of Goshawks and will be surveyed again in 2010. There are areas of unsurveyed suitable goshawk habitat within the project area.

Nesting/roosting NSO habitat was used to quantify amount of suitable nesting habitat for goshawks. Natural stands were considered suitable nesting habitat for goshawks, while plantations were considered unsuitable nesting habitat. There is approximately 17,350 acres of suitable northern goshawk nesting habitat within the project area. Approximately 2,975 acres (17 percent of project area) of suitable goshawk nesting habitat would be degraded (see NSO section above for the definition of degraded) based on alternatives 2, 3 or 4 proposed treatments. The majority of this would be from underburning. Roughly 2,710 acres of nesting habitat would be underburned only.

No goshawk habitat would be removed and treatments within plantations would improve goshawk foraging in the short-term and nesting habitat in the long-term (greater than 10 years). Habitat in historic goshawk nest sites is currently being encroached on by young conifers and hardwoods, which, if left untreated, would reduce the value and utility for goshawks. Precommercial thinning would reduce the encroaching understory vegetation that would then be burned, opening up the understory, and improving foraging habitat. Underburning would also reduce potential fire severity, thus protecting the existing stand structure in the short term from stand replacing fires.

In the long-term, fuel reduction treatments are expected to have substantial benefits to goshawk by reducing fuels to a level that would result in an acceptable fire behavior and post fire stand condition. Fuels treatments would generally reduce crown fire potential and maintain a surface fire type and reduce predicted stand mortality in the event of a fire. Treated stands would be more resistant to large-scale fires but would burn with sufficient intensity to create small openings within forested habitat. This burn pattern would create a mosaic of stands in different successional stages, consistent with patterns under historic fire regimes. This pattern of

successional stages would benefit goshawk prey species by creating horizontal diversity of habitat across the landscape.

Implementation of alternatives 2, 3 or 4 may impact individual goshawks but would not likely result in a trend toward federal listing or a loss of viability. This determination is based on the discussion above, as summarized in the following key points: (1) no goshawk management areas would be treated within the project area; (2) no goshawk habitat would be removed; (3) suitable goshawk habitat would be treated, but this would primarily be through underburning: treatments which would downgrade habitat only; (4) the small amount of thinning proposed in goshawk habitat would downgrade habitat only and would be focused on removal of understory vegetation which may improve goshawk habitat over the long-term; (5) thinning in plantations (unsuitable habitat) could result in development of goshawk habitat over the long-term; (6) fuels treatments would reduce the possibility of stand replacing fires that have the potential to adversely affect goshawk habitat; and (7) project design features have been developed (table 12) to minimize the likelihood of adverse impacts.

Cumulative effects to goshawks would not be measurable. Because direct/indirect effects from implementing this project under any of the action alternatives as described above would be minor, adding these effects to those of past and ongoing projects would also be minor. Recent past and ongoing projects were evaluated for effects to wildlife, including goshawks, and protective measures are implemented for these other projects to minimize the potential for adverse impacts. No additional future projects are anticipated in the project area. For this reason, cumulative effects would be minimal.

Willow flycatcher

Habitat for willow flycatchers occurs only in riparian reserves and meadow treatment areas. Approximately 13 acres of proposed meadow restoration/enhancement under alternatives 2, 3 and 4 could affect willow flycatchers. Underburns are also proposed within riparian areas that have suitable willow flycatcher habitat. The riparian reserves with suitable flycatcher habitat are small and patchy and are located adjacent to the wetted edge that is unlikely to have much effect from underburning. Implementation of project design features and the aquatic conservation strategy for the project (see appendix D) would reduce negative impacts from management within riparian reserves and is expected to provide long-term benefits to willow flycatcher habitat.

Spring underburns that back down into riparian reserves may directly affect some willow flycatcher habitat. Willow and alder habitat are located in the area directly affected by the water in the riparian reserves, these areas will be wet with green herbaceous vegetation and willow and alder will also have high live fuel moistures in the spring. It is highly unlikely that these areas would burn during the spring nesting season, however smoke may inundate nesting habitat resulting in nest abandonment. Treatment of riparian zones with underburns would reduce the fuels in these areas. Because underburns are designed to imitate low intensity fire and shrubs

such as willow and alder often become established following a disturbance (Petrides 1992), any impacts to willow flycatcher habitat are expected to be short term.

Cumulative effects would not be measurable. Because direct/indirect effects from implementing this project under any of the action alternatives as described above would be minor, adding these effects to those of past and ongoing projects would also be minor. Recent past and ongoing projects were evaluated for effects to wildlife, including flycatchers, and protective measures are implemented for these other projects to minimize the potential for adverse impacts. No additional future projects are anticipated in the project area. For this reason, cumulative effects would be minimal.

Because fuel reduction treatments may remove habitat or disrupt breeding activities, implementation of alternatives 2, 3 or 4 may impact individuals, but is not likely to result in a trend toward federal listing or a loss of viability for willow flycatcher. Due to the substantial reduction in underburning under alternative 4, the potential for adverse impacts to willow flycatchers is substantially less for alternative 4 than for alternatives 2 or 3.

Great Grey Owl

Great grey owl habitat will benefit from meadow treatments proposed under alternatives 2, 3 and 4. Proposed underburning would increase prey availability and the creation of small canopy openings would be beneficial for great grey owl foraging. Although no great grey owls have been observed in the project area, it is possible that noise disturbance during implementation could disturb owls during their nesting period.

Cumulative effects would not be measurable. Because direct/indirect effects from implementing this project under any of the action alternatives as described above would be minor, adding these effects to those of past and ongoing projects would also be minor. Recent past and ongoing projects were evaluated for effects to wildlife, including great gray owls, and protective measures are implemented for these other projects to minimize the potential for adverse impacts. No additional future projects are anticipated in the project area. For this reason, cumulative effects would be minimal.

Based on this, implementation of alternatives 2, 3 or 4 may impact individuals, but is not likely to result in a trend toward federal listing or loss of viability of the great grey owl.

Peregrine Falcon

Treatments are proposed within 1.5 miles of a peregrine falcon eyrie and would occur within the 4,640 acre peregrine falcon management area. Approximately 70 acres of plantation thinning and 280 acres of underburning (for a total of approximately 8 percent of the management area) would be implemented under alternatives 2, 3 or 4. Silvicultural prescriptions in these units are designed to promote late-successional forest and would maintain large trees, snags and down wood. Maintenance of these structures would sustain populations of cavity nesting birds that are prey for peregrine falcons. There may be short-term reduction in some prey species; however,

there would be long-term benefits of increased tree diameter and thus, larger snags, and in the event of a fire start, reduced fire severity in the thinned and underburned treatment units.

Silvicultural prescriptions for the stands in the peregrine falcon management area are designed to develop large trees and snags sooner than untreated stands. Fuels treatment in the area would help reduce the possibility of stand replacing fires, thus protecting the existing habitat. As a result, alternatives 2, 3 and 4 would have short-and long-term benefits for the peregrine falcon, no direct, indirect or cumulative adverse effect.

Wolverine

Direct effects of noise disturbance from use of heavy equipment during project activities can lead to displacement of animals or disruption in breeding or feeding activities. Noise disturbance related to proposed treatments would be short-lived and last for one season in any given location. Given the natural low densities of wolverines, their tendency to avoid human activities, and the low likelihood of their presence in the project area, it is expected that disturbance or disruption of normal breeding/feeding activities would be unlikely. These activities would have inconsequential effects on individuals and no overall effect on populations.

Direct effects on mid- and late-successional habitat would occur through commercial thinning, landing construction, and temporary road construction. Commercial thinning in the Project Area is designed to retain large trees, snags and large logs; however canopy cover will be reduced. Decrease canopy cover should be inconsequential in the ability of the treated areas to provide habitat for wolverines. Proposed actions would remove some large trees and create small openings in the forest canopy, which may degrade suitable habitat in the short term. In a study in Montana, no differences in movements, habitat use, or behavior was noted between wolverines occupying logged areas vs. unlogged areas (Hornocker and Hash 1981).

For purposes of this analysis, NSO nesting/roosting habitat was used as a proxy for suitable wolverine habitat because nesting/roosting habitat has large down woody debris that is associated with wolverine use. Underburning is the only treatment proposed in NSO nesting/roosting habitat. Approximately 16 percent of the available nest/roost habitat would be treated with underburning in alternatives 2 and 3 and less than 1 percent would be treated with underburning in alternative 4 (table 62).

Indirect effects from thinning and associated fuels treatments may include beneficial effects to prey species habitat. Creating small openings in treated stands, protecting large hardwoods and reducing ladder fuels and ground cover may improve habitat for deer, elk and small mammals. Thinning and fuels treatments may temporarily reduce snag and large down wood, decreasing resting and denning habitat and habitat for small mammals. In addition, fuels treatments will reduce the fire behavior potential thereby reducing the risk of loss of forested habitat to catastrophic wildfire. Silvicultural prescription will leave suitable habitat for wolverines and may increase deer, elk and small mammal numbers increasing the food supply.

The moderate to heavy existing road density in the project area and the human use that is associated with these roads make it unlikely wolverines currently use the project area. The project will not increase road densities within the project area.

Cumulative effects would not be measurable. Because direct/indirect effects from implementing this project under any of the action alternatives as described above would be negligible, adding these effects to those of past and ongoing projects would also be negligible. Recent past and ongoing projects were evaluated for effects to wildlife, including wolverines, and protective measures are implemented for these other projects to minimize the potential for adverse impacts. No additional future projects are anticipated in the project area. For this reason, cumulative effects would be minimal.

Because wolverine habitat would not be removed under alternatives 2, 3 or 4 and the presence of wolverines is unlikely in the area, implementation of alternatives 2, 3 or 4 would have no effect on the California wolverine.

Pacific Fisher

For purposes of this analysis, NSO nesting/roosting habitat was used as a proxy for fisher denning/resting habitat because NSO nest/roost habitat contains features that are associated with fisher use (large decadent trees, large downed woody debris, etc.). As shown in table 62, approximately 17,354 acres of suitable denning/resting habitat occurs in the project area (NSO nesting/roosting habitat in the table); only 16 percent of this would be treated under alternatives 2 and 3 and less than one percent would be treated under alternative 4. The only treatment proposed under alternatives 2, 3 or 4 in denning/resting habitat would be underburning.

Thinning would not be conducted in fisher denning/resting habitat. Thinning prescriptions in plantations and natural stands outside of denning/resting habitat are designed to maintain and promote the development of fisher habitat by creating conditions that would allow for the development of large diameter trees, snags, and downed wood. Trees infected with mistletoe would be removed, but silvicultural prescriptions have been designed to ensure that this component will remain on the landscape.

Thinning and fuel reduction treatments have the potential to impact fisher prey species by removing or reducing the availability of important habitat components. However, where thinning treatments similar to those proposed in this Project have been applied, effects to small mammal species commonly found in fisher diets have been shown to be insignificant or of short duration (Carey and Wilson 2001; Suzuki and Hayes 2003). Underburns carried out at very low and low intensity do not normally burn all areas within the fire and will leave hard down wood and snags in place, providing refugia for small mammals. In a study conducted in mixed conifer forest of the Sierra Nevada Mountains, overall small mammal biomass did not change significantly for three years following prescribed fire (Monroe and Converse 2006). Other effects described as year effects (weather and food availability), had a greater influence on total small mammal biomass than did the prescribed fire effects (Ibid).

Following proposed treatments under alternatives 2, 3 and 4, the project area would be more resilient if a wildfire were to start in the area; the risk of a high intensity fire would be reduced (see Fuels section in this chapter). A more natural fire regime would include fires that would burn with sufficient intensity to create small openings within forested habitat. This burn pattern would create a mosaic of stands in different successional stages, and be consistent with patterns under historic fire regimes. This pattern of successional stages would likely benefit fisher by creating horizontal diversity of habitat across the landscape.

Openings created by the yarding corridors will be narrow and will be covered or partially covered by canopies of adjacent trees. These openings will be linear in nature and smaller than many natural openings that occur in mid-and late-successional forest. Temporary roads, landings, and yarding corridor construction however may remove some large trees suitable for denning or resting. Openings created by temporary roads and yarder corridors are not expected to be barriers to fisher movements. No temporary roads or landings are located in suitable fisher denning/resting habitat.

Direct effects of noise disturbance from use of heavy equipment during project activities can lead to displacement of fisher or disruption in breeding/foraging activities. Noise disturbance would be relatively short-lived and last for one season in any given location. Given the natural low densities of fishers, based on survey data, it is expected that disturbance or disruption of normal foraging activities will be minimal. In addition, fishers are highly mobile animals and would likely avoid areas of human activity during foraging. The human activity during Project activities may disrupt forage or breeding behaviors of individuals.

Underburns will be carried out in a manner that keeps burns at low severity levels, which may remove some snags and down wood. Snags and down wood lost to under burns will likely be replaced by trees killed by the underburns. Burn prescriptions are designed to retain snag and down wood at the amount recommended in the Forest Plan (1995a) where stand conditions permit. Fuel reduction treatments are not expected to have a significant impact to the important structural components of fisher habitat. Because fisher have a diverse diet and may switch prey in response to changing density (Zielinski et al. 1999), they would likely find abundant prey in the event of a short-term reduction in some prey species following a prescribed fire.

Cumulative effects would not be measurable. Because direct/indirect effects from implementing this project under any of the action alternatives as described above would be negligible, adding these effects to those of past and ongoing projects would also be negligible. Recent past and ongoing projects were evaluated for effects to wildlife, including fisher, and protective measures are implemented for these other projects to minimize the potential for adverse impacts. No additional future projects are anticipated in the project area. For this reason, cumulative effects would be minimal.

Because treatments would remove some large trees and snags (though in small amounts) and underburning would occur within denning/resting habitat, implementation of alternatives 2, 3 or 4 may impact individuals, but is not likely to result in a trend toward federal listing or a loss of

viability for fisher. Effects to fisher prey species would be minimal and short-term. Over the long-term, proposed treatments would benefit fisher habitat by increasing denning/resting habitat and reducing the potential for high intensity fire. Due to the substantial reduction in underburning under alternative 4, the potential for adverse impacts to fishers is substantially less for alternative 4 than for alternatives 2 or 3.

American Marten

There are no historical records of marten in the analysis area. There have been no detections of marten in proximity of the project area. The probability of martens occurring in the area is very low. Effect to Marten habitat is expect to be minimal and proposed underburning would benefit habitat for marten in the long-term. Based on negative survey data, current range of the species, and low likelihood of occurrence, it is expected that the project would have no direct, indirect or cumulative effects on American martens.

Townsend's big eared bat

Thinning and fuels reduction treatments may result in the removal of some individual trees or snags that may be used for roosting. By meeting the recommendations for snags in the Forest Plan (1995a) and because the felling or removal of large trees would only occur under limited circumstances, impacts to roosting habitat are expected to be minimal. Townsend's big-eared bats are more commonly found roosting in caves or mines; caves are located on private property near the Klamath River and on the north end of the project area.

Mines occur throughout the project area. Proposed activities would occur within potential roosting habitat. Because this species is sensitive to disturbance at roost sites, these actions would likely have an effect on roosting behavior if bats are present.

Thinning is expected to have long-term benefits for Townsend's big-eared bats by promoting the development of large diameter trees which may provide suitable roosting sites. Proposed thinning and fuel treatments would change expected fire behavior over time, resulting in fires of less intensity, reducing the potential that existing habitat will be lost.

Cumulative effects would not be measurable. Because direct/indirect effects from implementing this project under any of the action alternatives as described above would be minor, adding these effects to those of past and ongoing projects would also be minor. Recent past and ongoing projects were evaluated for effects to wildlife, including Townsend's big eared bats, and protective measures are implemented for these other projects to minimize the potential for adverse impacts. No additional future projects are anticipated in the project area. For this reason, cumulative effects would be minimal.

Due to disturbance and the loss of individual large trees and snags, implementation of alternatives 2, 3 or 4 may impact individuals, but is not likely to result in a trend toward federal listing or loss of viability for Townsend's big-eared bats.

Red tree vole

The project area is within the suspected range of the Oregon red tree vole (*Arborimus longicaudus*). Oregon red tree voles have been documented in conifer stands ranging in elevation from sea level to 5,500 feet (Manning and Maguire 1999 in Biswell et al. 2002). General habitat for the red tree vole consists primarily of older growth conifer stands with multi-layered canopies and large branches capable of supporting nests and providing travel routes.

In 2000, distribution of the genus *Arborimus* in Siskiyou County in general and on the Happy Camp Ranger District in particular, was not well known. There is a historical account of red tree voles in the Elk Creek area (Zentner 1977). Surveys were conducted in 2000 on the Happy Camp Ranger District that included areas within the Two Bit project area; no red tree voles were found. Surveys were again conducted in 2002 and 2003 for several projects on the Happy Camp Ranger District; no red tree vole nests were detected during any of these surveys.

Based on the fact that (1) no red tree voles are known to occur in the project area and that there have been no recent detections during surveys; (2) older trees would be retained, and; (3) canopy cover closure would be retained in a high proportion of the project area, implementation of alternatives 2, 3 or 4 would have no effect on red tree voles.

Northwestern pond turtle

Habitat for western pond turtles is present along Indian Creek and its larger tributaries. Underburning conducted in the spring in areas adjacent to Indian Creek could burn in western pond turtle winter habitat. Although no studies were found that describe the effects of prescribed fire on wintering turtles, it is possible that turtles may be harmed by a low intensity fire. The turtles are buried in the leaf litter during this period and are generally within 600 feet of a permanent water source (Jennings and Hays 1994). Underburns proposed for alternative 2 and 3 would occur in areas adjacent to Indian Creek. Underburns proposed for alternative 4 would not occur in this habitat.

Cumulative effects would not be measurable. Because direct/indirect effects from implementing this project under any of the action alternatives as described above would be minor, adding these effects to those of past and ongoing projects would also be minor. Recent past and ongoing projects were evaluated for effects to wildlife, including northwestern pond turtle, and protective measures are implemented for these other projects to minimize the potential for adverse impacts. No additional future projects are anticipated in the project area. For this reason, cumulative effects would be minimal.

Implementation of alternatives 2, 3 or 4 may impact individuals, but is not likely to result in a trend toward federal listing or loss of viability for northwestern pond turtle. This is because implementation of project design features (see Chapter 2) and adherence to the aquatic conservation strategy (appendix D) would reduce adverse effects to riparian species like the western pond turtle.

Foothill yellow-legged frog and Southern torrent salamander

Less than 5 percent of any 7th field watershed would be impacted by thinning under alternative 2, 3 or 4, as discussed in more detail in Section 3.8- Water of this chapter. While perennial, intermittent and ephemeral streams occur in the project area and provide habitat for the foothill yellow-legged frog and southern torrent salamander, project design features have been developed to minimize the potential for adverse impacts to riparian habitats, including reducing the risk of sediment delivery downstream and changes in shading and stream temperatures (see Chapter 2). Therefore, proposed thinning, underburning and road use may have negligible, short-term indirect effects on stream habitat, but this would be reduced through implementation of project design features.

Cumulative effects would not be measurable. Because direct/indirect effects from implementing this project under any of the action alternatives as described above would be minor, adding these effects to those of past and ongoing projects would also be minor. Recent past and ongoing projects were evaluated for effects to wildlife, including frogs and salamanders, and protective measures are implemented for these other projects to minimize the potential for adverse impacts. No additional future projects are anticipated in the project area. For this reason, cumulative effects would be minimal.

Implementation of alternatives 2, 3 or 4 may impact individuals, but is not likely to result in a trend toward federal listing or loss of viability for the foothill yellow-legged frog or the southern torrent salamander. Alternative 4 would result in less potential for impact to foothill yellow-legged frogs than alternative 2 or 3 because substantially less underburning in or near riparian areas would occur.

Siskiyou mountain salamander

No talus habitat was found within proposed thinning units and therefore thinning would not affect habitat or individuals. Plantations are not suitable habitat because they lack sufficient amounts of large down woody debris.

Proposed underburns were not surveyed specifically for talus habitat and thus there may be populations of Siskiyou Mountains salamanders in these areas. Underburn areas were not surveyed because underburning would have minor impacts to individuals and habitat. Salamanders are surface active when conditions are wet and humid; when conditions are best for underburning, most salamanders will have retreated deep into the talus. In addition, prescribed burns are designed to mimic low intensity fire and therefore have low impact to overstory trees that provide shade to talus area. However a few individuals may be in down wood or other flammable material and would be susceptible to the effects of the prescribed burns

Cumulative effects would not be measurable. Because direct/indirect effects from implementing this project under any of the action alternatives as described above would be minor, adding these effects to those of past and ongoing projects would also be minor. Recent past and ongoing projects were evaluated for effects to wildlife, including salamanders, and

protective measures are implemented for these other projects to minimize the potential for adverse impacts. No additional future projects are anticipated in the project area. For this reason, cumulative effects would be minimal.

Salamanders located in the prescribed burn areas may be susceptible to the effects of the proposed burns in the project area. For this reason, implementation of alternatives 2, 3 or 4 may impact individuals, but is not likely to result in a trend toward federal listing or loss of viability for the Siskiyou Mountain salamander. Effects would be less under alternative 4 than under alternatives 2 or 3 because substantially less underburning would occur.

Blue-gray taildropper

Historic locations of this species are located within 100 feet of treatment unit 116. Project design features (see Chapter 2) have been developed to minimize the likelihood of adverse impacts to this occupied habitat. Surveys in potential habitat (natural stands with riparian reserves) will be conducted prior to the implementation of any thinning treatment. If blue-gray taildroppers are located, locations would be buffered from ground disturbing activities.

Proposed underburn areas were not surveyed because underburning would have minor impacts to individuals and habitat. Most mollusks will have retreated underground prior to the conditions being right for a prescribed fire. However a few individuals may be in down wood or other flammable material and would be susceptible to the effects of the prescribed burns.

Cumulative effects would not be measurable. Because direct/indirect effects from implementing this project under any of the action alternatives as described above would be minor, adding these effects to those of past and ongoing projects would also be minor. Recent past and ongoing projects were evaluated for effects to wildlife, including blue-gray taildropper and protective measures are implemented for these other projects to minimize the potential for adverse impacts. No additional future projects are anticipated in the project area. For this reason, cumulative effects would be minimal. Implementation of alternatives 2, 3 or 4 may impact individuals, but is not likely to result in a trend toward federal listing or loss of viability of the blue-grey taildropper. Because alternative 4 includes substantially less underburning than alternatives 2 or 3, the potential for impacts would be less.

Management Indicator Species

Harwood associated species (acorn woodpecker /western gray squirrel)

There are approximately 610 acres of oak stands and 90 acres of mature hardwoods within the project area (based on GIS analysis). Alternatives 2, 3 and 4 propose 27 acres of thinning to restore hardwood stands. Two acres of habitat typed as mature hardwood and 7 acres of habitat typed as oak stands would be underburned under alternatives 2 and 3. The objective of underburning treatments is to remove conifer encroachment on oaks stands to reduce fuels and improve oak woodland habitat.

Acorn storage trees are actively defended and are very important to the survival of species such as the acorn woodpecker and western gray squirrel (CDFG 1990). Acorn storage trees are likely to be located in larger areas of oak woodlands; territories usually range from 2 to 20 acres (CDGF 1990). Small inclusions of hardwoods in the commercial thin stands would not be targeted for treatment and the negative effects on the hardwood species association is expected to be minimal because prescription measure will be thinning around large hardwoods to encourage growth and mast production.

Prescriptions for the project will maintain and develop large black oaks that are quickly disappearing from the stands due to conifer encroachment. The maintenance and development of black oak is expected to be a short and long term benefit for the hardwood species association. Thinning and fuels treatment in and around oak woodland inclusions are designed in part to reduce the risk of high intensity wildfire which can damage oak woodlands. Overall the thinning will be beneficial to acorn woodpecker and the western grey squirrel.

Prescribed burns conducted in the spring would also affect acorn woodpeckers and western grey squirrels through smoke intrusion through their nesting habitat which could be heavy at times. The fuels treatments will help protect oak woodlands from stand replacing fires and would benefit both western grey squirrels and acorn woodpeckers by protecting their habitat. Fuels treatments have the potential remove some snags for safety reason which will be short term effects; however, the potential for reduced fire severity in these hardwood stands will provide an overall long term benefit for the hardwood species association habitat.

River/stream associated species (tailed frog/ American Dipper/Northern Water Shrew/Long-tailed vole

Less than 5 percent of any 7th field watershed would be impacted by thinning under alternative 2, 3 or 4, as discussed in more detail in the Water section of this chapter. While perennial, intermittent and ephemeral streams occur in the project area and provide habitat for river/stream associated species, project design features have been developed to minimize the potential for adverse impacts to riparian habitats, including reducing the risk of sediment delivery downstream and changes in shading and stream temperatures (see Chapter 2). Therefore, proposed thinning, underburning and road use may have negligible, short-term indirect effects on stream habitat, but this would be reduced through implementation of project design features.

Underburning is proposed within the 66 acres of riparian habitat. Effects to water quality due to prescribed fire will be short-term (1-2 years) and occur at the site scale. Water drafting, for road water, has the potential to directly kill or injure tailed frogs or impact habitat for the other river/stream associated species. All drafting equipment will be screened and water drafting will not reduce naturally occurring flow by more than 10 percent (see fisheries section in this chapter).

New road construction has been limited to 2.9 miles of temporary road (alternatives 2 and 4 only) no new roads will cross stream channels, and best management practices and project

design features have been developed to minimize the potential for adverse impacts from the use of ground-based logging equipment.

For these reasons, impacts to important components of tailed frogs, American dipper, northern water shrew, and long-tailed vole habitat, such as stream turbidity, temperature, and substrate; riparian vegetation; and downed woody debris adjacent to streams are expected to be negligible and short term under implementation of alternatives 2, 3 or 4. Impacts would be less for alternative 4 than for alternatives 2 or 3 due to the substantial reduction in prescribed burning.

Snag Associated Species (Red-breasted sapsucker/Hairy woodpecker/White-headed woodpecker/Vaux's swift/ Downy woodpecker/ Pileated woodpecker/Black-backed woodpecker)

There are roughly 0-5 snags per acre in the project area. In plantations, most snags are under 15 inches dbh and are not likely to be used by snag associated species. In the natural stands there are approximately 1-2 snags per acre (Carol Sharp pers. com.).

Temporary road and landing construction, and building yarder corridors would remove some large trees and snags suitable for nesting and roosting but would not be targeted for removal; snags and large trees would only be removed in these situations for safety reasons. Thus, at the scale of the project area, these impacts to large tree and snag habitat are expected to be minimal.

Thinning is designed to promote the development of late-successional habitat and would not eliminate important structural components of snag associated species such as large diameter trees, snags, and down woody debris. Canopy cover, an important element of pileated woodpecker and Vaux's swift habitat, is not expected to be substantially changed within potential habitat for these species because reduction of large trees is expected to be minimal and suitable trees will be readily available throughout the project area. Impacts to the distribution and abundance of these habitat components are expected to be minimal.

Fuel reduction treatments also have the potential to remove snags and down wood; however, prescriptions are designed to imitate low intensity fire and are designed to retain Klamath National Forest Plan recommendations for these components. As a result, fuel reduction treatments are not expected to have a measurable impacts to important structural components of snag associated species habitat.

Over time, thinning and fuel reduction treatments are expected to result in increases in amounts and distribution of important habitat components for snag associated species. Thinning and subsequent fuels treatments are expected to reduce crown fire potential by maintaining a surface fire type; reducing potential stand mortality in the event of a fire start. These factors indicate that stands would be more resistant to large scale fires but would still burn with sufficient intensity to create snags and small openings within forested habitat. Thus, these fire behavior patterns have the potential to create important structural components for snag associated species without significantly reducing existing components.

The implementation of alternative 2, 3 or 4 would result in the incidental loss of individual large trees and snags. However, new snags would be created by fuels treatments. The overall effect to snag habitat from implementation of alternatives 2, 3 or 4 would be minimal and short-term.

Late Successional Reserve

The size of the 100-acre LSRs and the Runway LSRs is shown in table 63 below and the percentage of each LSR that would be treated under alternatives 2, 3 and 4. Underburning is the primary treatment in LSRs.

Thinning in plantations that are within LSR would retain at least 50 percent canopy cover if the stand is considered suitable northern spotted owl habitat. Plantations that are within LSR but are not considered suitable northern spotted owl habitat may be reduced below 50 percent canopy cover. Prescriptions would reduce tree densities by thinning from below (see forest vegetation section in this chapter). Treatments would maintain or enhance tree species diversity by retaining all species present in the stand and would favor retention of hardwoods. Although LSR guidelines suggest retaining 10 percent of units as unthinned, the IDT team determined that it would be more beneficial to thin the entire unit and instead ensure that unthinned units remain in adjacent units so that unthinned habitat would still be present in the LSR and near the units being treated. Thus at a stand level, diversity will be maintained and enhanced in the LSRs.

Thinning would be designed to promote the development of late-successional habitat and would not remove important structural components of LSR such as large diameter trees (greater than 20 inches in diameter), hardwoods, snags, and down wood. Trees infected with mistletoe may be removed, but prescriptions have been designed to ensure that this structural component will remain on the landscape. The removal of large diameter trees would only occur under limited circumstances and such as operational trees. Operational trees are those that are cut for road and landing construction and clearing for yarder corridors in skyline units.

Underburning would benefit the development of LSR habitat. While a small amount (0.08 miles) of temporary road construction is proposed in LSRs it would be outweighed by the larger amount (0.80 miles) of road decommissioning. Therefore, the effects of disturbance to wildlife from vehicles traveling on roads will be reduced. All temporary roads will be barricaded and hydrologically restored to allow natural revegetation within several years after project completion, thus further reducing negative impacts to wildlife.

No cumulative effects are expected because no foreseeable future projects have been identified and ongoing project do not remove suitable NSO habitat within the LSR.

Table 64. Proposed Treatments in LSR

LSR Acres in Project Area	Treatment Type	Alt 2 Percentage of LSR Treated	Alt 3 Percentage of LSR Treated	Alt 4 Percentage of LSR Treated
100-Acre LSRs				
KL0286				
	Thin Plantation	1	1	1
	Thin Natural Stand	1	1	1
Total 68		2	2	2
KL0289				
Total 100	Underburn Only	45	45	0
KL0342				
	Thin Plantation	3	3	3
	Underburn Only	53	53	0
Total 105		56	56	3
Runway LSR				
	Thin Plantation	4	4	4
	Underburn Only	39	39	0
Total 3034		43	43	4

Management Area 6

Management Area 6 is approximately 6,400 acres in size and was designated for the purpose of providing habitat for furbearers, such as the Pacific fisher. Underburning is proposed within approximately 9 percent of MA 6 (585 acres) and roadside pole thinning is proposed on only 1 acre or less than 1 percent of the MA. Due to size of the area treated and the fact that the treatment itself would have minimal effects to forest structure, proposed treatments would not adversely affect the quality of the habitat in the MA for furbearers. Available denning/resting habitat (approximately 2,720 acres) would not be affected to any measurable degree by proposed treatments under alternatives 2, 3 or 4. Because substantially less underburning is proposed for alternative 4, effects to MA 6 would be less if alternative 4 were implemented.

Migratory Birds

Proposed thinning has the potential to disturb and disrupt breeding birds during the year that implementation occurs. Nesting seasons for migratory birds occurs from April through July depending on elevation. Not all thinning would occur in one year and would be staggered over time; not all thinning would occur with primary nesting seasons.

Studies that have addressed the response of avian communities to thinning treatments similar to those proposed in this project, have indicated that species richness increases following treatments and that density typically increases for more species than it declines (Hagar et al. 1996; Siegel and DeSante 2003; Hagar et al. 2004). Thinning live conifers would remove

potential nesting habitat for some species. However, thinning prescriptions would leave portions of stands unthinned; ensuring that habitat for species that require shaded forest stands would be well distributed throughout the project area. Additionally, thinning prescriptions are designed to retain and promote the development of all existing hardwoods and retain important structural components such as large diameter trees and snags. Therefore, thinning prescriptions would help to maintain a variety of habitat conditions that may effectively reduce the impact to some species and promote avian diversity across the landscape (Alexander et al. 2007; Hagar et al. 1996; Hagar et al. 2004). Thinning would target early, mid-successional stands that typically lack well developed understory. Over time, the thinned early- and mid-successional stands would likely support a richer avian community as their understory becomes more developed and the stands become more structurally complex. Thus, thinning would likely have little negative impact to existing diversity and abundance of avian species and would likely benefit the avian community over time.

Fuels reduction treatments such as underburning have the potential to remove habitat and/or impact nesting activities for some avian species. Prescriptions for underburns are designed to mimic low intensity fire and meet Forest Plan recommendations for down wood. Additionally, most underburns would likely occur before or after the nesting season for most of the avian species found in the project area. Thus, underburns are not expected to appreciably impact habitat components such as shrubs, grasses, and down wood, or damage active nests.

Temporary road, landing construction and yarder corridors would impact habitat for avian species by removing a variety of habitat components including live trees, snags, and shrubs. Combined, these actions are expected to impact a small percentage of the project area and are not expected to appreciable reduce the amount of habitat on the landscape. Where temporary roads are constructed through uniform stands they may actually increase avian species richness and diversity by creating horizontal heterogeneity in the stand (Hagar et al. 1996).

For this project, the long-term benefits to species (and their key habitats) from implementation of alternatives 2, 3 or 4 are maintenance of or increase in stand diversity and an increase in fire resiliency in treated stands. Alternatives 2, 3 or 4 would also promote early seral stage vegetation via under burning and maintain and enhance meadows. The short- and long-term adverse effects to migratory bird species and their key habitats include a potential loss of large snags and large down woody from operational hazard trees and underburning.

In balance, the long-term benefits are of greater conservation value to migratory bird species than the short- and long-term adverse effects. Implementation of alternatives 2, 3 or 4 may impact individual migratory bird species but is not expected to result in a loss of viability for these species.

Summary

Alternative 1 would comply with the Endangered Species Act but would not comply with the Forest Plan (1995a) which states that stands are to be managed to develop late-successional characteristics and that underburning should be encouraged in LSR and MA 6.

Alternatives 2, 3 and 4 would have similar effects to Forest Service Sensitive Species and species of concern, migratory birds, LSRs and MA 6 because treatments types are the same among alternatives, with a few exceptions. Implementation of alternatives 2, 3 or 4 may affect but is not likely to adversely affect NSO. Implementation of alternatives 2, 3 or 4 would not affect marbled murrelet, marbled murrelet Critical Habitat or NSO Critical Habitat.

Implementation of alternatives 2, 3 or 4 may impact eight sensitive species and species of interest (northern goshawks, willow flycatchers, California wolverines, Pacific fishers, Townsend's big-eared bats, northwestern pond turtles, Siskiyou mountains salamanders and blue-gray taildroppers) but is not likely to result in a trend toward federal listing or a loss of viability. Implementation of alternatives 2, 3 or 4 would not measurably affect five sensitive species and species of interest (bald eagles, peregrine falcons, American martins, foothill yellow-legged frogs, or southern torrent salamanders) or their habitat.

Implementation of alternatives 2, 3 or 4 would not adversely impact the quality of the habitat within LSRs or within MA 6; in the long-term, implementation of either alternative 2, 3 or 4 would result in beneficial changes to the quality of habitat in these areas due to the development of larger trees and the reduction in the risk of high severity fire.

Alternatives 2, 3 and 4 would comply with the Endangered Species Act and with the Forest Plan. Project design features have been developed for all alternatives that would minimize the potential for adverse impacts to terrestrial wildlife.

3.12 Social and Economic Resources

3.12.1 Methodology

Alternatives are analyzed and compared using the Quicksilver economic analysis program to estimate the Benefit-Cost ratios and the Net Present Values (NPV's). Quicksilver is a financial analysis tool developed by the USDA Forest Service to generate measures of financial efficiency. A 6-year planning horizon is used in this analysis; activities would begin in fiscal year 2010 and end in fiscal year 2015. NPV is a way of comparing all monetarily valued costs and benefits, and is calculated by subtracting the discounted sum of total costs from the discounted sum of total benefits. Similarly, benefit-cost ratios are the discounted sum of benefits divided by the discounted sum of costs. A ratio greater than one suggests that the benefits associated with a project are greater than the costs, although this estimate should be used in conjunction with the NPV to describe overall benefits. The data utilized in this analysis represents the best available estimate of the quantities, costs, and benefits associated with each alternative.

Economic impacts are estimated by alternatives for the study area. The study area consists of Siskiyou and Trinity Counties in California as well as Jackson and Josephine Counties in Oregon. Management activities would occur in Siskiyou County near the town of Happy Camp. For the purposes of this analysis, it is assumed, for all action alternatives, that 75 percent of commercial activity would be conducted by local firms.

The alternatives will be compared using the following indicators:

- Timber volume
- Benefit-Cost ratios and Net Present Values
- Jobs
- Revenue
- Social implications, including Environmental Justice

The information used in the preparation of this section comes from detailed analysis in the Logging Systems Report (North 2010) and the Socioeconomics Report (Wilson 2010) and are available in their entirety in the project record.

3.12.2 Affected Environment

Population and Demographics

In recent years, populations in the study area have remained relatively stable; most counties have experienced minimal population growth. The 2008 population in Siskiyou County is 44,970; in Trinity County it is 13,966; in Jackson County it is 205,305 and in Josephine County it is 83,290 (www.dof.ca.gov and www.pdx.edu/prc). Jackson County has experienced the most growth in recent years; the county seat, Medford, is the largest town in the County, and has experienced more growth in recent years in public infrastructure and retail outlets compared to some of the other counties.

Age distributions can influence the demand for services on the Klamath National Forest. Different age groups are likely to participate in different natural resource-based activities. The median age in each county is higher than the median age for their respective states (US Census Bureau 2000). For example, in Siskiyou County, the median age is 43; but for Oregon it is 38 and for California it is 34. This could be due to there not being adequate higher educational and job opportunities in the area to draw a younger demographic. Likewise, there may be a greater influence from retirees in the geographic region surrounding the Klamath National Forest. The economic structure of the communities must evolve to meet the demands of its residents. In areas with a large retiree influence, this may mean enhancing service-based industries. In the case of Happy Camp, however, it is unlikely that substantial population growth will occur that could result in the migration of businesses into the area. The infrastructure and services available will likely remain static, and will not be substantially influenced by Two Bit. Logging typically attracts a younger demographic; but it is likely that any jobs created would be filled by Happy Camp residents and would not impact the overall age distribution.

The vast majority of local residents in the Study Area are Caucasian. The counties have a similar ethnic composition to the State of Oregon; however it is very different than that of California. As a whole, California is much more ethnically diverse than the Counties in the study area. California's population is 60 percent Caucasian, where the distribution for the counties ranges from 87 percent in Siskiyou County to 93 percent in Josephine County. Nearly 36 percent of California's population comes from a Hispanic origin; whereas counties in the study area range from 4 percent to 8 percent. In general, the Native American population has a much higher presence around the KNF than in the states as a whole. Native Americans/Pacific Islanders are the second most populous race in Siskiyou and Trinity Counties at 4 percent and 5 percent respectively (US Census Bureau 2000).

Employment and Income

Employment and income statistics are important indicators of economic health. In recent years the study area has not received any extensive positive or negative changes in employment. Figure 10 displays the total employment levels for the four counties from 2001 to 2007. Total employment has remained steady for each county over the specified time period. Jackson County has experienced the greatest job growth. Due to the relative remoteness of many communities in the study area, including Happy Camp, jobs may not be as vulnerable to swings in market structure and labor demands as total employment at the state level. It is particularly important to consider the impact to employment in remote areas where jobs supported by the affected resources may consist of a large portion of total employment. Such areas may not be as resilient to a certain loss in jobs as a more metropolitan area. For example, a loss of 100 jobs in a certain sector in Trinity County is likely to have a more devastating effect on the local economy than the same loss of jobs in Jackson County. In a more populated and economically diverse county, the local economy is likely to be better positioned to absorb the loss in employment in one sector with job opportunities in other sectors.

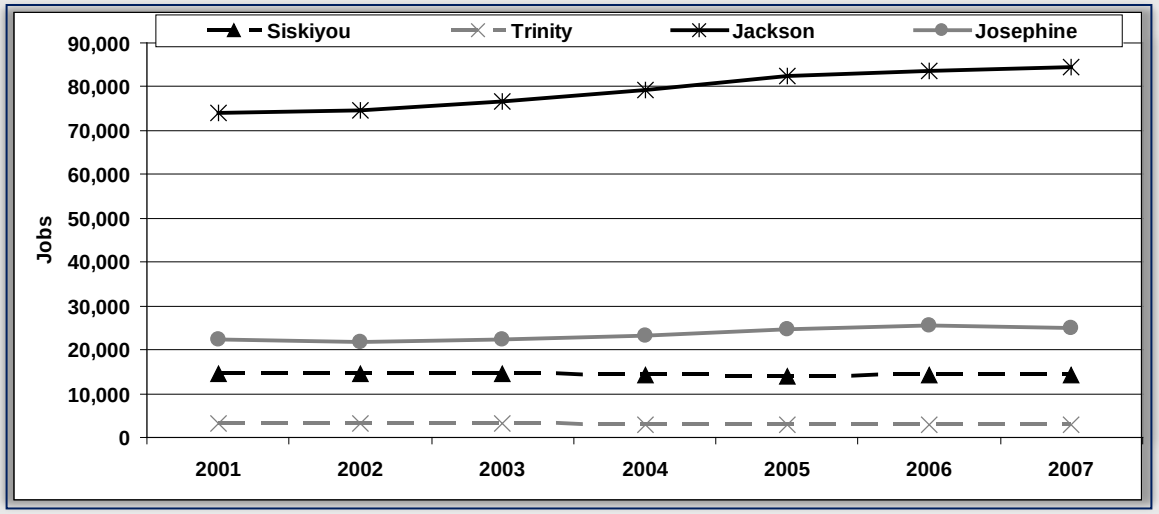


Figure 10. Employment Levels by County, 2001-2007

Source: www.bls.gov

Economic sectors are a set of local businesses by industry, grouped together according to similarities in the goods and services offered. Assessing employment and income by sector assists in the identification of those industries important to the economic sustainability of the region, and those potentially dependent on the activities taking place on NFS lands.

Total employment in the study area is 181,855 jobs; however, 68 percent of those jobs are in Jackson County (table 65). Proportionately, Josephine, Siskiyou, and Trinity Counties account for 20 percent, 10 percent, and 2 percent of total employment respectively. The government sector is the largest employer in Siskiyou and Trinity Counties. Retail trade, health and social services and construction are the dominant sectors in Jackson County. The largest sectors in terms of employment in Josephine County are retail trade and health and social services. Proportionally, the agriculture, forestry, fishing and hunting sector is an important employer in Siskiyou County, accounting for 7 percent of total employment. Activities on the Klamath National Forest support jobs in this sector, making them a valuable source of economic stimulus for many communities in Siskiyou County, including Happy Camp. Retail trade and accommodation and foods services are also important sectors in terms of employment. Businesses in these sectors likely generate economic stimulus from activities on the Forest due to travelers purchasing goods and services while on their way to visit the Forest. The importance of such activities varies by county. The more diverse economies of the larger counties may not be as reliant on Forest activities for economic stimulus.

Table 65. County Employment (Number of Jobs) by Economic Sectors

	Siskiyou	Trinity	Jackson	Josephine	Total
Ag, Forestry, Fish & Hunting	1,213	147	5,095	1,744	8,200
Mining	15	14	179	97	305
Utilities	53	7	95	27	182
Construction	1,147	208	13,379	2,946	17,680
Manufacturing	739	259	7,036	3,377	11,411
Wholesale Trade	267	6	2,708	1,105	4,086
Transportation & Warehousing	665	58	4,090	927	5,741
Retail trade	1,998	380	20,522	5,267	28,168
Information	270	32	1,993	396	2,692
Finance & insurance	373	65	3,796	1,242	5,476
Real estate & rental	675	109	4,641	1,156	6,581
Professional- scientific & technical services	672	122	4,987	1,032	6,812
Management of companies	76	0	1,765	177	2,017
Administrative & waste services	525	25	6,535	1,496	8,581
Educational services	105	36	1,482	363	1,986
Health & social services	1,868	425	14,651	4,959	21,903
Arts- entertainment & recreation	396	104	3,400	609	4,509
Accommodation & food services	1,861	351	8,395	2,930	13,537
Other services	1,297	394	7,439	2,604	11,735
Government	4,214	1,148	11,308	3,582	20,253
Total	18,429	3,889	123,497	36,040	181,855

Source: Minnesota IMPLAN Group (MIG) 2006

Environmental Justice

As stated in Executive Order 12898, it is required that all federal actions consider the potential of disproportionate effects on minority and low-income populations in the local region. The principals of Environmental Justice require agencies to address the equity and fairness implications associated with Federal land management actions. The Council on Environmental Quality (CEQ) (1997) provides the following definitions in order to provide guidance with the compliance of Environmental Justice requirements:

> ***"Minority population:*** *Minority populations should be identified where either: (a) the minority population of the affected area exceeds 50 percent or (b) the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis..."*

> ***"Low-income population:*** *Low-income populations in an affected area should be identified with the annual statistical poverty thresholds from the Bureau of the Census' Current Population Reports, Series P-60 on Income and Poverty. In identifying low-income populations, agencies may consider as a community either a group of individuals living in geographic proximity to one another, or a set of individuals (such as migrant workers or Native Americans), where either type of group experiences common conditions of environmental exposure or effect."*

Native Americans (American Indians/Alaska Natives) comprise a much higher percentage of the population in Siskiyou County (3.9 percent) and Trinity County (4.8 percent) than they do across the State of California as a whole (0.7 percent). They are the second most populous race (the first is Caucasian) in these counties (US Census Bureau 2000). For this reason, the Native American population meets the Environmental Justice criterion as a minority population meaningfully greater than the general population of the states.

In 2005, all counties in the Study Area except Jackson County had poverty rates higher than that of their respective states and poverty rates in Siskiyou, Jackson and Josephine Counties increased from 2000 to 2005. As of 2005, Siskiyou County has the highest poverty rate in the study area at 17.5 percent. This poverty rate suggests that a substantial proportion of the existing population is a low income group (US Census Bureau, Small Area Income and Poverty Estimates).

3.12.3 Environmental Consequences

Alternative 1- No Action

Direct and Indirect Effects

There would be no direct/indirect effects on the socioeconomic environment if no action were to take place in the project area. No timber would be harvested and no fuels treatments would occur. Any change in economic and social conditions would occur as a natural progression of economic and social activity in the Study Area. Existing conditions and trends would be expected to continue.

Cumulative Effects

Given that there are no measurable direct and indirect effects that would occur under the no action alternative, there would also be no measurable cumulative effects.

Alternative 2- Proposed Action

Direct and Indirect Effects

Timber Volume and Values

Commercial thinning proposed under alternative 2 would result in the production of timber commodities, primarily in the form of sawlogs. The project could produce fuel for the biomass

industry but the closest facility capable of utilizing fuel is in Anderson, California; the estimated cost of removing, processing and transporting fuel to this location would exceed the delivered fuel price. For this reason, this option is not considered further in this analysis. Sawlog volumes from small and medium sawtimber (primarily Douglas fir, ponderosa pine and white fir) are estimated to be 46,241 CCF. Table 66 below shows the estimated value and price of this volume.

Table 66. Timber Volume and Values for alternative 2, proposed action

Volume CCF	Base Rate Value $/CCF[1]	Estimated High Bid Stumpage Value $/CCF[2]	Estimated High Bid Total Stumpage Value
46,241	$9.96	$13.59	$628,471

[1]Base Rate Value is the minimum the Forest Service can charge for timber. [2]Indicated Stumpage Value is the estimate of what a timber purchaser would pay for the timber under current market conditions.

Twenty-five percent of the stumpage value would be paid to Siskiyou County because counties receive a portion of the revenue generated on National Forest System lands. These funds are used for the upkeep and maintenance of public schools and roads. This alternative would generate approximately $157,118 in payments to Siskiyou County.

Benefit-Cost Ratios and Net Present Value

Activities proposed under this alternative have a variety of economic implications. Commercial logging would provide a revenue stream back to the USDA Forest Service, and noncommercial activities propose costs to the government. The NPV and benefit-cost ratio for all activities is negative $2,595,396 and 0.19 respectively. The sale of saw timber is estimated to bring in revenue of $628,471 in 2009 dollars; however, the costs associated with preparation and administration of the sale, combined with the cost of restoration activities (underburning, meadow enhancement, etc.) outweigh the returns of the revenue stream. These values do not imply that alternative 2 is economically inefficient. In determining economic efficiency, all costs and benefits associated with the management activities are taken into account. This includes those that may not directly be monetized. Estimating the value of benefits and costs not accounted for in the market place is outside the scope of this analysis. Nonmarket benefits may include improved ecosystem health, increase in wildlife, and reduced threat of wildfire, among other effects. Thus, the financial measures reported in this document should be considered along with all other social and ecological impacts resulting from the management activities.

Jobs

Alternative 2 proposed actions would require human labor for implementation. This would affect the level of jobs and income in the study area. Overall, it is estimated that the activities associated with alternative 2 would support 183 jobs in the study area, and $5,388,500 in labor income. The agriculture industry would be impacted the most with 38 direct jobs, and 35 indirect and induced jobs. The manufacturing industry would also experience substantial growth with 15

direct and 18 indirect and induced jobs. The remaining jobs would be distributed across other sectors in the economy as a result of business and household purchasing patterns.

Social Implications, including Environmental Justice

In addition to the economic effects, there would also be implications for the lifestyles and values of local residents. The vast majority of social impacts would occur in the community of Happy Camp nearest the project area. During the public scoping phase for this project, concerns were raised by local residents regarding the level of smoke generated from proposed underburning and increases in logging traffic and impacts to recreation during project implementation. A total of 7,250 acres would be burned under this alternative. The amount and location of proposed underburning may result in short-term but adverse impacts to local air quality due to the level of smoke produced, exacerbated by the tendency for smoke in these areas to settle in the basin. This can result in inconvenience and discomfort for residents that live along Indian Creek and in the town of Happy Camp, particularly those with allergies or breathing conditions. Project design features have been developed to minimize these effects as much as possible, although not eliminate them. Effects to air quality are the subject of the air quality section of this chapter and the potential for effects to recreation is the subject of the recreation section of this chapter. Logging would occur over a period of two or more years and would result in increased traffic from logging trucks through Happy Camp and throughout the project area. There could be some indirect effects in the form of dust and slower travel times for residents. Volume and seasonality of traffic would depend on the plan of operation by the logging companies. Project design features have been developed to minimize this effect to local residents as shown in Chapter 2.

Implementation of alternative 2 is unlikely to result in a disproportionate adverse effect on minority and low income populations; effects should be experienced by all residents equally. Individuals in these populations may benefit from any increase in jobs and income in the area.

Cumulative Effects

Cumulative effects include the total change in social and economic conditions that would result from the specifications under this alternative in conjunction with the direct and indirect effects of other present and reasonably foreseeable activities. Past activities are assumed to be represented by existing conditions. The project area lies wholly within the Indian Creek watershed, which is approximately 86,200 acres in size. Although resource management is common practice across the entire study area, only projects within this watershed (see table 15 at the beginning of this chapter) are used. There are currently no known plans for logging or restoration activities on private lands. Resource management is expected to occur on 3,345 acres in the watershed, in addition to 96.3 miles of road storm proofing and 11.3 miles of road decommissioning. Estimates of the economic and social impacts associated with these projects are not readily available; however, on the margin, it is expected that they will support additional jobs and income and affect the social environment as in alternative 2 alone. In general, the study area has low

population density, a large proportion of the population is in the working age group, and unemployment rates are higher than state averages. Thus, new jobs would likely be filled by unemployed residents. This should contribute to reduced unemployment rates and increased resident incomes. Social impacts are more difficult to quantify. However, it is not expected that the activities associated with this project would substantially alter the social environment. Communities within or near the Indian Creek watershed would continue to be dominantly rural and driven by natural resource based activities.

Potential Sale Quantity

Timber volume harvested from this project contributes to the Klamath National Forest's Potential Sale Quantity. The Klamath National Forest Plan as amended by the Northwest Forest Plan forecasted a PSQ of 51 MMBF. The Potential Sale Quantity only considers volume produced from matrix (regulated) lands. The average volume sold between 1995 and 2006 was 25.4 MMBF per year, or 49 percent of the Potential Sale Quantity. Alternative 2 would contribute approximately 23.1 MMBF to the annual target, or 45 percent of the Potential Sale Quantity.

Alternative 3 – No Temporary Roads

Direct and Indirect Effects

Timber Volume and Values

Commercial thinning proposed under alternative 3 would result in the production of timber commodities, primarily in the form of sawlogs, as described for alternative 2. Sawlog volumes from small and medium sawtimber (primarily Douglas fir, ponderosa pine and white fir) are estimated to be 39,785 CCF; this is lower than alternative 2 due to the fact that 270 fewer acres are proposed for thinning under alternative 3. Table 67 below shows the estimated value and price of this volume.

Table 67. Timber Volume and Values for alternative 3, No Temporary Roads

Volume CCF	Base Rate Value $/CCF[1]	Estimated High Bid Stumpage Value $/CCF[2]	Estimated High Bid Total Stumpage Value
39,785	$9.96	$13.16	$523,400

[1]Base Rate Value is the minimum the Forest Service can charge for timber. [2]Indicated Stumpage Value is the estimate of what a timber purchaser would pay for the timber under current market conditions.

Twenty-five percent of the stumpage value would be paid to Siskiyou County because counties receive a portion of the revenue generated on National Forest System lands. These funds are used for the upkeep and maintenance of public schools and roads. This alternative would generate approximately $146,909 in payments to Siskiyou County.

Benefit-Cost Ratios and Net Present Value

Activities proposed under this alternative have a variety of economic implications. Commercial logging would provide a revenue stream back to the USDA Forest Service, and noncommercial activities propose costs to the government. A total of 39,785 CCF of timber would be harvested, yielding total discounted revenue of $523,400. The NPV and benefit-cost ratio for all activities is negative $2,890,486 and 0.14 respectively. There would be slightly more underburning to achieve the desired conditions of the landscape, which would add costs to government. There would also be a cost savings since no new temporary roads would be built, but there would be less revenue from the sale of saw timber.

Jobs

The activities associated with alternative 3 would support 162 jobs and $4,746,900 in labor income. The distribution of jobs across industries is similar to that of the proposed action. The agriculture industry would be impacted the most with 33 direct jobs, and 30 indirect and induced jobs. The manufacturing industry would experience an increase of 13 direct and 15 indirect and induced jobs. In comparison to the other action alternatives, this one generates the fewest jobs and income for the study area.

Social Implications, including Environmental Justice

Social impacts would be very similar to that described for alternative 2. There would be a small increase in potential for adverse effects from smoke because there would be more acres of underburning. Fewer temporary roads would mean less ground disturbance, and less volume harvested would mean less traffic from logging operations. However, commercial thinning would be such that there would likely not be a noticeable difference in traffic between the action alternatives. Implications for recreation would be similar to that described under the proposed action.

Cumulative Effects

Other projects in the study area that may contribute to cumulative effects are described under the proposed action. Under this alternative there would be no disturbance from new temporary roads, more smoke associated with underburning, and less timber commercially harvested. Cumulative effects would be similar to those reported for alternative 2 since the differences between direct/indirect economic effects are small.

Potential Sale Quantity

This alternative would contribute approximately 19.9 MMBF to the annual target, or 39 percent of the Potential Sale Quantity.

Alternative 4 - Minimized Underburning

Direct and Indirect Effects

Timber Volume and Values

Commercial thinning proposed under alternative 4 would result in the production of timber commodities, primarily in the form of sawlogs. Sawlog volumes from small and medium sawtimber (primarily Douglas fir, ponderosa pine and white fir) are estimated to be the same as that for alternative 2 (46,241 CCF, table 64) because alternative 4 proposes the same level of thinning treatments.

Twenty-five percent of the stumpage value would be paid to Siskiyou County because counties receive a portion of the revenue generated on National Forest System lands. These funds are used for the upkeep and maintenance of public schools and roads. This alternative would generate approximately $157,118 in payments to Siskiyou County, the same as that generated for alternative 2.

Benefit-Cost Ratios and Net Present Value

The primary difference between alternative 4 and alternative 2 is reduced underburning and introduction of mastication. Volume harvested and revenue stream would be the same, but there would be a different cost structure associated with mastication as a replacement for underburning. The NPV and benefit-cost ratio for alternative 4 is negative $1,521,906 and 0.28 respectively. Although total monetary costs are greater than total monetary benefits, this alternative yields the greatest NPV and benefit-cost ratio among the action alternatives. However, this does not imply that this is the most economically efficient alternative. All other benefits and costs must be weighed against those of the other alternatives.

Jobs

This alternative would support a total of 173 jobs and $5,097,000 in labor income. The distribution of job across economic sectors is similar to that of alternatives 2 and 3. The majority of jobs would be supported in the agriculture and manufacturing industries. Due to the higher unemployment rates, labor required for new jobs would be supplied by the local labor market. Therefore activities associated with the Two Bit project would not affect household migration patterns.

Social Implications, including Environmental Justice

The primary difference in the effects of this alternative compared to the others is the social implications of reduced burning. The minimal amount of burning required to meet the desired conditions would be conducted. Mastication would replace underburning across much of the project area. This would greatly reduce the risk of adverse effects from smoke. Effects from logging traffic and impacts to recreational capacity would be similar to those described under the proposed action.

Cumulative Effects

The cumulative effects would be similar to those reported under alternative 2 because timber volume is the same. The primary difference would be the reduced presence of smoke from underburning.

Potential Sale Quantity

This alternative would contribute approximately 23.1 MMBF to the annual target, or 45 percent of the Potential Sale Quantity.

Summary

Table 68. Summary of effects to socioeconomic indicators from all alternatives

Indicator	Alternative 1, No Action	Alternative 2, Proposed Action	Alternative 3, No Temporary Roads	Alternative 4, Minimized Underburning
Timber volume	None	46,241 CCF	39,785 CCF	Same as Alternative 2
Estimated Revenue	None	$628,471	$523, 400	Same as Alternative 2
Net Present Value	Not applicable	($2,595,396)	($2,890,486)	($1,521,906)
Cost-Benefit Ratio	Not applicable	0.19	0.14	0.28
Jobs Created	None	183	162	173
Labor Income Created	None	$5,388,500	$4,746,900	$5,097,000
Other Social Implications	No Change	Smoke, logging traffic and recreation impacts, minimized through project design features	Slightly more smoke and slightly less logging traffic; effects slightly less than alternative 2	Substantially less smoke but the same logging traffic and recreation impacts as alternative 2, minimized through project design features

Alternative 4 has the highest NPV and benefit-cost ratio. This means that it has the greatest amount of monetary benefits compared to the costs. However, these measures do not imply that this alternative is the most economically efficient. All other factors must be taken into account including nonmonetary benefits and costs, and how well the alternative meets the purpose and need. Under alternative 4 there would be fewer total acres treated with underburning and

mastication would be used instead to treat fuels as compared to alternatives 2 and 3. This reduces the total cost of management activities, but would yield different on-the-ground benefits. Total costs include administration, sale preparation, restoration activities, etc. The only benefit accounted for in the marketplace is the revenue from the sale of sawtimber. In order to determine economic efficiency, all costs and benefits associated with the management activities should be taken into account. This includes those that may not directly be monetized. Nonmarket benefits and costs include improved ecosystem health, reduced threat of fire, increased logging traffic, smoke from underburning and any other impact to the socioeconomic environment.

Impacts to employment and income are reported as direct, indirect and induced effects (table 69). The total impact is the sum of those effects. Although the primary activities associated with resource management lie within the agriculture and manufacturing industries, they also stimulate employment in a variety of other sectors. For example, activities associated with alternative 2 directly increase employment in the accommodation and food services industry by four jobs. Those jobs are supported in response to the increased economic activity generated by the additional production of wood products and other resource management activities. In addition to those four jobs, another four jobs are generated in that industry in response to the increased interindustry purchasing resulting from the increased demand for the output of the directly affected industries, as well as the increased expenditures from households due to the increase in local income (i.e. the indirect and induced effects). Thus, the estimated total employment supported in the accommodation and food services industry as a result of the activities proposed under alternative 2 is eight jobs. Impacts to the remaining industries are reported below in the same fashion. Overall, alternative 2 would contribute the most jobs to the study area followed by alternative 4 and alternative 3, respectively.

Table 69. Employment Impacts across Alternatives (number of jobs)

	Alt. 2		Alt. 3		Alt. 4	
	Direct	Indirect & Induced	Direct	Indirect & Induced	Direct	Indirect & Induced
Agriculture, Forest, Fish and Hunt	37	34	35	30	29	32
Mining	0	0	0	0	0	0
Utilities	0	0	0	0	0	0
Construction	0	0	0	0	0	0
Manufacturing	15	18	13	15	15	18
Wholesale Trade	2	3	2	2	2	3
Transportation & Warehousing	2	3	2	2	2	3
Retail Trade	6	6	5	6	6	6
Information	1	1	1	1	1	1
Finance & Insurance	2	3	2	2	2	3
Real Estate & Rental & Leasing	2	2	2	2	2	2
Prof, Scientific, & Tech Services	2	3	2	2	2	2
Management of Companies	1	1	1	1	1	1
Admin, Waste Mngt & Rem Serv	2	2	2	2	2	2

	Alt. 2		Alt. 3		Alt. 4	
	Direct	Indirect & Induced	Direct	Indirect & Induced	Direct	Indirect & Induced
Educational Services	1	1	1	1	1	1
Health Care & Social Assistance	6	7	5	6	6	7
Arts, Entertain & Recreation	1	1	1	1	1	1
Accommodation & Food Services	4	4	3	4	4	4
Other Services	4	4	3	4	4	5
Government	0	1	0	0	0	1
Total	89	94	81	81	81	92

Labor income is affected in a similar manner to employment. The greatest change in income is experienced by the agricultural industry, followed by manufacturing. Increases in local income are typically viewed as an economic benefit; however, such benefits must be weighed in accordance with the other social and ecological impacts associated with project implementation. Overall the management activities would not drastically alter the economic conditions of the study area. There could be smaller communities within the study area that would be affected more than others. Happy Camp is likely to experience the greatest impact on their local economy. Given the high unemployment rates in the region, new jobs created from the vegetation management activities would be filled by local residents; thus, household migration patterns should not change. Economic impacts should be positive in the form of lower unemployment and greater local income.

In addition to the economic implication, three important social concerns were identified during the scoping period. Although those effects cannot be quantitatively estimated, they are recognized through a qualitative assessment of potential consequences for the social environment. The presence of smoke would be greatest under alternative 3; however, burning would be spread out over a five year period under each alternative in order to reduce impacts on the human environment, and strict burning procedures would be followed in all instances. Logging traffic would be somewhat less under alternative 3 because less volume would be harvested. The total impact from traffic would depend on the plan of operation implemented by commercial logging companies. It is unlikely that differences in traffic would be noticeable across alternatives. Project design features would reduce the risks of adverse effects from smoke, but would not eliminate them. There are no other anticipated effects that would substantially alter the social environment under any of the action alternatives.

3.13 Scenery and Recreation Resources

3.13.1Methodology

Scenic Quality of or within National Forests is valued for the aesthetic enjoyment and physiological benefits it offers. “Viewing Wildlife” and “Viewing Natural Features” are the top two recreation activities of visitors to the Klamath National Forest (pg. 15, August 2002, USDA

Forest Service, National Visitor Use Monitoring Results). Scenic quality within the project area is important to the people who live and work in the area, and travel through the area enjoying views from Grayback Road (State of Jefferson Scenic Byway) travel corridor, various County and Forest roads, and the rural community of Happy Camp. The scenery of the area contributes a small but important part to the Klamath National Forest's scenic heritage.

Visual Quality Objectives (VQO) are defined in the Forest Plan and apply to site-specific projects visible from the Forest's inventoried Moderate (Level 1) and High (Level 2) Sensitivity Viewpoints. VQOs are minimum conditions to be achieved as soon as possible in all management areas and within 3 years for all VQOs except Preservation and Maximum Modification which must be met immediately. Facilities and developments, such as roads, trails, campground facilities, structures, signs, and interpretive stations, are not required to meet the Management Area VQOs when viewed in immediate foreground (300 feet).

A landscape with very minimal visual disruption is considered to have high scenic integrity. Landscapes that have increasingly discordant relationships among scenic attributes are viewed as having diminished scenic integrity. Scenic integrity objectives, for purposes of this analysis also called Visual Quality Objectives, are definitions of acceptable degrees of deviations from the landscape character that may occur at any given time. It is a continuum ranging over these five levels. Visual Quality Objectives are:

- Maximum Modification - very low integrity, or heavily altered – landscapes where character appears extremely altered. This is not a management objective, but is sometimes used to show landscapes that are in need of rehabilitation.
- Modification - low integrity, or moderately altered – landscapes where character appears moderately altered. Deviations begin to dominate the character being viewed but these often compliment the character or are compatible with it.
- Partial Retention - moderate Integrity, or slightly altered– landscapes where character appears slightly altered. Deviations are noticeable but they remain visually subordinate to the character being viewed.
- Retention - high integrity, or appears unaltered – landscapes where character appears intact. Deviations are present but not evident.
- Preservation – very high integrity, or unaltered – landscapes where character is intact with only minute, if any, deviations.

Conditions that may be used to fine-tune Forest Plan VQOs include discrepancies in landscape variety classification, changes in visual sensitivity levels, and discrepancies in the seen-area mapping (e.g. the ability to view an area from a designated road or trail (USDA Forest Service 2008). As stated in the Forest Plan, areas not visible from inventoried Level 1 and 2 Sensitivity Viewpoints are to be managed so as to appear as little modified as possible consistent with management goals, and no more altered in appearance than Maximum Modification (S & G #11-8).

This evaluation applies current National Forest Landscape Management methodology in conjunction with existing Forest Plan direction. It relies on previous field studies of similar types of projects, as well as observations from sensitive viewpoints, and consideration of public

preferences for scenic quality. Cumulative scenic quality is evaluated within a larger context than the individual project activities themselves, but the potentially affected viewsheds as a whole. This evaluation is based on the following:

- Generally speaking, based on past experience with projects of a similar nature, commercial thinning to 60 percent canopy closure would typically meet a Retention VQO and 40% canopy closure would typically meet a Partial Retention VQO. However, other factors such as viewing angle, viewing distance, viewer orientation, vehicle speed, lighting, season, duration of view, etc can influence this. Field review was used to verify these assumptions.
- Several field reviews of critical units proposed in this project were conducted during 2009, focusing on project activities located in Retention or Partial Retention VQOs, or those that were potentially visible from high sensitivity viewpoints.
- Extensive review of project descriptions and maps; assessing project activity locations (orientation, slope position, and distance from viewer), logging systems, combined with on the ground knowledge of topography and vegetation.
- All proposed project activities in Modification and Maximum Modification VQO areas would easily meet their assigned VQOs. Most activities are not even visible from any high or moderate sensitivity viewpoint.

The alternatives are compared using the following indicators:

- Consistency with Forest Plan VQOs (measured through changes in landscape character, sense of place, scenic attractiveness, scenic integrity and visually sensitive areas)
- Changes in recreation opportunities
- For cumulative effects, qualitative changes across the viewshed

The information used in the preparation of this section comes from detailed analysis in the Recreation and Scenery Report (Talley 2009) and is available in its entirety in the project record.

3.13.2 Affected Environment

Visual Quality Objectives

Landscape Character

Landscape Character describes what “kind” of scenery, or visual image, is made by a particular landscape. In the project area, low to moderately steep mountainous terrain, bisected by numerous side drainages, faces Indian Creek as it winds through the Klamath Mountains. In the background, higher elevation ridges and peaks provide a visual backdrop. These ridges of the Klamath Mountains dominate the project area’s landscape character, although breaks in the forest canopy from previous wildfires, rock outcrops, and older harvest activities are evident. These ridges visually frame streams and the wide, winding Indian Creek drainage. Vegetation is diverse in both pattern and species, with the Douglas fir/mixed conifer forest being most dominant. Conifer species include ponderosa pine, sugar pine, incense cedar, and white fir. Also common are riparian forest stringers and mixed hardwood stands of canyon live oak, Pacific madrone, and big leaf maple. Some forested areas are extremely dense, where wildfires have been artificially suppressed for at least 50 years. This density of vegetation obstructs in-canopy

views to the forest floor, and also increases the forest risk of extreme wildfire events that could be adverse to valued landscape character attributes. Streams display high water clarity. Air quality is high, with coastal moisture occasionally adding clouds and haze to the typical clear views under blue skies.

Sense of Place

The sense of place in the project area, or landscape character expectations of current user groups is defined by an independent, rural residential lifestyle; both the low population density and the distance from human population centers contribute to this sense of place. Some local Happy Camp residents use the forest as a means of employment such as in logging or commercial guiding. Local activities include sightseeing, recreating of all sorts, gathering activities (firewood, mushrooms, and other special forest products) and just getting in touch with the land. Local residents form a unique interest group that wants a healthy and sustainable watershed in what they consider their backyard. Communities of interest include local residents, highway travelers and wilderness visitors.

Scenic Attractiveness

The project area is categorized as Distinctive – A along watercourses, high elevation ridges and meadows and Common - B along midslopes.

Scenic Integrity

Scenic integrity is the relative degree of natural appearance displayed by a landscape. In the project area, scenic integrity (as viewed from inventoried sensitive viewpoints) includes evidence of existing roads and streets, bridges, powerlines, businesses, and isolated residences and ranches. These alterations are located primarily on private lands along Indian Creek. As one moves upslope onto National Forest System land, there is some evidence of forest roads and signs, past logging, and a rock pit. Cumulatively, across the project area as a whole, the alterations are minor, and generally a near natural appearance remains dominant and the area meets Partial Retention VQOs as defined in the Forest Plan.

Viewsheds, Visual Sensitivity Levels, and Viewer Position

The table below displays project area viewpoints, their visual sensitivity, and the viewer position that project activities may be visible from. The visual assessment of project activities utilized these viewpoints. These viewpoints are taken from the inventoried sensitivity level map (Scenery Sensitivity Levels map, Klamath National Forest - Westside, 9/19/08) maintained on file in the Supervisors Office. There is one National Scenic Byway and three Forest System roads, and one campground.

Table 70. High and Moderate Sensitivity Level Viewpoints

Potential Viewpoint(s)	Visual Sensitivity Level [1]	Viewer Position [2]
Indian Creek Road – #7C01 residences along first eight miles (State of Jefferson Scenic Byway)	High	Inferior
Grayback Road #48 (State of Jefferson Scenic Byway)	Moderate	Inferior
Kelly Lake Trailhead Road (#18N33, #18N30, #18N34)	Moderate	Superior
South Fork Indian Creek Road (#17N32)	Moderate	Inferior
West Branch Campground	High	Inferior
Poker Flat Trailhead Road (#18N30, #18N33)	Moderate	Superior

1 visual sensitivity levels: high=high level of interest in scenery; moderate=moderate use/interest and often characterized by a secondary county road or forest road, recreation site or area.
2 viewer positions: inferior=activity is viewed looking up; intermediate=activity is viewed level with the viewer; superior=activity is viewed looking down

Recreation

Recreation use in the project area consists primarily of dispersed recreation activities, including camping, swimming, fishing, whitewater rafting, hiking, hunting, and woodcutting. Indian Creek is a popular local attraction for swimming, fishing, and whitewater boating. West Branch Campground, located along Indian Creek, receives very little use. Two trailheads, Kelly Lake and Poker Flat, provide dispersed camping opportunities at the trailhead, hiking and equestrian access to the Siskiyou Wilderness and fishing at Kelly Lake. The State of Jefferson Scenic Byway traverses the project area, providing an important link for both local residents and travelers between the Klamath River corridor and the Illinois Valley in Oregon. One portion (Siskiyou-6) of the Siskiyou Roadless Area is located in the project area.

3.13.3 Environmental Consequences

Alternative 1- No Action

Direct/Indirect and Cumulative Effects

Visual Quality Objectives & Recreation

Under this alternative, there would be no commercial thinning, specialized treatments (e.g. sanitation thinning or hardwood release), prescribed burning or road decommissioning. Because no actions would be taken in the project area, there would be no changes to Visual Quality Objectives; no changes would occur to existing landscape character, sense of place, scenic attractiveness, scenic integrity and visually sensitive areas and there would be no changes in recreation opportunities. Because no direct/indirect effects would occur, there would be no cumulative impacts across the viewshed.

Alternative 2 – Proposed Action

Direct/Indirect Effects

Visual Quality Objectives

VQOs for proposed thinning areas are shown in table 71 below. Other proposed treatments are not shown on this table, but are discussed in detail below.

Table 71. Proposed Thinning Treatments within Visual Quality Objective Categories

Proposed Thinning Treatment	Visual Quality Objective Category (from Forest Plan)	Percent of Treatment Area
Thin Natural Stand		
	Partial Retention	27%
	Modification	68%
	Maximum Modification	5%
Thin Plantation		
	Retention	1%
	Partial Retention	34%
	Modification	50%
	Maximum Modification	15%
Roadside Pole Thin		
	Partial Retention	2%
	Modification	98%
Roadside Sanitation Thin		
	Modification	100%

No proposed treatments would be visible from either of the high sensitivity viewpoints – West Branch Campground and the Lower Indian Creek Road (to private land boundary at South Fork Indian Creek); these viewpoints are therefore not discussed further.

Underburning

The short term visual impacts from underburning would create brown vegetation, red tree crowns, blackened duff layer, scorched trunks, and minor disturbance from fuelbreak construction. Recovery times of three years would allow revegetation or “greening up” of many of the burn effects. At that point, any residual effects from the underburn would appear as a natural occurrence, consistent with the many wildfires that have occurred throughout this area. Underburning would create long term positive effects such as the creation of more open stands where larger trees can be observed by travelers, greater species diversity, and a reduction in the severity of future fires. This activity would easily meet all assigned VQOs and would contribute to the Forest Plan Standard and Guideline 11-4 for perpetuating the Forest’s ecologically established landscape character.

Roadside Sanitation Thin & Pole Thin

The thinning of small diameter trees or trees with dwarf mistletoe infection along roads would create long term positive effects where travelers can look into more open stands, observe larger

trees (where present) and provide greater species diversity. Because none of the roadside treatments would occur along high or moderate sensitivity routes and are not visible from them, they would easily meet their assigned VQOs.

Commercial Thinning

Most (68%) of thinning in natural stands would occur within Modification VQO; most (65%) of thinning in plantations would occur within Modification or Maximum Modification VQOs; most (98%) of roadside pole thinning would occur within Modification VQO; and all of roadside sanitation thinning would occur within Modification VQO. This means that the majority of all of these treatments are consistent with their VQOs since Modification and Maximum Modification VQO categories allow for alterations of natural-appearing landscapes.

Proposed thinning treatments would generally create more open stands of varying densities, with some openings, and some unthinned areas in small patches. The thinning of small diameter trees would create long term positive effects where travelers can look into more open stands, observe larger trees (where present) and provide greater species diversity. The retention of taller trees with well developed crowns would provide visual screening of units when seen from distant viewpoints.

There are approximately 15 units located in the foreground distance zone (0-1/2 mile) of Grayback Road that are in Partial Retention VQO. When traveling this road, its winding nature, combined with topographic and/or vegetative screening, severely limit visibility to the road itself, except for occasional, brief glimpses thru openings in the trees. None of these units would be visible from the road. For this reason, these proposed activities would meet the Partial Retention VQO.

There are numerous commercial thinning units located on the west-facing slope of Indian Creek in a Modification VQO area. From the viewpoint near Louse Creek, Units 6, 7, 8, 41, 63, and 200 would be visible. Given their distances from the viewpoint, as well as the thinning prescriptions, all units would appear natural and meet their respective VQOs. None of the other units in the Green Creek, Mill Creek, Doolittle Creek, Deadman Point, and Four Bit Gulch areas, as well as any units located west of the Grayback road would be visible from the Grayback Road or the viewpoint near Louse Creek.

Units visible along Kelly Lake and Poker Flat roads that have a Partial Retention VQO include Units 220, 20, 64, 21, 24, 26, 27, 28, and 227. The thinning of small diameter trees would create long term positive effects where travelers can look into more open stands, observe larger trees (where present) and greater species diversity from free thinning. All units are located in the foreground distance zone and meet the assigned VQO of Partial Retention. Unit 22 is in a Retention VQO and project design features have been developed (see Chapter 2) to ensure activities are not noticeable. All other units which are not immediately adjacent to these roads would not be visible.

Units visible along South Fork Road with a Partial Retention VQO include Units 108, 109, 110, and 104. Units visible along this road with a Modification VQO include 100, 101, and 103.

The thinning of small diameter trees would create long term positive effects where travelers can look into more open stands, observe larger trees (where present) and greater species diversity from free thinning. These activities would appear near natural and meet the Partial Retention VQO. All other units in the South Fork Indian Creek drainage would not be visible when traveling along this road.

Road Decommissioning

The decommissioning of three road segments would rehabilitate existing visual impacts. At each road intersection, the first 100 feet (or more) of the road would be backfilled and recontoured to eliminate or hide the intersection. Revegetation of the opening would further disguise the road. The three roads are described below:

- Road 18N43: This through road intersects with both the 18N30 and 18N33 roads, which are both moderate sensitivity routes providing access to the Kelly Lake Trailhead. The west half of the road is in a Retention VQO and the east half in a Modification VQO. This activity would easily meet the assigned VQOs.
- Road 17N28B: This spur is located in a Partial Retention VQO area and is not visible from any inventoried sensitivity routes. This activity would easily meet the assigned VQO.
- Road 17N02: This through road is located in a Maximum Modification VQO area and is not visible from any inventoried sensitivity routes. This activity would easily meet the assigned VQO.

Meadow Enhancement

This activity involves the removal of small encroaching conifers, handpiling and burning, and limited use of prescribed fire. By eliminating encroachment, this activity would increase plant species diversity and perpetuate the Forest's ecologically established landscape character (Forest Plan Standard and Guideline 11-4). ME-5 is located in both the Siskiyou Roadless area and in a Retention VQO area and is visible from the Poker Flat Trailhead area. Management activities would not be noticeable because project design features have been developed to minimize this (see Chapter 2). To eliminate the stark "line effect" between the meadow and adjacent forest, the edges would be feathered with a variable spacing, density, and species removal. Burning of cut trees and limbs and flush cut stumps would further minimize the noticeability that any management activity has occurred. Therefore this area would continue to be natural appearing and meet the Retention VQO as well as preserve roadless area characteristics. The elimination of conifer encroachment would maintain this area of high scenic quality. All other meadow enhancement units (ME1 -4, ME6-14) would not be visible from any sensitive viewpoints, and therefore meet their assigned VQOs.

Recreation Opportunities

The operational impacts from the project activities such as traffic, noise, dust, and smoke are short-term adverse impacts which would be temporary in nature. Dispersed recreational activities such as camping, hiking, hunting and fishing would be affected by these short-term impacts, but

due to the large size of the project area and the fact that project activities would be implemented over time and not all at once, would minimize these impacts.

The use of both temporary roads and reconstructed temporary roads would provide recreationists approximately seven miles of additional short-term motorized access until these roads are hydrologically restored and rehabilitated. The decommissioning of roads would eliminate opportunities on these roads for motorized recreation activities such as camping, hunting, firewood collection, and driving for pleasure. However, the same types of opportunities readily exist on the many miles of roads throughout the project area.

An indirect beneficial effect of underburning would be a short term increase in forage for deer populations and utilization of the area; thus improving the quality of the deer hunt in those areas.

Changes in stand structure and composition resulting from different treatments may result in some short-term changes in recreational use patterns, but the same recreational opportunities would continue following the completion of project activities which is the very nature of dispersed recreation. Recreation use and opportunity would not measurably increase or decrease as a result of this project.

Cumulative Effects

Individually all project activities would meet or exceed their assigned VQOs; however cumulative scenic quality effects are evaluated in a larger context than the individual project activities themselves—the potentially affected viewsheds as a whole. The scenery analysis area includes the multitude of viewsheds throughout the project area. The cumulative effects from past vegetative alterations have slightly diminished scenic quality over the years. However many of these past activities have either revegetated or are not visible from sensitive viewpoints. When viewed from multiple viewpoints, proposed management activities in all viewsheds would be natural or near natural appearing and cumulatively appear visually subordinate to the characteristic landscape.

Combining the effects of past, present and foreseeable future projects with the implementation of alternative 2 would not result in measurable cumulative impacts to recreational opportunities in the project area; all past, present and future actions all have the potential for short-term adverse impacts during implementation, but over the long-term these would not result in measurable changes in the type or quality of recreational use in the area.

Alternative 3 – No Temporary Roads

Direct/Indirect and Cumulative Effects

Visual Quality Objectives

The differences between alternative 2 and alternative 3 are small from a scenery and recreation point of view. There would be slightly less thinning and slightly more underburning under

alternative 3 and no new temporary roads would be built. As discussed for alternative 2, these project activities would be consistent with all VQOs for the areas proposed for treatment. The project design features developed for Unit # 22 and ME-5 would also apply in this alternative.

Cumulatively, VQOs would be met on all 9,330 treatment acres. As a result, all viewsheds would remain natural or near natural appearing and appear visually subordinate to the characteristic landscape.

Recreation Opportunities

The direct, indirect, and cumulative effects of this alternative are essentially the same as alternative 2, although there would be less short-term motorized access for dispersed recreation activities since there would be no construction of temporary roads.

Alternative 4 – Minimized Underburning

Direct/Indirect and Cumulative Effects

Visual Quality Objectives

The primary difference between alternatives 2 and 4 is total acres treated with underburning. All other aspects of alternative 4 (thinning & specialized treatment; logging systems; roads, landings and skid trails; meadow enhancement; and road decommissioning) are the same as those previously described for alternative 2. Alternative 4 proposes mastication instead of prescribed burning to treat fuels within many thinned units to minimize the production of smoke.

A masticator grinds and chops up small diameter trees and brush in place, leaving behind crushed vegetation (limbs, brush, trees) which partially covers bare soil. In the short term (1-2 years), masticated areas would appear lighter in color and more open, thereby increasing textural contrasts with adjacent trees or brush. However recovery times for VQOs of three years would allow revegetation or “greening up” to reduce effects to acceptable levels. The visual changes in color, texture, and scale would appear as natural or near natural appearing occurrences from all viewpoints within three years.

As discussed for alternative 2 and 3, project activities, including mastication, would be consistent with all VQOs. The project design features developed for Unit # 22 and ME-5 would also apply in this alternative.

Cumulatively, VQOs would be met on all 2,850 treatment acres. As a result, all viewsheds would remain natural or near natural appearing and appear visually subordinate to the characteristic landscape.

Recreation Opportunities

The direct, indirect, and cumulative effects of this alternative are essentially the same as alternative 2. The significant reduction of the number of acres underburned would provide less opportunity to improve the quality of the deer hunt in those areas.

Summary

Actions proposed under alternatives 2, 3 and 4 would be consistent with Forest Plan VQOs. Changes in visual quality and recreational opportunities would be short-term and minor, primarily occurring during the time of implementation. Beneficial effects to visual quality would occur in the long-term through the development of larger trees and more openings and improved recreational access and hunting quality. Treatment proposed in the Siskiyou Inventoried Roadless Area would be consistent with roadless area characteristics and management direction.

3.14 Cultural Resources

3.14.1 Methodology

The National Historic Preservation Act (NHPA) requires Federal agencies to take into account the effects of their actions on properties listed or eligible for listing on the National Register of Historic Places (NRHP). Impacts were assessed using criteria defined by regulations for Protection of Historic Properties (36 CFR Part 800). The process begins with the identification and evaluation of cultural resources for NRHP eligibility, followed by an assessment of effects on eligible resources. If an action could change in any way the characteristics that qualify the resource for inclusion on the NRHP, it is considered to have an effect. An effect is a direct or indirect alteration of the characteristics of an historic property that qualifies it for inclusion in the NRHP. Effects are “adverse” when the alterations diminish the integrity of a property’s location, design, setting, materials, workmanship, feeling, or association. A “no adverse effect” occurs when the project has an effect on the resource but is not harmful to the characteristics that may qualify the resource for inclusion on the NRHP.

Archaeological remains are widely recognized as being limited in number, nonrenewable, and fragile resources (Nickens 1991; Williamson and Blackburn 1990). These resources consist predominantly of the physical evidence or cultural debris left on the landscape by past societies. Culturally significant areas may also be classified similarly, and may consist of significant concentrations of plants, locations for spiritual practices and sacred viewsheds. Archaeological sites and culturally significant areas within the Area of Potential Effect (APE) were identified through a field inspection and consultation with the Karuk Tribe. The potential for project activities to affect site eligibility to the NRHP was assessed both in the field and after reporting on the results of the field inventory and Native American consultation. The KNF is required to protect sites from and/or mitigate effects to sites following Section 106 of the NHPA or by using Standard Resource Protection Measures (SRPM’s) as outlined in the Programmatic Agreement. The primary factor for determining whether project activities would have an effect on cultural resources was the level of ground disturbance within the site vicinity. Implementation activities such as temporary road construction, construction of fuel breaks to conduct under burns, and the use of heavy equipment to complete timber harvesting activities have the most potential for affecting cultural resources.

It is assumed that fuels treatments, timber harvesting activities, and protection and habitat enhancement of botanical or biological resources will have some level of effect to the cultural resources within the APE. Portions of the project area were extensively surveyed in an effort to locate and record previously unidentified cultural resources within it. In some areas such as the pine plantations, the needle cast, slash and thick vegetation made it difficult to locate artifacts. It is therefore assumed that some resources (in general those not eligible for the NRHP) may not have been identified.

Alternatives are compared using the following impact thresholds, based on 36 CFR Part 800 as a guide:

- **Negligible:** The effect on cultural sites and areas would be at the lowest levels of detection – barely measurable with any perceptible consequences, either beneficial or adverse, on cultural resources. For purposes of Section 106, the site's NRHP eligibility would not be threatened, and the determination of effect would be no adverse effect.
- **Minor:** The effect on cultural sites and areas would be measurable or perceptible, but it would be slight and localized within a relatively small area for a site or group of sites. The action would not affect the character or diminish the features of a NRHP eligible or listed archaeological site and would not have a permanent effect on the integrity of any cultural resource site. For the purposes of Section 106, the site's NRHP eligibility would remain intact, and the determination of effect would be no adverse effect. A beneficial minor effect would involve the maintenance and preservation of sites. For purposes of Section 106, the determination of effect would be no adverse effect.
- **Moderate:** The effect would be measurable and perceptible. The action would change one or more character-defining features of a cultural resource, but it would not diminish the integrity of the resource to the extent that its NRHP eligibility would be jeopardized. For purposes of Section 106, the site's NRHP eligibility would be threatened, and the determination of effect would be adverse effect. A beneficial moderate effect would involve site stabilization. For purposes of Section 106, the determination of effect would be no adverse effect.
- **Major:** The effect on cultural or archaeological sites would be substantial, noticeable, and permanent. For NRHP eligible or listed archaeological sites, the action would change one or more character defining features of an archaeological resource, diminishing the integrity of the resource to the extent that it no longer would be eligible for listing in the NRHP. For purposes of Section 106, the site's NRHP eligibility would be lost, and the determination of effect would be adverse effect. A beneficial major effect would involve active intervention to preserve and improve sites. For purposes of Section 106, the determination of effect would be no adverse effect.
- **Short Term:** The effect anticipated to occur within 1 to 5 years of implementation of the activity
- **Long Term:** The effect that would occur after the first five years of implementation.

3.14.2 Affected Environment

Prehistoric

The project lies within territory traditionally ascribed to the Karuk Tribe and is an area that was utilized for travel, trade and subsistence activities. For generations, the Indian Creek area has

been a travel corridor for Karuk tribal members traveling to Oregon, and the Tribe continues to use this route to the present day. The Karuk names for geographic areas are descriptive of the environmental and/or ecological features and functions of the area. The Karuk Dictionary states that Indian Creek is called *athithuuff* meaning a location that translates into hazel-stick creek. The Two Bit project area has numerous stands of hazel both within and adjacent to natural openings, plantations and meadow areas. Important species such as hazel were often managed and enhanced by the tribe through the use of fire. According to the oral history of the Karuk tribe, fire was set as a routine way of maintaining the health of the landscape. Landscapes managed intensively by the Karuk people resulted in fine-grained vegetation mosaics that had a short-rotation burn regime. These fine-grained mosaics contained numerous plant species that were enhanced by the use of fire and aided in perpetuating the oak woodlands/grasslands, basketry material and edible and medicinal plant species.

There have been few archaeological investigations into the prehistoric chronology of settlement within the Klamath River corridor and its tributaries (including Indian Creek). Excavations at the Pilot Ridge site (approximately 90 miles southwest of the project area revealed evidence of 8,000 years of human occupation and highlighted the fact that archaeological site distributions shifted over time in response to climatically induced vegetation shifts (Busam 2006:16, Fitzgerald and Hilderbrandt 2001:4, Hildebrandt and Hays 1993a:113).

Historic

Euro-American trapping brigades first entered Siskiyou County in 1827, with regular forays through the area continuing into the early 1840s. With the discovery of gold along the middle Klamath River the Karuk's extensive territory was suddenly overwhelmed – first by miners and then by farmers, ranchers, and other more permanent settlers. With the 1851-52 gold strikes, the gentler slopes in the lower elevations of the Klamath watershed steadily became transformed into intensive mining areas. Grazing of pigs, sheep and cattle has also occurred in the area since the 1850s.

Archaeological Sites

Approximately 38 previously recorded archaeological sites are located within the project area boundary. Thirty of these are historic in nature and are associated with mining operations that occurred within and adjacent to the Area of Potential Effects (APE). Typically, historic sites on the Forest contain structural, household, or mining materials that are susceptible to damage from management activities such as underburning. Many of these sites are gradually deteriorating over time due to weathering and human activities, which compromise the integrity of materials or features. Natural processes such as wildland fire, flooding, weathering, and erosion significantly affect historic features especially those made of materials such as wood and metal. There have been relatively few prehistoric sites identified in the Happy Camp area. This is not due to a lack of such sites, but rather a lack of inventory and recordation over the last 20 years. However,

there are 8 previously recorded prehistoric sites located within the project area boundary. All archeological sites within the APE in the project area would be flagged and avoided during the project activities.

Culturally significant areas

The Two Bit project area has many culturally significant plants that are not in the proper condition to be used by local tribal members for edible, medicinal, ceremonial and utilitarian items. Aggressive fire suppression and livestock grazing have affected plant populations for more than 80 years in the project area. Approximately 80 percent of the area proposed for thinning is within existing plantations. Currently, stands are dense and lack species diversity, which limits the gathering opportunities for Native Americans. Beargrass and Hazel found within these stands are in need of burning to improve their condition for use in weaving.

3.14.3 Environmental Consequences

Alternative 1- No Action

Direct/Indirect Effects

Archeological Sites

Because no action would be taken in the project area there would be no direct effect on archaeological sites from management actions. There is potential for damage to prehistoric and historic sites as a result of high intensity fire if a wildfire were to start in the project area. High temperatures and prolonged exposure to heat may affect artifacts and the ability to acquire relevant data (such as obsidian hydration readings) that would affect the information potential and hence NRHP potential of any given site. Fire is especially destructive to historic resources made of wood and some metals and would essentially destroy these materials, likely rendering a site ineligible for the NRHP. Short term effects to archaeological resources would be minor, but long-term effects would be moderate to major.

Culturally Significant Areas

Because no action would be taken in the project area, there would be no direct effect to cultural significant areas from management actions. However, areas in which plants that would benefit from the use of fire to enhance species availability would continue to degrade, resulting in a gradual loss of the desired species. Continued encroachment and expansion of conifers would result in the loss of hardwood species within the project area. The opportunity to provide Karuk cultural resources such as basket material, improved hunting and subsistence opportunities would be diminished. In addition, high intensity fire may result in the loss of important settings and viewsheds used in spiritual practices.

Effects to culturally significant gathering areas would be related to a gradual loss of such resources. Over time, this could result in the abandonment of the gathering areas by the Tribe.

These areas provide some economic benefit to Tribal people for subsistence and spiritual practices. Short and long term effects would be minor to major as a result of loss of archaeological data, plant communities and spiritual sites.

Cumulative Effects

Archaeological sites

If wildfires were to start in the project area, they would likely be of high intensity. Through time, high intensity fire within the project area would likely destroy structures and features of historic sites that would result in the loss of potential NRHP eligible districts. Combining taking no action in the project area with other wildfires that have burned in the surrounding areas (see fuels section) would result in loss of data at prehistoric sites would contribute to their deterioration. This has the potential to result in ineligibility for the NRHP. Emergency fire suppression activities would have minor to major effects on cultural and archaeological properties as a result of fuels buildup.

Culturally Significant Areas

Effects to culturally significant gathering areas and plants from high intensity wildfires would accelerate over time, resulting in the loss of tribally important plant communities. Effects to culturally significant spiritual sites from fires and fires suppression activities could result in the loss of important settings and viewsheds, rendering them unsuitable for use in spiritual practices.

Alternative 2 – Proposed Action

Direct Effects

Archaeological sites

Underburning

Any fire, wild or prescribed, may result in cultural resources being damaged, destroyed or result in inadvertent exposure of sites to increased visibility and illegal collection activities. High intensity wildland fires and prescribed burns could destroy or alter sensitive scientific data that can be gathered through the examination of obsidian hydration profiles. Fire use and fuels management actions that increase erosion, runoff and compaction rates of soils through vegetation loss and use of heavy equipment could engender minor to moderate adverse effects to cultural resources located near or within the project area. However, direct effects to archaeological sites from underburning for this project would be minimized through avoidance. Sites that are historic in nature would be protected through fireline construction. Prehistoric sites would be assessed for the information they contain and either protected by fireline construction or monitored during the burn process. Thus, the use of fire within the project area would not have a direct adverse effect on appropriately mitigated sites.

Thinning, Specialized Treatment, Meadow Enhancement and Commercially Thinned Acres

Direct effects to archaeological sites would be minimized through the implementation of project design features which would ensure site avoidance and onsite monitoring during ground disturbance. Thus, vegetation manipulation would not have a direct adverse effect to appropriately mitigated sites.

Road Construction/Decommissioning

The construction of new temporary roads and the decommissioning of existing roadways have the potential to cause direct negligible to major adverse effects to archaeological resources. These effects can be caused by the use of heavy machinery to construct or decommission roads that go through existing sites. These routes would be identified before project implementation and examined by the district archaeologist to insure that no sites would be affected. New roads would be constructed outside of site boundaries. Thus, road construction/decommissioning activities would not have an adverse effect on appropriately mitigated sites. Short and long term effects to archaeological sites would be negligible to minor as a result of road construction and decommissioning.

Culturally Significant Areas

Underburning

Direct effects to culturally significant plant locales would be beneficial and improve plant health and productivity. The reduction of fuels in the project area would act to reduce high severity fire effects to spiritual areas, aiding in maintaining culturally significant viewsheds and sacred areas. Thus the use of fire within the project area would not have an adverse effect.

Thinning, Specialized Treatment, Meadow Enhancement and Commercially Thinned Acres

Direct effects to culturally significant areas would be minimized by implementation of project design features including flagging and avoiding known sites. Thus, the use of vegetation treatments would not have an adverse effect on these resources. Short and long term effects to culturally significant areas would be negligible to minor as a result of vegetation treatments.

Road Construction/Decommissioning

The construction of new roads and the decommissioning of existing roadways could affect existing culturally significant plant populations. These areas will be identified and flagged for avoidance as appropriate. Short and long term effects to culturally significant areas would be negligible to minor as a result of road construction and decommissioning.

Indirect Effects

Archaeological Sites and Cultural Significant Areas

Archaeological sites can be affected by the disclosure of site locations as a result of “flag and avoid” mitigation. Long-term potential disclosure of site locations would be a result of untreated

islands or vegetation pockets that attract attention within treatment areas. Temporary road construction has the potential to indirectly incur minor to moderate impacts to archaeological and culturally significant areas by providing access to formerly inaccessible areas. Sites may then be illegally excavated and artifacts and features may be removed or damaged. Short and long term indirect effects to archaeological sites and culturally significant areas would be minor to moderate as a result of all proposed project activities.

Cumulative Effects

Combining the implementation of alternative 2 with past, present and future projects would result in an overall beneficial effect to culturally significant areas through vegetation manipulation and underburning across a larger area, creating improved conditions for important plants. Archeological sites have the potentially to be adversely affected with any ground disturbing action, minimized through flagging and avoiding all known sites during project design. Therefore, cumulative effects to archeological sites would be minor to moderate, minimized through project design features applied to all past, present and future projects for protection and avoidance.

Reducing the likelihood of a high intensity wildfire through proposed actions in the APE, combined with similar types of other projects already implemented or in progress (see description of these actions at the beginning of Chapter 3) would result in a cumulative beneficial effect to both archeological resources and culturally significant areas. Viewsheds and important settings would benefit from this reduction in high severity fire.

Alternative 3 – No Temporary Roads

Direct and Indirect Effects

Archaeological Sites and Culturally Significant Areas

The activities that would take place under this alternative are similar to those of alternative 2 with the exception of there being no new temporary roads constructed. There would be less thinning and slightly more burning under alternative 3 when compared to alternative 2. Because the types of treatments are the same as alternative 2 and only vary in the quantity, alternative 3 would have essentially the same effects to archeological resources and culturally significant areas as described above for alternative 2. However, no temporary road construction would result in less chance for inadvertent archeological site disturbance. In addition, slightly more prescribed burning would result in increased benefit to culturally significant areas through improvements to preferred plants in more areas. Short and long term direct/indirect effects to archaeological sites and culturally significant areas would be negligible to moderate as a result of all proposed project activities.

Cumulative Effects

Archaeological Sites and Culturally Significant Areas

Because the differences between alternative 2 and 3 are small and very primarily in the quantity of treatment and not in the type of treatment, cumulative effects are essentially the same as those previously described. Combining the implementation of alternative 3 with past, present and future projects would result in an overall beneficial effect to culturally significant areas through vegetation manipulation and underburning across a larger area, creating improved conditions for important plants. Archeological sites have the potentially to be adversely affected with any ground disturbing action, minimized through flagging and avoiding all known sites during project design. With no new temporary road building under alternative 3, these impacts are slightly less than for alternative 2. Therefore, cumulative effects to archeological sites would be minor to moderate, minimized through project design features applied to all past, present and future projects for protection and avoidance.

Reducing the likelihood of a high intensity wildfire through proposed actions in the APE, combined with similar types of other projects already implemented or in progress (see description of these actions at the beginning of Chapter 3) would result in a cumulative beneficial effect to both archeological resources and culturally significant areas. Viewsheds and important settings would benefit from this reduction in high severity fire.

Alternative 4 – Minimized Underburning

Direct/Indirect Effects

Archaeological Sites and Culturally Significant Areas

The activities that would take place under this alternative are similar to those of alternatives 2 and 3 except that substantially less underburning would occur under alternative 4 and mastication would be used as a treatment method. Because the types of treatments (except mastication) are the same as alternatives 2 and 3 and only vary in the quantity, alternative 4 would have similar effects to archeological resources and culturally significant areas as described above for alternatives 2 and 3. However, mastication would introduce another ground-disturbing activity with the potential for direct adverse effects to archeological resources. This would be minimized through flagging all known sites and avoiding them during project implementation. Substantially less prescribed burning would result in substantially less benefit to culturally significant areas because fewer areas would receive underburning.

However, less underburning also equates to less smoke production. This would result in substantially less adverse short-term impacts to Karuk tribal members living in the project area due to smoke (see socioeconomics section for more details on local communities).
Short and long term direct/indirect effects to archaeological sites and culturally significant areas would be negligible to moderate as a result of all proposed project activities under alternative 4.

Cumulative Effects

Archaeological Sites and Culturally Significant Areas

Because the differences between alternative 2, 3 and 4 are relatively small and vary primarily in the quantity of treatment and not in the type of treatment, cumulative effects are essentially the same as those previously described. Combining the implementation of alternative 4 with past, present and future projects would result in an overall beneficial effect to culturally significant areas through vegetation manipulation and underburning across a larger area, creating improved conditions for important plants. However, this cumulative beneficial effect would be less for alternative 4 than for alternatives 2 or 3. Archeological sites have the potentially to be adversely affected with any ground disturbing action, minimized through flagging and avoiding all known sites during project design. With mastication introduced as an additional ground disturbing activity in alternative 4, these impacts are slightly greater than for alternatives 2 or 3. Therefore, cumulative effects to archeological sites would be minor to moderate, minimized through project design features applied to all past, present and future projects for protection and avoidance.

Reducing the likelihood of a high intensity wildfire through proposed actions in the APE, combined with similar types of other projects already implemented or in progress (see description of these actions at the beginning of Chapter 3) would result in a cumulative beneficial effect to both archeological resources and culturally significant areas. Viewsheds and important settings would benefit from this reduction in high severity fire.

Summary

Alternative 1 would have minor to major effects on archaeological and cultural significant areas within the project area. The potential for high intensity wildfires would continue and this could result in adverse effects to these resources resulting in the loss of archaeological data, important plant communities and the spiritual practices of the Karuk Tribe.

Alternatives 2, 3 and 4 would have similar adverse and beneficial effects to archeological resources and cultural significant areas because the types of treatment would be the same and essentially vary only in the quantity of proposed treatments. Because alternative 3 would not construct any new temporary roads, adverse effects to archeological sites are less than for alternatives 2 or 4. Because alternative 4 includes substantially less underburning than alternatives 2 or 3, the beneficial effects to cultural significant areas are less because fewer areas of preferred plant species would be underburned.

3.15 Climate Change

3.15.1 Methodology

The methods used to assess how the success of the alternatives could be affected by climate change and the predicted impacts of the alternatives on climate change came from guidance in the Climate Change Considerations in Project Level NEPA Analysis (USDA 2009f) and

information provided by the Climate Change Resource Center found at (http://www.fs.fed.us/ccrc/topics/landscape-analysis.shtml).

Cutting trees and prescribed burning can result in the release of greenhouse gases through smoke from prescribed burning and to a limited extent, through operation of chain saws and vehicles. These actions may also result in alteration of large pulses of greenhouse gas emissions through a decrease in the potential for large-scale wildfire. The effect of climate change on the proposed project include such as things as changes in rainfall and temperature patterns over time that can influence the success of proposed treatments over the long-term. These two factors are used to compare alternatives.

3.15.2 Affected Environment

Temperatures range from an average low of 21.5 ºF in January to a high of 83.6 ºF in July. Mean annual precipitation is 62.64 inches, the majority of that occurring in from November-March with November being the wettest month.

The temperature of the earth's atmosphere is regulated by a balance between amount of radiation received from the sun that is reflected by the earth's surface and clouds, and the amount of radiation absorbed by the earth and atmosphere. Greenhouse gases, which include carbon dioxide and water vapor, keep the earth's surface warmer than it would be otherwise because they absorb infrared radiation from the earth and, in turn, radiate this energy back down to the surface. While these gases occur naturally in the atmosphere, there has been a rapid increase in concentrations of greenhouse gases in the earth's atmosphere from anthropogenic (human) sources since the start of industrialization, which has caused concerns over potential changes in the global climate. For over the past 200 years, the burning of fossil fuels, such as coal and oil, and deforestation has caused the concentrations of heat-trapping "greenhouse gases" to increase significantly in our atmosphere. These gases prevent heat from escaping to space, somewhat like the glass panels of a greenhouse (EPA 2009).

Forests play a major role in the carbon cycle. The carbon stored in live biomass, dead plant material, and soil represents the balance between CO2 absorbed from the atmosphere and its release through respiration, decomposition, and burning. Over longer time periods, indeed as long as forests exist, they will continue to absorb carbon (USDA Forest Service 2009b).

Ongoing climate change research is summarized in reports by the United Nations Intergovernmental Panel on Climate Change (IPCC) (www.ipcc.ch), US Climate Change Science Program's Science Synthesis and Assessment Products, and the US Global Change Research Program. These reports concluded that climate is already changing; that the change would accelerate, and that human greenhouse gas emissions, primarily carbon dioxide emissions, are the main source of accelerated climate change (USDA Forest Service 2009b).

Projected global climate change impacts include air temperature increases; sea level rise; changes in the timing, location, and quantity of precipitation; and increased frequency of extreme weather events such as heat waves, droughts, and floods. These changes would vary

regionally and affect renewable resources, aquatic and terrestrial ecosystems, and agriculture. While uncertainties would remain regarding the timing and extent magnitude of climate change impacts, the scientific evidence predicts that continued increases in greenhouse gas emissions would lead to increased climate changes.

3.15.3 Environmental Consequences

Alternative 1- No Action

Direct and Indirect Effects

Implementing alternative 1, no action, would not result in direct greenhouse gas emissions or direct changes in climate or overall vegetation patterns. Carbon would remain sequestered in the forested portions of the project area. Not taking action to reduce tree stocking and improve forest health in the project area to a condition more in keeping with the existing range of variability would contribute to a less resilient ecosystem that would be more susceptible to long-term shifts in temperature and rainfall patterns. If a wildfire were to start in the project area, it is likely to be a high intensity fire. A high intensity, stand-replacing wildfire would result in substantial greenhouse gas emissions, primarily through the release of carbon dioxide.

Because there would be no greenhouse gas emissions produced as a direct result of taking no action, implementing alternative 1 would not contribute to the cumulative impacts of past, present and future projects.

Alternative 2 – Proposed Action

Direct and Indirect Effects

It is not currently feasible to quantify indirect effects of individual or multiple projects on global climate change (USDA Forest Service 2009b). Implementation of alternative 2 would result in release of greenhouse gases through thinning and burning, primarily through release of carbon dioxide from burning and emissions from vehicles and equipment used. However, these emissions would be localized and temporary. By reducing the risk of high intensity, stand-replacing wildfire in the project area, alternative 2 reduces the risk of subsequent substantial release of carbon dioxide during a large wildfire. As shown in Section 3.5, table 36, carbon dioxide emissions would be substantially lower for a prescribed burn than for a wildfire. There is an indirect beneficial effect by treating these acres because live stands of trees would retain higher capacity to sequester carbon dioxide compared to stands killed by uncharacteristically severe wildfires.

Cumulative Effects

At this time there are no regulations to limit greenhouse gas emissions. The current state of science does not allow for site specific analysis of greenhouse gas emissions at local or regional levels. Likewise, global climate change models are not yet able to determine specific impacts of

greenhouse gases on local climate patterns. In general, however, moving the project area toward its natural range of variability would create an ecosystem more resilient to climate shifts over time. This would occur in the project area and in other areas in the region where similar restoration projects are underway.

Alternative 3 – No Temporary Roads

Direct, Indirect and Cumulative Effects

The relative amount of prescribed burning and thinning treatment proposed for alternative 3 is considered the same as alternative 2, for purposes of analyzing effects to climate change; only small differences in acres of treatment are proposed. For these reasons, the direct/indirect and cumulative effects are the same as those previously described for alternative 2.

Alternative 4 – Minimized Underburning

Direct, Indirect and Cumulative Effects

The amount of prescribed burning is much lower for alternative 4 than for alternatives 2 and 3. Carbon monoxide emissions for alternative 4, based on modeling would be substantially lower with 4,500 total tons released over the course of the project, compared to 62,000 total tons for alternatives 2 and 3 (table 36 in Air Quality Section 3.5). However, as discussed in the Fire and Fuels section of this chapter, alternative 4 would not reduce the risk of high intensity wildfire in treated areas as successfully as alternative 2 and 3; therefore, large pulses of carbon monoxide emissions have a greater likelihood of occurring if a wildfire were to start in the project area under alternative 4 when compared to alternatives 2 and 3.

However, alternative 4 would achieve project objectives and would result in a more fire resilient ecosystem, just not as well as alternatives 2 or 3. Moving the project area toward its natural range of variability would create an ecosystem more resilient to climate shifts over time. This would occur in the project area and in other areas in the region where similar restoration projects are underway.

3.16 Short-term Uses and Long-term Productivity

NEPA requires consideration of “the relationship between short-term uses of man’s environment and the maintenance and enhancement of long-term productivity” (40 CFR 1502.16). As declared by the Congress, this includes using all practicable means and measures, including financial and technical assistance, in a manner calculated to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans (NEPA Section 101)

The proposed treatments are designed to accomplish multiple objectives and do not necessarily maximize timber volume production from Klamath National Forest lands designated

as Management Area 17-general forest; however, one of the goals of the Two Bit project is to provide a programmed flow of timber products (Chapter 1). An economic analysis was done for this project that is summarized previously in this chapter. All action alternatives would generate timber volume, jobs, revenue, and labor income. All action alternatives would also result in nonmarket benefits and costs that include improved ecosystem health and reduced threat of fire, moving the project area toward desired conditions.

3.17 Unavoidable Adverse Effects

All action alternatives (alternatives 2, 3 and 4) include the implementation of a substantial list of design features and best management practices (Chapter 2 and appendix E) intended to avoid, minimize the extent of, or reduce the potential for adverse effects on the environment. All practicable measures to protect the environment are included in the action alternatives; however, some adverse impacts cannot be avoided. Individual larger, older trees would be felled during the course of operations. Individual botanical and wildlife species of concern may be harmed or disturbed. Erosion would likely be accelerated in some places. Each section of Chapter 3 describes the spatial and temporal context for unavoidable adverse effects predicted from alternatives 2, 3, and 4.

3.18 Irreversible and Irretrievable Commitments of Resources

Irreversible commitments of resources are those that cannot be regained, such as the extinction of a species or the removal of mined ore. Irretrievable commitments are those that are lost for a period of time such as the temporary loss of timber productivity in forested areas that are kept clear for use as a power line rights-of-way or road.

This project does not involve any irreversible commitments of resources. The short-term and long-term impacts described in Chapter 3 involve some irretrievable commitments, including the loss of biomass, loss of productivity in areas cleared for roads and landings (limited in extent and to be rehabilitated at the end of the project to hasten recovery), and loss of soil in local areas of accelerated erosion (cumulative watershed impacts have been discussed – vegetation recovery is included in the modeled results). This project does not involve take of any species listed under the federal Endangered Species Act.

3.19 Energy Requirements

This project does not involve any unusual energy requirements. Energy efficiency has been considered in the logging systems plan, with the most efficient system proposed where consistent with prescription objectives and project design features.

3.20 Legal and Regulatory Compliance

NEPA at 40 CFR 1502.25(a) directs "to the fullest extent possible, agencies shall prepare draft environmental impact statements concurrently with and integrated with …other environmental review laws and executive orders." Alternatives 2, 3, and 4 comply with following laws and regulations:

- Endangered Species Act
- Clean Water Act
- Clean Air Act
- National Historic Preservation Act
- Coastal Zone Management Act
- National Forest Management Act

There are no conflicts between alternatives 2, 3 and 4 and the objectives of federal, regional, state and local policies and plans.

Chapter 4. Consultation and Coordination

4.1 Preparers and Contributors

The Forest Service consulted the following individuals, Federal, State, and local agencies, tribes and non-Forest Service persons during the development of this environmental impact statement:

ID Team Members:

Angie Bell: 18 months experience; BS Geology; MS Geology; expertise in Geomorphology; responsible for geologic analysis

Bob Talley: 29 years experience in landscape architecture; Bachelor of Landscape Architecture; expertise in Scenery, Wild & Scenic Rivers, and Recreation; responsible for recreation and scenery analysis

Carol Sharp: 27 years experience in Silviculture; BA in Psychology and 2 years course work in Forestry; expertise in silviculture; responsible for silviculture analysis

Clint Isbell: Experience in fire modeling, condition class modeling, fire and fuels planning, and monitoring; knowledge and experience in post fire severity mapping, ecological data analysis, and ArcGIS. BS in Natural Resources; MS in Natural Resources-Fire Ecology; expertise in firefighting and fire ecology; responsible for fire/fuels and air quality analysis

Dustin Walters: 10 years experience in soils and hydrology; MS in natural resource conservation from University of Montana; expertise in NEPA analysis and environmental compliance, watershed restoration, watershed improvement assessments, BMP monitoring, timber analysis, estimating project costs, NEPA writing

Deborah Lutch McGlothlin: 19 years experience in wildlife management, National Environmental Policy Act coordination and implementation and interdisciplinary team leadership; responsible for project co-team leadership, document preparation and project record

Erin Rentz: 8 years experience in botany and plant ecology; BS Botay; MS Ecology and Systematic Biology; expertise in Botany, weed management, monitoring and plant inventory; responsible for botany and noxious weed analysis

Gregg Bousfield: 5 years experience in watershed sciences; BS Forest Hydrology, MS Watershed Management; expertise in road sediment source identification, GIS, data analysis and modeling; responsible for water analysis and cumulative watershed effects modeling

Janice Schultz: 9 years experience in writing and editing technical documents for the National Environmental Policy Act; expertise in formatting, writing and editing, preparing administrative records for NEPA, and public affairs; responsible for document compilation

John Allen: Bachelor’s degree in Natural Resource Management, 30 years in timber sale and fuels management project planning and preparation, interdisciplinary team leadership, and NEPA coordination and oversight. Assistant team leader for this project

Jon Grunbaum: 20 years experience in fishery and watershed sciences; BS Fisheries Science, MS Fisheries Science; expertise in fisheries monitoring and inventory, and land/water interactions; responsible for fisheries analysis

Joshua Wilson: 4 years experience in resource economics and public lands management; BS Managerial Economics; MS Agriculture and Resource Economics; 2 years graduate work in Forestry; responsible for socioeconomic analysis

Juan de la Fuente: 35 years experience in geology; BS in Geology; expertise in geomorphic processes; responsible for geology analysis

Kathy McCovey: 8 years experience in forestry, 15 years experience in archaeology and anthropology; BS in Anthropology/Archaeology; currently a student in the Environment and Community Master's program at Humboldt State University; expertise in archaeology/anthropology, forestry, ethnobotany, and Native Americans of northern California; 30 years of fire experience

Nicholas Larson: 8 years experience in forest management; BS Forest Science; expertise in forestry; responsible for project coteam leadership

Richard VandeWater: 17 years experience in GIS; MS in Sociology; expertise in GIS and database management; responsible for mapping, database management and GIS

Tim Burnett: 17 years experience in wildlife management; BS in Wildlife Biology

4.2 Federal, State, and Local Agencies:

Since project initiation in 2008, the Forest Service worked with local, state, and federal agencies and Karuk tribal representatives to develop the alternatives. The coordination with others has occurred as part of public involvement for the project and as part of compliance with laws, policies and plans described throughout this document.

Interagency consultation with US Fish and Wildlife Service and National Marine Fisheries Service is currently in progress regarding effects to listed species under the Federal Endangered Species Act, such as coho salmon, northern spotted owl, and fisher.

Representatives from the state of California reviewed the part of the project in inventoried roadless area and the State Water Board visited the project in the field.

The project was discussed at regular monthly meetings with Karuk tribal representatives.

Distribution of the Environmental Impact Statement.

This environmental impact statement has been distributed to individuals who specifically requested a copy of the document. In addition, copies have been sent to the following Federal agencies (or agencies otherwise notified of availability); federally recognized tribes, State and local governments, and organizations:

American Forest Resource Council
Office of Environmental Policy and Compliance
U.S. Department of the Interior Fish and Wildlife Service
Environmental Protection Agency, Region 9
National Marine Fisheries Service
North Coast Regional Water Quality Control Board
California Department of Fish & Game
USDA, National Agricultural Library
Karuk Tribe
Klamath Forest Alliance
Klamath – Siskiyou Wildland Center
Klamath Alliance for Resources and Environment
Siskiyou County
Siskiyou County Fish and Game Commission
Cascadia Wildlands Project
Environmental Protection Information Center
Oregon Wild
Sierra Pacific Industries
Advisory Council on Historic Preservation
USDA, APHIS PPD/EAD
NOAA Office of Policy and Strategic Planning
Natural Resources Conservation Service
US Army Engineer Division, South Pacific

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4.4 Glossary

90th Percentile Fire Weather ~ The highest 10% of fire weather days. Fuel moisture, temperature, relative humidity, and wind speed are only exceeded 10% of the time based on historical weather observations; also called severe conditions

Active Crown Fire ~ A fire that moves into and through the tree crowns, generally due to a combination of fire intensity and ladder fuels

Activity Fuels ~ Fuels created by management actions

Anadromous Fish ~ Species of fish that are born in freshwater, move to the ocean to mature, and return to freshwater to reproduce

Annosus root disease (*Heterobasidion annosum*) ~ Fungus that attacks a wide variety of woody plants. Infection may spread by spores that colonize freshly cut stumps or basal wounds, or via root contact

Aquatic ~ Living or growing in water

Aquatic Conservation Strategy~ A strategy "developed to restore and maintain the ecological health of watersheds and aquatic ecosystems contained within them on public lands" (USDA Forest Service and USDI Bureau of Land Management 1994b, B-9)

Aquatic Conservation Strategy Objectives ~ Objectives that "define the context for the agency review and implementation of management activities. Complying with the Aquatic Conservation Strategy objectives means that an agency must manage the riparian-dependent resources to maintain the existing condition or implement actions to restore conditions. The baseline from which to assess maintaining or restoring the condition is developed through a watershed analysis. Improvement relates to restoring biological and physical processes within their ranges of natural variability." (USDA Forest Service and USDI Bureau of Land Management 1994b, B-10)

Areas with Watershed Concerns (AWWC) ~ Areas identified in the LRMP ROD (USDA Forest Service 1995b) because cumulative watershed effects are a special concern due to a combination of high disturbance levels (roads, timber harvest, fire), potential for landslides, potential for surface erosion, and poor aquatic habitat conditions. The LRMP ROD (ibid.) states that a "cautious approach will be taken in AWWC, with respect to future land management activities," and that "Watershed Analysis, as part of ecosystem analysis, will be required prior to implementing site-disturbing activities"

Basal Area~the term used in forest management that defines the area of a given section of land that is occupied by the cross-section of tree trunks and stems at their base.

Beneficial Uses ~ "Beneficial uses" of the waters of the state that may be protected against water quality degradation include, but are not necessarily limited to, domestic, municipal, agricultural, and industrial supply; power generation; recreation; aesthetic enjoyment; navigation; and preservation and enhancement of fish, wildlife, and other aquatic resources or preserves (from Section 13050(f) of California's Porter-Cologne Water Quality Control Act)

Best Management Practices ~ Measures certified by the State Water Quality Control Board and approved by the Environmental Protection Agency as effective means of reducing water quality impacts from non-point sources of pollution

Black Stain Root Disease ~ a tree root disease that is distinguished from other root diseases by dark-brown to purple-black discoloration in the sapwood of the lower bole and root collar. When observed in cross section, the black stain appears in arcs roughly concentric with the growth rings. *L. wageneri var. pseudotsugae* (Harrington et Cobb) causes black stain in Douglas-fir

Board Foot ~ A unit of measurement equal to an unfinished board one-foot square by one-inch thick

Burn Severity ~ Effects of fire on the soil surface; related to fire intensity and duration

Canopy: Tree crowns in a stand

Canopy Base Height ~ The distance from the ground to the base of the tree crowns (usually an average value for a stand)

Capable Lands ~ Lands where at least 20 cubic feet of commercial wood products can be grown per acre per year

Chain ~ Unit of linear measure often used on public lands, particulary in measuring the rate of wildfire spread (chains per hour). One chain equals 66 feet.

Classified Road ~ Roads wholly or partially within or adjacent to National Forest System lands that are determined to be needed for long-term motor vehicle access, including State roads, county roads, privately owned road, National Forest System roads, and other roads authorized by the Forest Service

Coarse Woody Debris (CWD) ~ Woody material at least 20-inches in diameter from whatever source that is dead and lying on the forest floor. Term used for terrestrial species habitat. See Large Woody Debris for aquatic species habitat

Conk ~ A fibrous but sometimes fleshy fruiting body of a wood-rotting fungus that has a definite form and structure.

Compacted Soils ~ Soils with reduced porosity

Critical Habitat ~ Defined in the ESA as (1) the specific areas within the geographical area occupied by the species, at the time it is federally listed, on which are found those physical or biological features essential to the conservation of the species, and which may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by the species at the time it is listed, when it is determined by the Secretary of the Interior that such areas are essential for the conservation of the species

Crowning ~ Situation where fire rises to the tree tops and begins advancing from tree top to tree top, or where fire intermittently ignites tree crowns as a surface fire advances.

Cumulative Effects ~ Those effects resulting from incremental effects of actions, when added to other past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes such other actions

Cumulative Watershed Effects Model ~ A model for Cumulative Watershed Effects with three components: Equivalent Roaded Acres (ERA), sediment delivery from surface erosion (USLE), and sediment delivery from mass wasting (GEO). The model quantifies disturbances and land sensitivity at the 7th field watershed scale and can calculate them at larger scales. The estimated results fall on a continuum. As disturbances increase over time and space, at some point the risk of initiating or contributing to existing adverse cumulative watershed impacts becomes a cause for concern. Concern thresholds have been identified for each component based on field observations in the Forest

Diameter Breast Height (DBH) ~ The diameter of a standing tree at a point 4½ feet above ground level, measured from the uphill side.

Direct Attack ~ Any treatment applied directly to burning fuel such as wetting, smothering, or chemically quenching the fire or physically separating the burning from unburned fuel.

Direct Effects ~ Those effects occurring at the same time and place as the initial cause or action.
Dispersal ~ The relatively permanent movement of individual animals from one location to another. Usually dispersal is the movement of young animals from where they were born to a site where they eventually settle to breed
Douglas-fir beetle ~Adults and larvae of the species *Dendroctonus pseudotsugae* Hopkins feed in the phloem layer of inner bark, girdling tree, and usually killing it. Evidence that a Douglas-fir has been successfully attacked is the red-orange boring dust in bark crevices or on the ground around the tree.
Dwarf Mistletoe (*Arceuthobium spp.)* ~ A host specific parasitic seed plant found in all the major conifer species (red fir, white fire, Douglas-fir and incense cedar)
Ecosystem ~ A dynamic community of biological organisms, including humans, and the physical environment with which they interact
Effects ~ Impacts; physical, biological, economic, and social results (or expected results) from implementing an activity
Embeddedness ~ Degree to which large streambed materials such as cobbles and gravel are surrounded or covered by fine sediment
Endangered Species ~ Any species that is in danger of extinction throughout all or a significant portion of its range
Environmental Justice: Executive Order 12898 requires an assessment of whether minorities or low-income populations would be disproportionately affected by proposed actions
Equivalent Road Acres (ERA) ~ An index of average watershed disturbance expressed in road equivalent acres relative to a "threshold of concern" assigned for the watershed.
Erosion: A general term for movement of soil particles on the surface of the land initiated by rainfall and running water. This includes surface erosion and channel erosion, as opposed to landsliding
Filtering Capacity ~ Ability of a riparian reserve to trap sediment and prevent it from reaching a stream.
Fine Fuels ~ Fuels less than 3 inches in diameter that is easy to ignite
Fir Engraver Beetle (*Scolytus ventralis*) ~ A burrowing beetle that attacks most true fir species in the western United States; attacks can result in bark kill around the tree bole, top kill, and tree mortality
Fire Behavior ~ The manner in which a fire reacts to fuels, weather, and topography
Fire Intensity ~ A general term relating to the heat energy released in a fire
Fire Regime ~ The combination of fire frequency, predictability, intensity, seasonality, and distinctive characteristics of fire in an ecosystem; Agee (1993) defines three broad categories of fire severity "based on the physical characters of fire and the fire adaptations of vegetation"
Flatheaded Fir Borers ~ Insect larvae of the species *Melanophila drummondi (Buprestidae*) invade previously weakened trees. Adult lays eggs in crevices in the bark and their larvae destroy the cambial surface of trees. This species typically attacks injured, mistletoe infected, dying, fire-

killed and recently felled trees but sometimes it attacks and kills apparently healthy trees, especially on dry sites.

Imminent Mortality ~ Mortality is imminent when the majority of the root system is destroyed and the remaining roots can no longer support the remaining live portions of the tree (Thies and Sturrock 1995). We define "imminent" as likely to occur in several months to, possibly, a few years (up to five). Similarly, mortality is imminent in trees with destroyed portions of crowns and thus with greatly diminished ability to supply adequate quantities of carbohydrates to the bole and roots. Imminent mortality occurs when the carbohydrate budget is in deficit; respiration exceeds photosynthesis, and stored carbohydrate reserves become exhausted (Waring 1987).

Laminated Root Rot ~ one of the most damaging root diseases amongst conifers in northwestern America. It is caused by *Phellinus weirii*, a fungus, and affects mostly fir trees and cedars

Low Severity Fire Regime ~ Effect of typical fire is benign; fires are frequent (often < 20 years), of low intensity, and the ecosystems have dominant vegetation well-adapted to survive fire

Mixed Severity Fire Regime ~ Fires are of intermediate frequency (25-100 years), range from low to high intensity, and have vegetation with a wide range of adaptation

High Severity Fire Regime ~ Fires are usually infrequent (often >100 years) but may be of high intensity, most vegetation is at least top-killed

Fire Return Interval ~ Number of years between two successive fire events in a given area.

Fire Risk ~ The statistical probability of a fire start occurring over a ten-year period for a given thousand-acre area

Fire Severity ~ The degree to which a site has been altered or disrupted by fire; severity is affected by fire intensity and how long the fire remains at the site. In this document, fire severity is defined as tree mortality

Fire Suppression ~ All work and activities associated with extinguishing a fire

Force Account ~ Term to refer to Forest Service personnel and equipment

Forest Plan (LRMP) ~ The Klamath National Forest Land and Resource Management Plan, approved in 1995. The Forest Plan provides land allocations, Standards and Guidelines, and direction for management of the Klamath National Forest.

Fuel Loading ~ The quantity of fuel per acre in a given area

Fuel Treatment ~ The process of removing and/or modifying natural or human created fuels to reduce fire hazard and achieve other resource objectives

Fuels ~ Anything within the forest that will burn; usually live and dead woody vegetation

Full-Bench Skid Trails ~ For ground-based equipment skid trails, the entire road surface is cut into the hill slope

Geographical Information System Coverage ~ Data layer in a Geographical Information System.

Grapple System ~ A mechanical method of piling fuels using an articulating arm on a low ground pressure vehicle that picks up the material and places it on the pile

Green Tree Retention ~ A regeneration cut in an even-aged silvicultural system that maintains a portion of the existing stand, creating a two-storied structure with two or more age classes present

Ground-based Equipment ~ Equipment that runs on the ground, like tractors, rubbertired skidders, and masticators

Group Selection ~ Harvest treatment in an uneven-aged silvicultural system that removes small groups of trees, resulting in different age classes in the stand

Hawksworth Rating System ~ A system developed by Hawksworth in 1977 to rate severity of infection by dwarf mistletoe in a tree or stand. The rating system forms a basis for defining management implications and recommendations

Head of Fire ~ Advancing edge

Healthy Stand (for the Project Area) ~ Exhibits insect and disease levels such that mortality is not substantial (snag and coarse woody debris levels are within Forest standard and guidelines); little decadence (few dead or dying trees, relatively few large down logs or snags) although the area maintains some structural components of older stands; trees per acre (stocking level) within the range that can be supported by the land; and conditions such that wildfire would not burn more than 25% of the dominant vegetation at a high intensity

Hydrologic ~ Dealing with the movement and properties of liquid water in environmental systems. Includes the circulation patterns of water in the biosphere from condensation and precipitation to movement both on and under the ground surface to evaporation back into the atmosphere

Hydrologic Recovery ~ Harvested timber stand with sufficient canopy closure that snow accumulation, melt rates, and soil protection from raindrop impact are comparable to pre-harvest levels; this typically is achieved when the average tree size is 8” diameter breast height or 35 feet tall. Recovery is complete by around 30 years after harvest on the westside of the Forest

Hydrologic Restoration ~ A term used in this analysis regarding rehabilitation of temporary roads, skid trails and landings after use. Actions such as removal of berms, re-contouring, spreading of slash or straw, and/or installation of water bars or similar measures would be used to minimize surface runoff and erosion and encourage natural revegetation.

Impacts ~ Physical, biological, economic, and social results (or expected results) from implementing an activity

Incorporation by Reference ~ A technique used to cut down on the bulk in environmental documents without impeding agency and public review of the action. The material included as part of the document must be cited in the document and its content briefly described

Indirect Effects ~ Those effects occurring later in time or that are spatially removed from the activity

Inference Point ~ The midpoint of a zone where disturbances become great enough to cause concern about initiating or contributing to adverse cumulative watershed effects

Infiltration (soil) ~ The movement of water through the soil surface into the soil

Interdisciplinary ~ The utilization of individuals representing two or more areas of knowledge and skills focusing on the same subject

Irretrievable ~ An irretrievable commitment of resources entails a loss of production, harvest, or use of natural resources. Such decisions are reversible, but the production opportunities foregone are irretrievable (50 Federal Register 26082)

Irreversible ~ An irreversible commitment of resources entails a loss of future options. This applies primarily to the effects of use of non-renewable resources such as minerals or cultural resources, or to those factors, such as soil productivity, that are renewable only over a long period of time (50 Federal Register 26082)

Issue ~ Point of discussion, debate, or dispute about the environmental effects of the proposed action

Ladder Fuels ~ Small trees and brush in the understory that allow fire to move from the ground into the tree crowns

Land Allocation ~ The assignment in the LRMP of a management emphasis to particular land areas with the purpose of achieving goals and objectives

Late-successional characteristics ~ Characteristics of a stand of trees indicative of maturity, including mature and overmature trees in the overstory; multi-layered canopy with trees of several age classes; and standing dead trees and down material

Late-successional habitat ~ Older forested stands with moderate to high canopy closure; often containing a multilayered, multispecies canopy dominated by large overstory trees; large trees with broken tops or other indications of old and decaying wood; numerous large snags; and moderate to heavy accumulations of large logs on the ground

Late-successional stands ~ Late-successional stands within the Project Area are defined as stands with an average DBH greater than 24 inches. On the north and east facing slopes, theses stands contain a mix of conifer species and generally exhibit complex structure and abundant DWD. Late-successional stands on south and west facing slope, are typically more open and pine dominated with less DWD. True fir late-successional stands are generally single storied with little understory

Late-successional reserves (LSR) ~ Large blocks of habitat that are distributed across the range of the northern spotted owl and spaced closely enough to facilitate dispersal of owls. Late-successional reserves are managed to provide habitat for late successional and “old growth” species

Management Area (MA) ~ A distinct geographical area with specified objectives and prescriptions

Management Direction ~ A statement of multiple use and other goals and objectives, along with the associated management prescriptions and Standards and Guidelines to direct resource management

Mass Wasting ~ Movement of soil material in landslides and debris torrents

Masticator ~ Equipment that grinds or chews up vegetative material

Matrix ~ Lands outside of reserves and withdrawn areas; lands assigned a regulated timber yield

Monitoring ~ Process of collecting information to evaluate if objective and anticipated or assumed results of a management plan are being realized or if implementation is proceeding as planned

Montane ~ Pertaining to mountain conditions

National Environmental Policy Act (NEPA) ~ The act that governs how federal agencies assess impacts of management actions on public lands. The process is interdisciplinary and requires consideration of the environmental effects of alternatives and disclosure of those effects.

National Forest System Road ~ A classified Forest road under the jurisdiction of the Forest Service. The term "National Forest System Roads" is synonymous with the term "forest development roads" as used in 23 U.S.C. 205

Noxious Weed ~ Any plant so designated by the Weed Control Regulations and identified on a regional district noxious weed control list. They are generally non-native and resistant to control efforts

Overstory ~ The portion of trees in a forest which forms the uppermost layer of foliage

Passive Crown Fire ~ A fire that remains on the ground surface but exhibits some individual tree or group torching; fire intensity is still fairly low

Peak Flow ~ The greatest stream or river flow occurring in a year from a single storm event

Port-Orford-Cedar Root Disease ~ the most serious disease of Port-Orford-cedar (*Chamaecyparis lawsoniana*) is a root disease caused by the fungus *Phytophthora lateralis*. Infected trees are often attacked by bark beetles, which speed death and may modify foliage discoloration by altering the rate of drying. Recently killed trees are pre-disposed to windthrow.

Quadratic Mean Diameter (QMD) ~ the measure of average tree diameter conventionally used in forestry. QMD was chosen as an indicator because of its relationship to the health of trees and susceptibility to damage from fire and its relationship to calculating stand density index (SDI). QMD combined with trees per acre (TPA) also reflects the number of small diameter trees that may function as ladder fuels.

Rain-on-Snow Event ~ Rain falling on a snowpack and rapidly melting the snow, causing the melt water to be added to the rain, creating flood conditions

Record of Decision ~ A document separate from but associated with an environmental impact statement that states the management decision and provides the rationale for that decision

Red Ring Rot ~a wood-decay disease of the inner wood of stems of living conifers. It is caused by the fungus *Porodaedalea*

Residual ~ The trees remaining after harvesting; also known as the crop trees

Resilience ~ An ecosystem's ability to maintain structure and patterns of behavior in the face of disturbance

Riparian ~ In general, characterized by being situated on the bank of a river or other body of water; in ecology, the term is applied both to species that live near streams and to the area adjacent to streams where vegetation and microclimate are influenced by the presence of the stream

Riparian Reserves ~ A land allocation in the LRMP that includes an aquatic ecosystem and the adjacent upland areas directly affecting it. It also includes unstable and potentially unstable lands that are not associated with aquatic areas. Specific Standards and Guidelines provide direction for these areas as outlined in Management Area 10 of the LRMP

Risk ~ The chance of loss

Risk Ratio (for cumulative watershed effects model) ~ Amount of the disturbance in the watershed relative to the hydrologic or sediment inference point

Road ~ A motor vehicle travelway. A road may be classified, unclassified, or temporary (36 CFR 212.1).

- **Classified Roads:** Roads wholly or partially within or adjacent to National Forest Systemlands that are determined to be needed for long-term motor vehicle access, including State roads, county roads, privately owned roads, National Forest System roads, and other roads authorized by the Forest Service (36 CFR 212.1).
- **Temporary Roads:** Roads authorized by contract, permit, lease, other written authorization, or emergency operation, not intended to be a part of the forest transportation system and not necessary for long-term resource management (36 CFR 212.1). For purposes of this project, temporary roads are assumed to have a 10 to 20-foot-wide driving surface, with an average driving surface width of 12 feet and a 15 to 30-foot-wide road prism width, depending on steepness of slope.
- **Unclassified Roads:** Roads on National Forest System lands that are not managed as part of the forest transportation system, such as unplanned roads, abandoned travelways, and offroad vehicle tracks that have not been designated and managed as a trail; and those roads that were once under permit or other authorization and were not decommissioned upon the termination of the authorization (36 CFR 212.1). The regulations at 36 CFR 223.37 require revegetation within 10 years.

Road Cut ~ Soil or rock material removed during road construction, usually from the upslope side of the road

Road Decommissioning ~ Activities that result in the stabilization and restoration of unneeded roads to a natural state. For purposes of this analysis, decommissioned roads would no longer be used by motor vehicles; actions would include such things as removal of aggregate, excavation of culverts, stream channel restoration, decompaction of road surfaces, cross-ditching (drainage structures), outsloping, seeding or mulching exposed soils, disposing of excavated culverts, and blocking vehicular access with a series of berms or barriers.

Road Fill ~ Soil or rock material placed on the ground as part of the road surface

Road Maintenance ~ The ongoing upkeep of a road necessary to retain or restore the road to the approved road management objective

Sanitation ~ The removal of damaged or susceptible trees, essentially to prevent the spread of insects or disease; an improvement cut

Scoping ~ The process used to identify the scope of issues to be addressed and to determine the significant issues related to a proposed action

Sediment ~ Soil particles in water. Suspended sediment consists of small soil particles carried along by the water's turbulent flow

Silviculture ~ The art and science of growing and tending forest vegetation. It includes controlling the establishment, composition, and growth of forests for specific management goals

Silviculture Prescription ~ A site-specific operational plan that describes the forest management objectives for an area. It prescribes the method for harvesting the existing forest stand, and a series of silviculture treatments that will be carried out to establish a free growing stand in a manner that accommodates other resource values as identified

Site Potential Tree Height ~ The average maximum height of the tallest dominant trees (200 years or older) for a given site class

Skyline Yarding System ~ Moving logs from the stump to the landing either partially or fully suspended by a cable

Snag ~ A standing dead tree

Social Analysis ~ Analysis that uses social science information to determine how proposed actions would affect humans

Soil Porosity ~ State of having pores or holes in the soil that hold air or water; permeability

Soil Productivity ~ The capability of a soil to produce a specific crop such as fiber, forage, etc., under defined levels of management

Stand ~ A community of trees or other vegetation uniform in composition, constitution, age, spatial arrangement, or condition to be distinguishable from adjacent communities

Stand Density Index (SDI): A relative measure of the amount of stocking on a forest area. Often described in terms of stems per acre

Standard and Guideline ~ A principle requiring a specific level of attainment, a rule to measure against

Stocking ~ The degree to which trees occupy the land, measured by BA and/or number of trees by size and spacing, compared with a stocking standard; that is, the BA and/or number of trees required to fully utilize the land's growth potential. Where tree growth is inhibited due to competition from too many trees, the site is said to be overstocked

Stocking Control ~ See thinning

Suppression Forces ~ Resources used to fight a fire, consisting of firefighters with hand tools at a minimum; may also include fire engines and bulldozers, helicopters and tanker planes

Suppressed Trees ~ Smaller trees in the lower canopy layer

Surface Fire ~ Fire that remains on the forest floor because the combination of fire intensity and ladder fuels is not sufficient to move it into the tree crowns. Only surface fuels and small vegetation are burned

Surface Fuels ~ Loose combustible material on the soil surface, consisting of fallen leaves, twigs, bark, and small branches, as well as grasses, small plants, seedlings trees, dead branches, and logs

Thinning ~ Removing trees from a stand to redistribute the growth potential or to benefit the quality of the residual stand

Threatened Species ~ Any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range

Torching ~ Ignition and subsequent flare-up of a fire, usually burning from the bottom to the top of a tree or small group of trees

Tree Crown ~ Leafy portion

Turbidity ~ Deposition of substrate material suspended in water

Understory ~ Vegetation (trees or shrubs) growing under the canopy formed by taller trees.

Variable Density Thinning ~ A thinning treatment that results in an irregularly distributed and unevenly stocked stand. Conditions range from widely spaced (40'–60') trees (those being cultured for large tree attributes) to no-thin areas with dense thickets of trees. Between these extremes, the remaining stand is thinned with variations according to tree species, crown position, tree attributes, slope position, aspect and elevation

Velvet Top Fungus ~ Fungi of the species *Phaeolus schweinitzii* t attack heartwood in living trees and are one of the most common root- and butt-rotting fungi. Many conifer species in North America and throughout Eurasia are susceptible. Typically, a tree becomes infected when a spore enters at a wound.

Vertical Fuels ~ Standing vegetation, either live or dead.

Watershed ~ The entire land area that drains to a specific point

- **5th field watershed:** A watershed that ranges from about 40,000 to 250,000 acres in size
- **6th field watershed:** A watershed that ranges from about 10,000 to 40,000 acres in size
- **7th field watershed:** A watershed or drainage that ranges from about 2,500 to 10,000 acres in size

Water Repellency (for soils) ~ Loss of soil porosity, preventing water from infiltrating and causing water to run off

Watershed Analysis ~ Watershed analysis is a systematic procedure for characterizing watershed and ecological processes to meet specific management and social objectives

Western Oak Bark Beetles ~ Insects of the species *Pseudopityphthorus pubipennis* are native to California and other parts of the western United States and attack stressed, dying, and recently dead trees, often those infected by the sudden oak death pathogen. Soon after bleeding or seeping on the surface of the main tree stem appears due to sudden oak death infection, oak bark beetles aggregate and attack the tree close to the bleeding sites.

Wet Weather Operations Standards ~ Specific information used to help determine when activities are at risk of not meeting BMPs. The guidelines are used to determine if conditions are favorable for wet weather or winter operations, and to provide guidance as to when conditions

warrant suspension of operations, when operations may begin or resume, or when and what remedy may be appropriate.

White Pine Blister Rust ~ A non-native rust fungus of the species *Cronartium ribicola*. The disease is often most severe following years with extended, cool, moist conditions during late summer and early fall. Infections of pine, typically in young trees, are not consistent from year to year, but occur in "wave years," when weather is ideal.

4.5 Index

A

Aquatic Conservation Strategy, 3, 9, 12, 20, 21, 22, 43, 47, 131, 138, 146, 149, 152, 154, 292, 294, 310, 370, 371
Archaeological Sites, 269, 272, 273, 274, 275

B

Best Management Practices, 21, 37, 38, 291, 292, 294, 376

C

Climate Change, 67, 275, 276, 292
Consultation, 1, 4, 5, 281
Cumulative Watershed Effects, 12, 154, 291, 295

F

Forest Plan, viii, 1, 2, 6, 8, 9, 11, 12, 16, 20, 22, 27, 30, 33, 34, 49, 50, 51, 59, 61, 62, 66, 96, 108, 112, 131, 134, 135, 138, 146, 149, 152, 154, 166, 167, 168, 172, 179, 183, 184, 186, 199, 200, 207, 209, 211, 212, 213, 234, 235, 243, 244, 252, 258, 259, 260, 262, 264, 267, 292, 297, 310, 319, 327, 378

K

Klamath National Forest Plan, 2, 240, 252

L

Late-Successional Reserve, 6, 8, 28, 290
Logging Systems, 19, 29, 245, 288, 326, 366

M

Matrix, 2, 300

P

Project Design Features, 37, 39
Public Involvement, 11

R

Riparian Reserves, 2, 3, 6, 7, 9, 10, 12, 16, 17, 19, 20, 21, 22, 27, 28, 29, 33, 40, 41, 42, 43, 44, 47, 48, 50, 106, 135, 139, 141, 146, 150, 154, 159, 160, 162, 163, 165, 166, 181, 187, 191, 301, 308, 364, 370, 376, 377, 379, 380, 381
Roadless Area, 5, 6, 66, 261, 291

S

Scoping, 302, 306

T

Thinning, 8, 15, 16, 17, 18, 19, 27, 28, 29, 33, 50, 51, 60, 61, 75, 96, 97, 99, 100, 102, 103, 104, 105, 108, 141, 147, 158, 160, 171, 173, 176, 178, 192, 221, 225, 228, 232, 233, 235, 239, 240, 241, 242, 262, 263, 272, 303, 313, 315, 316, 330, 378

U

Underburning, viii, 13, 16, 21, 22, 27, 29, 30, 33, 34, 40, 45, 46, 58, 61, 75, 103, 104, 105, 106, 107, 120, 123, 142, 148, 149, 150, 152, 160, 164, 165, 166, 174, 178, 197, 205, 206, 213, 220, 226, 228, 229, 232, 236, 239, 241, 242, 254, 255, 262, 266, 271, 272, 274, 278, 322, 330, 390

V

Visual Quality Objectives, 66, 258, 259, 261, 262, 265, 266

Appendix A – Public Scoping Comments and Responses

Table 72. Scoping Comment Disposition

Comment	Commenter	Concern[1]	Disposition
Economics			
Using restrictive limited operating periods (LOPS) will result in increased logging costs and difficulties in implementing the project. Please limit the use of LOPs.	1	Non-significant Issue	Limited operating periods are developed based on project-specific mitigation measures/project design to minimize impacts to resources and to meet the standards and guidelines in the forest plan. However, the USFS recognizes that LOP's can have an impact on the feasibility of implementing the project and makes every effort to ensure that LOPs are used only when necessary. For example, the USFS conducts owl surveys prior to project implementation to ensure that the best available information is used for the project and avoids use of "default" LOPs.
Conduct a thorough economic analysis in order to make the project viable. Take recent cost increases and lumber price decreases into account	1	Procedural concern	Economic analysis is an important part of the analysis for this project. See Chapter 3 of the DEIS.
Do not implement the project until lumber prices rise. It is better to leave trees on site until market improves than to sell at bottom price	4	Procedural concern	Economic analysis is an important part of the analysis for this project. See Chapter 3 of the DEIS. The USFS agrees that the current economic situation can have an impact on the viability of the sale and intends to take this into consideration when preparing the project for implementation. For instance, the USFS would consider how best to combine units for treatment and expects that multiple smaller sales may be necessary.
Ensure logging system viability is considered	1	Procedural concern	See responses above regarding economics

Comment	Commenter	Concern[1]	Disposition
The project should provide the highest amount of revenue back to the local economy	1	Significant Issue	While economics is an important aspect of the project that is evaluated in detail in the DEIS (see Chapter 3), the USFS agrees that an alternative that would maximize harvest in order to ensure financial viability, has merit worthy of consideration. This alternative was initially considered by the IDT (see Chapter 2, Alternatives for more details and a description of the **Maximize Harvest alternative)** but then dismissed from further detailed analysis for the reasons described, although one component of it was added to all action alternatives.
I will buy the 10-15 snags along property line in Section 16, one mile north of Poker Flat, if you intend to sell them	8	Suggestion/comment	Thank you for your interest in bidding on individual components of the project. The USFS may contact you regarding this aspect of the project at a later date.
Hand piling is expensive and can lead to a nonviable project. Use this as a last resort	1	Suggestion/comment	Most units would be whole tree yarded or machine piled. Hand piling is proposed only for limited situations as a project design feature to minimize impact from other slash treatments to a sensitive resource. The cost of this treatment would be factored into the overall project cost during the economic analysis
If the project shrinks in size, it can have an adverse, cumulative impact to the local industry infrastructure and the ability to accomplish future land management objectives	1	**Significant Issue - Economics**	While economics is an important aspect of the project that will be evaluated in detail in the DEIS (see Chapter 3), the USFS agrees that an alternative that would maximize harvest in order to ensure financial viability, has merit worthy of consideration. This alternative was initially considered by the IDT (see Chapter 2, Alternatives for more details and a description of the **Maximize Harvest alternative)** but then dismissed from further detailed analysis for the reasons described, although one component of it

Comment	Commenter	Concern[1]	Disposition
			was added to all action alternatives.
Providing a programmed flow of timber products would be out of the ordinary for the Klamath, considering the last 10 years. The few remaining timber companies may not be prepared to react to available product.	10	Non-significant issue	The USFS agrees that there is currently a limited local infrastructure to respond to a large sale. Currently, mills within the Klamath working circle are able to process logs from the smaller, contemporary Klamath National Forest program.
Implementation			
Please add me to your bid list for the road work, meadow restoration, and natural stand thinning	8	Suggestion	Thank you for your interest in bidding on this project. Please contact the Forest Supervisor's Office to be put on the timber sale bidder's list
Ensure USFS staff and contractors for this project work closely so that water quality protection measures are followed during implementation	9	Procedural concern	The USFS agrees in the importance of ensuring all project design features and best management practices developed for this project are implemented correctly. Adherence to these measures is a part of any contract and is legally binding.
Ensure landings are large enough for whole tree yarding, if this is proposed	1	Procedural concern	The USFS will ensure that all landings are of appropriate size for the type of use during project design and implementation
Water Quality, Riparian Reserves & Fisheries			
The project may qualify for a waiver under the Categorical Waiver for Discharges Related to Timber Activities on Federal Lands Managed by the USDA, USFS, in the North Coast Region, if eligibility requirements are met	9	Procedural concern	The USFS will work with the North Coast Water Quality Control Board on the eligibility of this project for a waiver
Ensure a cumulative watershed effects analysis is done and design the project to reduce impacts below the threshold of concern	9	Procedural concern	The USFS agrees that a cumulative watershed effects analysis is an important step in determining the potential for impact to water quality and fisheries. This will be conducted as part of this project and discussed in Chapter 3 of the DEIS. If analysis determines that project effects would exceed thresholds, further analysis will be conducted to address site-specific reasons for exceeding, and project

Comment	Commenter	Concern[1]	Disposition
			magnitude or project design may be modified. See also disposition of comment below.
Water quality can be adversely impacted by the proposed action. Consider mitigation measures such as installation of critical dips, replacement of undersized culverts, and application of erosion control measures in actively eroding or unstable areas	9	**Significant Issue – Water Quality, Fisheries and Cumulative Watershed Impacts**	The USFS agrees that implementing best management practices is an important step in minimizing the potential for adverse impacts to water quality and fisheries, and this is part of the proposed action, as described in Chapter 2 and portions of Chapter 3 in the DEIS. If analysis determines that project effects would exceed thresholds, further analysis will be conducted to address site-specific reasons for exceeding, and project magnitude or project design may be modified. While project design features are a part of the proposed action to ensure watershed effects are minimized, the USFS has also developed an additional alternative that would minimize new road construction and tractor logging in riparian reserves. See Chapter 2, Alternatives for more details and a description of the **No New Temporary Roads Alternative**
Include best management practices in the EIS and specifically include discussion of wet weather operations, activities in riparian reserves, road maintenance, erosion control measures, evaluation of treatments in unstable areas and measures designed to minimize adverse cumulative effects	9	Procedural concern	See responses above regarding best management practices and creation of an additional alternative
Ensure the project is designed and implemented so that it provides protection and recovery for coho salmon, Chinook salmon and steelhead trout	9	**Significant Issue – Water Quality, Fisheries and Cumulative Watershed Impacts**	The USFS agrees that protection of habitat for coho salmon, Chinook salmon and steelhead trout is important and this is incorporated into the best management practices and project design features of the proposed action. However, as this concern relates to watershed effects, please see response above regarding the development of an additional alternative

Comment	Commenter	Concern[1]	Disposition
Proposed actions could result in a decrease in stream shading that can result in increased water temperature that can harm water quality. Ensure that shading is not reduced on any streams	9	**Significant Issue – Water Quality, Fisheries and Cumulative Watershed Impacts**	The USFS recognizes the importance of shading on the temperature of water within important habitats for sensitive fisheries. While stream shading impacts are not expected on any perennial streams, as described in Chapter 3 of the DEIS, this important habitat component will be tracked through the analysis. The Klamath River and all of its tributaries, including Indian Creek, are 303d listed as impaired for water temperature, nutrients and dissolved oxygen.
Road construction and yarding activities in riparian reserves violates the Aquatic Conservation Strategy of the Northwest Forest Plan and the Basin Plan	2	Procedural concern	All action alternatives will be analyzed, and modified as necessary, to ensure that all ACS objectives can be met. The USFS recognizes that these activities can be detrimental to water quality and fisheries if not implemented correctly. Best management practices have been developed to ensure any activities proposed are consistent with the standards and guidelines in these guiding documents. The USFS has also developed additional alternatives that limit certain types of treatments in riparian reserves. See Chapter 2 in the DEIS.
The EIS should disclose a comprehensive cumulative effects analysis	2	Procedural concern	The USFS agrees that a cumulative watershed effects analysis is an important step in determining the potential for impact to water quality and fisheries. This will be conducted as part of this project and discussed in Chapter 3 of the DEIS.
Silvicultural Prescriptions & Science			
Identify long-range desired conditions and how long proposed treatments will be effective when developing prescriptions	1	Procedural concern	The USFS agrees that developing long-range desired conditions is important. These are described in Chapter 1 of the DEIS. How effective specific proposed treatments will be in meeting these is

Comment	Commenter	Concern[1]	Disposition
			discussed in detail in Chapter 3 and in the appendices to the DEIS.
Do not use residual canopy cover in designing prescriptions; it will not be effective	1	Procedural concern	Residual canopy cover projections are sometimes made based on prescriptions in order to assist in wildlife and other resource effects analysis, as part of the DEIS. Residual canopy cover is generally not a design feature of a prescription.
Using prescriptions based on a 10-20 year interval will not be effective in meeting your objectives because it is unlikely you will reenter during this period. I suggest you develop prescriptions based on a 30-40 year reentry period at a minimum. This will achieve your objective and make the project more economically viable	1	**Significant Issue - Economics**	The prescriptions for this project are based on a 20-30 year rotation, not a 10-20 year rotation, to minimize the number of re-entries required while also meeting forest plan standards and guidelines for multiple resources. However, the USFS recognizes that a longer re-entry period could result in a more economically viable sale. For this reason, a M**aximize Harvest alternative** has been developed to respond to this issue. See Chapter 2 of the DEIS for more details.
Do not set diameter limits; they have no silvicultural merit and do not support your purpose and need.	1	Non-significant issue	The USFS recognizes that using diameter limits is not always successful in meeting a specific objective for a particular stand. However, the USFS contends that using a diameter limit, as one of several tools, can be an appropriate way to develop a prescription. Diameter limits are sometimes used in developing a prescription for a certain stand to achieve other objectives or to ensure sensitive species or other resource requirements are met. It is not likely that diameter limits would be used as a tool to develop prescriptions for the Two Bit project, except in the few stands within Late Successional Reserves.
Logging will not decrease mistletoe in a stand but will actually increase it and can result in increased mortality of remaining overstory trees	2	Non-significant issue	Logging is a broad term and could include implementation methods for a variety of silvicultural treatments; some types of

Comment	Commenter	Concern[1]	Disposition
			treatments, such as a seed tree that leaves infected trees, can increase the spread of dwarf mistletoe. The treatment proposed in Unit 237 would include several types of sanitation thinning designed to reduce Douglas-fir mistletoe adjacent to several young plantations or naturally regenerated areas and at least one high-vigor previously thinned mid-seral stand. Treatment designs would consider long established practices for managing stands with mistletoe in Douglas-fir. Assistance from our Northern Service Area Pathologist would be requested as needed. The entire 36 acres within the proposed unit would not be treated; focus would be along stand boundaries where spread of mistletoe could be reduced to meet management objectives within this stand, which is within MA-17 -General Forest. The vigor of the mistletoe is directly influenced by the vigor of the host tree so mistletoe growth may increase in infected trees when they are thinned. However, there is evidence that trees with increased vigor from thinning can often grow fast enough to keep ahead of the spreading mistletoe and remain vigorous during the management period. This treatment would not include thinning of entire stands of trees.

Comment	Commenter	Concern[1]	Disposition
The EIS should address the scientific literature regarding mistletoe. The presence of dwarf mistletoe is often beneficial to ecosystems.	2	Procedural concern	The USFS agrees that endemic levels of dwarf mistletoe in an ecosystem have a variety of benefits, including providing nesting substrates for spotted owls, among other species. The proposed treatment of some Douglas fir trees with dwarf mistletoe within 36 acres within a 67,000 acre analysis area is not intended to rid the ecosystem of dwarf mistletoe; only to reduce the risk of infection to regeneration and to one uninfected stand in this particular area. Literature has been reviewed concerning beneficial effects and would be considered when designing final management strategies for this area. However, with mistletoe infections in Douglas-fir on National Forests reported to be from 13% to 50% of trees, this small treatment area and other stands in the project where a few infected trees may be removed, will have an undetectable effect on the amount of mistletoe available in the ecosystem. We have presently chosen to manage this small area in the MA-General Forest to reduce mistletoe to protect plantations and stands with few infections at this time. A summary of the scientific literature related to dwarf mistletoe is provided at the end of this table[1].
Thinning a mere 36 acres will not slow the spread of dwarf mistletoe already rampant on the Klamath National Forest. Regular thinnings over large acreages would be necessary to control a forest disease.	10	Non-significant issue	The purpose of the proposed action in Unit 237 is to reduce the presence of dwarf mistletoe in this small area and not to control the disease across the forest. Removal of infected trees is planned mainly to reduce new infections in several small plantations and in one healthy natural stand.

Comment	Commenter	Concern[1]	Disposition
Treating stands may result in pest and disease problems (such as root rot) by creating simplified forests	2	Non-significant issue	This project primarily includes thinning of plantations and a lesser extent natural stands, most of which have had some previous harvest. Treatments would likely increase diversity by opening stands to where they are not in the stem exclusion phase and species other than the dominant conifer species could populate a portion of the stands. In natural stands, treatments would remove smaller trees in the lower layers and a portion of the codominant trees in the main canopy, but the major components of the stand would remain. Most stands in the project do not have a high incident of root disease, but measures would be taken to not increase root disease. For example, true fir stumps would be treated with a borax compound to prevent the spread of *H.annosum*. To discourage Douglas-fir black stain root disease, soil compaction wouldl be minimized by monitoring soil moisture and skid trail use during treatments and spacing would be relatively wide to minimize root stress and root grafting. Tree wounding, which can allow infection to enter through the cambium, wouldl be minimized by yarding design and appropriate oversight by sale administrators. One of the recommended management techniques for several root diseases, some that affect Douglas-fir, is to improve the host tree vigor (Fillip 1990). One way to do this is to reduce competition by thinning while taking precautions not to produce conditions that could exacerbate a situation where root disease is already present. With knowledge of these potential risks, prudent silvicultural treatment can be implemented to minimize

Comment	Commenter	Concern[1]	Disposition
			potential unwanted consequences during stand management treatments (Fettig 2006, Filip 1990). Stand composition is important for minimizing future pest damage, including root disease. The thinning in the proposed stands is designed to maintain a relatively diverse stand composition or move the stand towards a resilient mix of species. The later would include increasing the amount of Douglas fir in a planted ponderosa pine stand, maintaining minor species, decreasing white fir in lower elevations, and maintaining hardwoods.
The EIS should address the scientific controversy regarding logging's effects on insects and diseases. Disease and insect problems may be worse in managed stands than in natural stands	2	Procedural concern	The EIS will consider relevant information for the project including information contained in the Scott Black report for the Xerces Society.
Thinning weeping spruce will result in adverse impacts to weeping spruce. Protect these populations from treatment	4	Non-significant issue	Additional site review will be done for stands that contain weeping spruce and most likely, project design features will be developed to maintain weeping spruce within existing stands during thinning or underburning.
Weeping spruce seed and western white pine seed should be collected to mitigate possible loss	4	Non-significant issue	Planned treatments would not eliminate the species or the seed source from the project area. For underburns, burn plans would be developed so that objectives including soil cover and tree scorch could be managed; burning would not be done during periods when it is too dry to meet resource objectives. Areas with substantially different aspects and elevations would generally be broken into separate burns and accomplished at times when the burn plan criteria could be met. It is correct that there is variation in intensities within large underburns. Additional design measures for the project, including underburning

Comment	Commenter	Concern[1]	Disposition
			would provide better management and enhancement of the species and will be researched. The District has seed collected for weeping spruce in the Indian Creek Watershed stored from past collections, although planting of this species has not been done since the early 1990's. Analyzing for collection of seed for genetic conservation is beyond the scope of this project. However, the District supports the need to maintain seed from these important species.
Treatments in western white pine stands will result in increased susceptibility to blister rust and other diseases. Protect seed-producing and young reproduction.	4	Non-significant issue	Thinning prescriptions would include components to maintain western white pine (WWP) within treatment areas similar to that included for sugar pine. Design features would likely include some "free" thinning around WWP to reduce competition stress on healthy individuals. There are no substantial stands of WWP within the treatment area but rather consist of small groups and individuals. WWP occurs most often in cold air drainages and glacial circs generally at higher elevation, although in colder areas, trees appear lower on the slopes. The cooler environmental conditions will facilitate, in some areas, protection of groups of trees. Areas that have WWP or WPP regeneration as a significant component would be excluded from underburns or parameters developed for prescribed fire would be used to reduce the risk of damage to WWP.
Enhance sugar pine stands in prescriptions	4	Non-significant issue?	The silvicultural prescriptions would follow Regional guidelines to maintain sugar pine within treatment stands. Discussions with the Forest genetic staff would occur concerning the treatment of sugar pine.

Comment	Commenter	Concern[1]	Disposition
			Prescriptions would include free thinning around some of the best individual trees to reduce competition and risk pine beetle attack, and overall thinning would provide more growing space for these pines. Sugar pine would not be planned for removal except in some specific cases: (1) the trees are suppressed or have less than 30% crown ratio and show extensive blister rust and have other signs that there is imminent mortality; (2) there are groups/clumps of sugar pine over a sustainable stocking level for sugar pine (measured locally by BA) where the smaller sugar pine in the group will be removed until the remaining stocking is below a level where the pine is at risk to pine beetle, and (3) scattered sugar pine with blister rust and other damage in stands with a high percentage of sugar pine where over the long term, the trees would be shaded out of the stands by larger conifers. Many sugar pine showing signs of blister rust would be retained within thinning stands.
Historic conditions are not clearly defined. Historic conditions should more accurately include green tree removal and selection treatments that are more similar to treatments done 50 years ago, not commercial thinning.	10	Procedural concern	Historic conditions are more thoroughly described in the DEIS in Chapter 1. Historic conditions used for the analysis are conditions present before European-American settlement.
Roads			
Using long skid trails will result in more environmental impacts than creating temporary roads to access treatment areas. Consider developing an adequate road system to effectively and efficiently harvest timber for this project.	1	Non-significant issue	The USFS agrees that an adequate road system is necessary to effectively harvest timber for this project and proposes this as part of the proposed action. The USFS also recognizes that roads can have negative impacts to resources and so intends to minimize the level of new road construction

Comment	Commenter	Concern[1]	Disposition
			to the lowest level necessary while still meeting the purpose and need for the project.
Construction of new, temporary roads will result in long-term adverse impacts to soil health and hydrology. Road construction, use and maintenance in the Indian Creek Watershed are causing watershed degradation. Consider an alternative to road construction	2	**Significant issue – Water Quality, Fisheries and Cumulative Watershed Impacts**	The USFS recognizes that roads can have negative impacts to water quality, fisheries and overall soil health in a watershed. While project design features are a part of the proposed action to ensure watershed effects are minimized, the USFS has also developed an additional alternative that would minimize new road construction and tractor logging in riparian reserves. See Chapter 2, Alternatives for more details and a description of the **Minimize New Temporary Roads and No New Road Construction alternatives.**
Decommissioning roads in the watershed does not justify the creation of new ones. Creating new ones will result in adverse impacts.	4, 5	**Significant issue – Water Quality, Fisheries and Cumulative Watershed Impacts**	See responses above. The USFS contends that any road decommissioning is a positive step to take in the Indian Creek Watershed. The level of road decommissioning and the level of temporary road construction are both factors evaluated as part of the cumulative watershed effects modeling and are described in Chapter 3 of the DEIS.
Additional road construction in the Indian Creek Watershed will result in adverse cumulative impacts to aquatic health	2, 5	**Significant issue – Water Quality, Fisheries and Cumulative Watershed Impacts**	See responses above.
The proposed action will result in adverse impacts to the road system and sediment contributions. Ensure road maintenance and closure is funded and made part of the project	4	Non-significant issue	Temporary road construction is funded by the sale, as well as the closing and restoration of hydrologic function to the roads that were used as part of the sale. However, road decommissioning is funded by watershed restoration funds, separate from the timber sale
The EIS should address and avoid the harmful impacts of road construction on ecosystems	2, 5	Procedural concern	The DEIS includes an evaluation of the effects of temporary road construction, as

Comment	Commenter	Concern[1]	Disposition
			part of Alternatives 2 and 4. Alternative 3 would not construct any new temporary roads, forming the basis for comparison in Chapter 3, including that using the results of the cumulative watershed effects analysis.
The EIS should reflect the Medford BLM analysis of road impacts on edge effects and microclimatic changes shown in the Ashland Resource Area	2	Procedural concern	The small amount of temporary road construction proposed would have minimal impact to species and habitat. Because of the amount of road decommissioning compared to temporary road construction, there would be a net decrease in open roads. Therefore, the effects of disturbance to wildlife from vehicles traveling on roads would be reduced. All temporary roads would be barricaded and hydrologically restored to allow natural revegetation to occur within several years following project completion, thus further reducing negative impacts to wildlife.
Consider decreasing road density even further in the project area to be consistent with the Forest Plan.	2	**Significant issue – Water Quality, Fisheries and Cumulative Watershed Impacts**	The action alternatives analyzed in detail as described in Chapter 2 have an additional road segment proposed for decommissioning for a total of approximately 4.5 miles of decommissioning. See also responses above regarding the creation of an alternative that does not create any new temporary roads.
Road construction and log haul routes may contribute to the spread of *p. lateris* and may adversely effect Port Orford Cedar and Pacific Yew	2, 5	Non-significant issue	Project design features have been developed to minimize the likelihood of adverse impacts to Port Ortford Cedar and Pacific Yew. See Chapter 2 in the DEIS
Prescribed Burning, Smoke and Air Quality			
Use fire crews to accomplish project objectives without burning	4	Procedural concern	The USFS agrees that some project objectives can be met without the use of prescribed fire and that this is part of the proposed action (pile burning at landings,

Comment	Commenter	Concern[1]	Disposition
			for example). The USFS disagrees that all project objectives could be met without some level of prescribed burning. Prescribed burning and other slash treatment methods are part of all alternatives considered, to varying degrees. See Chapter 2 of the DEIS
Analysis should disclose the amount of carbon emissions expected	1, 4	Procedural concern	The air quality analysis shows projected levels of carbon emissions from alternatives. See Chapter 3 of the DEIS. The Northern Plateau Air Basin Air Pollution Control District monitors (or estimate) carbon emissions for the air basin. The Air Pollution Control District takes this information taken into consideration when determining 'burn days' and coordination with Forest Burn Plans be sure the air quality in the air basin adheres to air quality standards.

Comment	Commenter	Concern[1]	Disposition
Analysis should discuss the feasibility of actually being able to implement the prescribed burning in timely and efficient manner	1	Procedural concern	Prescribed burning would be implemented as time and funding allows, over the course of an approximate ten year period, prioritized by treatment areas and with other on-going USFS project work. The USFS expects burning to be conducted in a timely and efficient manner, with the above caveats. However, the USFS also acknowledges that a substantial amount of prescribed burning is proposed and that it may be difficult to achieve, particularly that which is proposed outside of treatment units, within a 10 year period, considering all other projects on-going or planned on the district. As described in more detail below, an alternative that limits underburning to just thinned units is a component of Alternative 4 and Alternative 3 has a reduced level of underburning compared to the original proposal. See Chapter 2 of the DEIS.
Broadcast burning may adversely impact the area around the green gate swimming hole. Please do not burn this area and use hand piling or chipping instead	4	Non-significant issue	This area is in the Underburn Unit 4 and creating an unburned buffer around this swimming hole is a component of all action alternatives.
Proposed prescribed burning is too large and unmanageable and will result in fires getting out of control	4	Non-significant issue	The USFS recognizes that the original proposal of 8,600 acres of underburning would be difficult to accomplish in a timely fashion, but disagrees that it is essentially unmanageable. Underburns were designed to provide flexibility in implementation to break up fuel continuity and take advantage of existing roads and topography to reduce the need for line construction. The large areas allow the District a choice for different seasonal burning windows within those boundaries. None of the large underburns is planned to be completed in a single time period.

Comment	Commenter	Concern[1]	Disposition
			However, the USFS recognizes that managing a prescribed burn is not always exact and that a variety of factors can play a role in the success of a burn and whether a managed burn goes out of prescription. The USFS will follow all agency protocols and protective measures when conducting any prescribed burning to ensure the safety of fire fighters, the protection of life and property, and meeting project objectives. To respond to issues regarding air quality and the feasibility of implementing a high level of prescribed burning as part of this project, however, the USFS developed alternatives with varying levels of undeburning, as described in Chapter 2 of the DEIS..
It is important to be successful with burning for this project to regain the trust of the local community	4	Suggestion	The USFS acknowledges that the local community is affected by actions near Happy Camp and in proximity to private residences. See response above.
Comply with air quality standards for burning	4	Procedural concern	Compliance with state air quality standards is a routine procedure that the USFS implements prior to initiating any prescribed burn. A permit is required from the state before a burn is ignited.
Carbon dioxide emissions should be monitored and constrained	4	Procedural concern	The air quality analysis discusses carbon dioxide emissions
Underburning will result in adverse impacts to weeping spruce, a species that is not fire-adapted and could result in cumulative impacts since some were lost to wildfire last year. Protect the population near 18N33D.	4	Non-significant issue	A design feature has been added to the alternatives that includes establishing a no-burn buffer around this population in Underburn Unit 2.
The level of prescribed burning will result in unwanted smoke impacts, particularly to those that live along Indian Creek and other nearby areas	Public meeting	**Significant Issue – Air Quality and Amount of Prescribed Burning**	The USFS agrees that smoke from prescribed burning can sometimes be heavy and can affect residents and others living in proximity to burn operations. While these are short-term impacts that dissipate

Comment	Commenter	Concern[1]	Disposition
			over time, the USFS recognizes that these adverse impacts should be minimized when possible. Burning only when a permit has been issued from the state is one way to ensure effects from smoke are minimized. This is a standard design feature of the proposed action. See Chapter 2 of the EIS. However, the USFS has also developed an alternative that limits the extent of prescribed burning. See Chapter 2 of the DEIS. However, it should be recognized that smoke with low-intensity prescribed burning is much less than that generated from a high-intensity wildfire. Performing prescribing burning treatments to reduce fuel loading results in a long-term benefit of less smoke production from a wildfire.
Wildlife			
Address the unique regional wildlife connectivity values provided by the Siskyou Crest in the EIS	2	Procedural concern	Wildlife habitat connectivity is a component of the wildlife resource analyzed for this project. This is summarized in Chapter 3 of the DEIS.
Address the impacts to biological diversity (connectivity, habitat linkages, distribution opportunities)	2	Procedural concern	Biological diversity is a component of the wildlife resource analyzed for this project. . This is summarized in Chapter 3 of the DEIS.
The EIS should disclose the impacts of the project on Management Indicator Species including population numbers, locations and trends and that snag-dependent species be monitored and surveyed for	2	Procedural concern	Management indicator species is a component of the wildlife resource analyzed for this project. . This is summarized in Chapter 3 of the DEIS.
The EIS should include surveys and evaluation of effects to American Martins, eagles, deer and black bear and avoid adverse impacts as much as possible	5	Procedural concern	Wildlife species with the potential to be affected by project implementation is a component of the wildlife resource analyzed for this project. This is summarized in Chapter 3 of the DEIS.
The EIS should address the project impacts on the	2, 5	Procedural concern	Wildlife species with the potential to be

Comment	Commenter	Concern[1]	Disposition
Pacific fisher			affected by project implementation is a component of the wildlife resource analyzed for this project. . This is summarized in Chapter 3 of the DEIS.
Avoid actions that will remove or downgrade habitat suitable habitat for the Northern spotted owl	2, 5	Non-significant issue	Minimal or no downgrading of suitable nesting/roosting habitat is expected, although some downgrading of foraging habitat is possible. The USFS is working closely with the US Fish and Wildlife Service to ensure the Two Bit project follows all interim guidelines. Overall, the Two Bit project is expected to have minimal effect on suitable Northern Spotted Owl habitat. See Chapter 3 of the DEIS.
The EIS should outline the effects of alternatives on game habitat, particularly deer, black bear, Roosevelt elk, grey squirrel, mountain quail, blue grouse, ruffed grouse, and turkey	6	Procedural concern	Game species with the potential to be affected by project implementation is a component of the wildlife resource analyzed for this project. . This is summarized in Chapter 3 of the DEIS.
The EIS should disclose the timing, results and influence of wildlife and plant surveys on the project. Do not rely on the 2007 Record of Decision that eliminates the survey and manage program	2	Procedural concern	Wildlife and plant surveys conducted as part of this project are summarized or referenced in the Wildllife Specialist Report for this project and referenced in Chapter 3 of the DEIS.
The EIS should disclose the number and location of snags that will be felled and consider limiting snag removal as much as possible	2, 5	Non-significant issue	Snags would only be removed if they pose a safety threat during operations. See project design features in Chapter 2 of the DEIS
Suggested Alternatives or Alternative Components			
Consider a “Citizens Alternative” to influence project layout and implementation. This alternative includes using only the existing road system and previous skid trails, no treatment in natural stands in T19E, R6E sections 34-35, post-harvest prescribed fire, underburning, riparian reserves are treated only with hand-work, helicopter yarding or using existing skid trails, and road densities reduced	2	**Alternative**	This alternative was considered. See Chapter 2 of the DEIS for details.
Remove the fence around Sutcliffe Douglas Fir Test	4	Non-significant issue	This suggestion is outside the scope of the

Comment	Commenter	Concern[1]	Disposition
in Underburn Unit 2 to improve wildlife habitat			proposal
Three genetic test areas could be adversely impacted by underburning treatments. These should be protected	4	Non-significant issue	The USFS agrees that these areas should be protected during prescribed burn treatments. This has been added to the project design features for this project. See Chapter 2 for more details.
Inventory sites in Units 90-94 where arsenic compounds were used in the 1970's. Mitigate or restore these areas if arsenic levels warrant	4	Suggestion	An inventory of arsenic levels is outside the scope of the proposal. However, the USFS agrees that an investigation into this issue may be warranted and agrees to look into it, separate from this project.
Honestly evaluate the no action alternative	2	Procedural concern	A detailed evaluation of the no action alternative is a requirement of a Draft Environmental Impact Statement. The no action alternative is described in Chapter 2 and a detailed evaluation is included in Chapter 3 of the DEIS.
Include protection of a spring and waterline near Deadman Point	3, 7	Non-significant issue	The USFS agrees these should be protected during project implementation. A project design feature has been developed. See Chapter 2 of the DEIS.
Using diesel and gasoline as burning mix results in adverse impacts to water quality and air quality. Consider alternatives such as fry oil and alcohol.	4	Non-significant issue	While the USFS agrees that diesel and gasoline have the potential for adverse impacts to water and air quality at certain levels and in certain situations, the USFS disagrees that the limited use proposed for this project would result in substantial adverse impacts. Proper use and disposal of diesel and gasoline is included in project design features in Chapter 2 of the DEIS and would be included in any subsequent contract. The USFS cannot legally require a purchaser to use an alternative fuel source.
Would use of prescribed fire (rather than logging) accomplish meadow restoration goals?	2	Suggestion/Question	Logging is not proposed in meadows, only removal of small-diameter, sub-merchantable trees and limited prescribed fire.

Comment	Commenter	Concern[1]	Disposition
Consider additional road decommissioning near Port-Orford cedar stands	2, 5	Non-significant issue	This is outside the scope of the proposal
Requests for More Detail			
The EIS should disclose how many hazard trees will be felled, the number and location of trees over 20" dbh that will be removed, location of tractor and cable logging corridors, activities within NSO critical habitat, how survey and manage protocols will be followed, how Siskyou Mountain and Del Norte salamanders will be managed, and the location and functional status of riparian reserves	2, 5	Procedural concern	The DEIS discloses those aspects of the alternatives, relative to the significant issues, that would result in effects to the human environment, including wildlife and plant species. While the DEIS includes a site-specific analysis of the potential impacts to resources from project components, it is not possible to have every detail of project implementation known at the time of the DEIS. Project design features, mitigation measures and monitoring, identified in the DEIS in Chapter 2 and 3 are developed to ensure that any site-specific details not known at the time of DEIS preparation are accounted for during project implementation.
Logging Systems			
Ground-based logging systems, including yarding and landing construction, will result in root damage, scarring of individual trees, and soil damage	2	Non-significant issue	Project design features and best management practices have been developed (see Chapter 2 of the DEIS) to minimize the likelihood of adverse impacts from these activities. Sale administration during implementation also provides additional oversight to ensure these impacts do not occur, or are minimized as much as possible.
Visual Quality			
Leaving visible stumps in meadows will result in adverse impacts to visual quality. Cut or grind stumps flush to soil surface	4	Non-significant issue	Because only small, diameter, sub-merchantable trees would be removed from meadows, and the number of these will be low, any stumps left are not expected to be noticeable to the casual observer. A detailed scenery analysis is a part of the DEIS and is summarized in Chapter 3.

Comment	Commenter	Concern[1]	Disposition
Invasive Species			
Using heavy equipment and intense fire in meadows will result in adverse impacts to this sensitive resource and could result in increases in invasive plants	4	Non-significant issue	Intense fire is not proposed for meadow restoration. Use of heavy equipment would be limited. Project design features and best management practices have been developed to minimize the likelihood of increases in invasive plants. See Chapter 2 of the DEIS.
Establish a monitoring plan for invasive species encroachment as part of this project	4	Non-significant issue	While the USFS agrees that proposed actions have the potential to result in increases in invasive species in some areas, best management practices and project design features have been developed to minimize this as much as possible. Invasive species are the subject of the Botany and Noxious Weed section of Chapter 3 of the DEIS. A Noxious Weed Risk Assessment has been prepared for this project which includes a monitoring component.
Treatment of Natural Stands			
Logging in natural stands will result in soil compaction, tree root damage and potentially more harm than benefit. Carefully consider treatments in riparian reserves, late successional reserves and other natural stands to ensure you are meeting the guidance in the Forest Plan	5	Procedural concern	The USFS agrees that logging can have detrimental impacts. This project is designed to meet the guidance in the forest plan. Best management practices and project design features have been developed to minimize the likelihood of adverse impacts from logging. See Chapter 2 of the DEIS.
Follow the Klamath Forest Plan/Other Guiding Documents			
The NEPA analysis should clearly tie proposed activities to the Forest Plan	1	Procedural concern	Chapter 1 of the DEIS describes the purpose and need for the project and how the project relates to the Forest Plan.
Ensure that the recommendations made in the Indian Creek Watershed Analysis are followed and	2, 5	Procedural concern	The Indian Creek Watershed Analysis was used as a guiding document throughout the

Comment	Commenter	Concern[1]	Disposition
that Forest Plan direction is adhered to			analysis process for this project. How the recommendations of this analysis were used to develop the purpose and need for the project is described in Chapter 1 of the DEIS. In Chapter 3 of the DEIS, watershed effects analysis is summarized.
Ensure the project is designed and implemented to meet the water quality standards outlined in the Basin Plan	9	Procedural concern	The hydrologic analysis for this project includes discussion of how the project meets the standards and guidelines in the Basin Plan. This is summarized in Chapter 3 of the DEIS in the Water Quality and Fisheries section.
Ensure private property owners are aware of the proposal since proposed actions may adversely impact their land	4	Procedural concern	The initial proposed action was included in a scoping letter that was sent to all property owners in the analysis area in February 2009. A public meeting was held on March 4 in Happy Camp to discuss the proposal and hear any concerns or comments.

[1] Dwarf mistletoes are parasites that extract water, nutrients, and carbohydrates from the infected host. Where dwarf mistletoe populations develop significant, long-term infestations, cumulative tree damages have various ecological and evolutionary effects. Depending on management objectives and priorities, these effects are interpreted as positive, negative, or usually of mixed consequences (USDA Forest Service 2002).

Dwarf mistletoes provide forage, foraging sites, protected and special sites, and desirable stand structures for numerous wildlife species including creation of snags. Numerous studies have reported use by birds and mammals for food, nesting, and cover. When considering silvicultural treatments, an evaluation is recommended that considers management objectives and potential ecological impacts and benefits (USDA Forest Service 2002).

Dwarf mistletoes markedly affect the growth, form, and survival of infected trees and therefore how these trees and their stands develop and respond to silvicultural treatments. Effects to trees included: distorted growth from branch and stem infections, changes in wood quality, reduced overall tree growth, increased susceptibility to attack by secondary insects and fungi, and increased mortality. These damages aggregate over time, affecting forest health, sustainability, and productivity (USDA Forest Service 2002). With regard to fire, several features of mistletoe infection

increase the tree's flammability. Infection induces excess resin deposition and increases litter accumulation (including detached brooms). Retained brooms and infected branches form a fuel ladder from the ground into the canopy. Mistletoe severity (Dwarf Mistletoe rating (DMR)) is related to scorching, mortality, and sanitation (USDA Forest Service 2002). Fire exclusion policies of the last century have increased both infection levels and fire hazard (Alexander 1976)

Several biological and ecological features make dwarf mistletoes especially amenable to silvicultural treatment. Mistletoes are generally host specific so retaining immune or less susceptible host trees can reduce mistletoe spread. Numerous infections are required to cause serious damage and the effects accumulate slowly. Seed dispersal is limited to about 30 to 50 feet and the amount of seed is limited. Mistletoe infections typically begins in the lower trees crown and vertical spread is slow enough that trees with rapid height growth can outgrow or at least keep pace with mistletoe intensification (USDA Forest Service 2002). Greater crown closure does result in reduced light within the canopy which reduces the mistletoe reproduction and increases shading out (death) of lower infected branches reducing infections. Seed dispersal within the stand is also reduced in dense stands because seeds are intercepted close to the infected tree.

In the Two Bit project within stands identified for thinning and most of the stands identified for underburning, mistletoe infection is generally absent or light with only a few groups or patches of trees heavily impacted. Dwarf mistletoes that occur most often in the project area are Douglas-fir dwarf mistletoe (Arceuthobium douglasii) and white fir dwarf mistletoe (Arceuthobium abietinum); red fir dwarf mistletoe (A. abietinum f. sp. magnificae) is common in red fir stands in the Two Bit project area, but none of these stands are planned for entry in this project. Units 237 and 300 are within regulated lands and include more concentrated infections of Douglas-fir mistletoe. Unit 237 was a small regeneration cut where infected overstory trees were left so that the natural Douglas-fir regeneration is being infected. Unit 300 includes some heavily and some lightly infected patches along the road where spread could be slowed into non-diseased stands with removal of individual or small groups of trees. In both cases, some heavily infected older stands in the vicinity would not be treated under this project. The plantations proposed for thinning are nearly all free of mistletoe with the exception of a few residual Douglas-fir, white fir, and occasional incense cedar or pine within or adjacent to plantations. In plantations and natural stands, especially within regulated lands, infected trees would be a priority for removal during thinning consistent with the purpose and need for the Two Bit project.

Appendix B – Treatment Objectives by Thinning Unit

Table 73. Treatment objectives by thinning unit by alternative

Unit	Acres	Riparian Reserve Acres	Management Area	Treatment Objectives	Alt 2 - Proposed Action	Alt 3 – No New Roads	Alt 4 – Minimized Underburning	Similar Stand Structure and Species Composition
1	26	1.1	General Forest/Riparian Reserve	Fire resilient stand managed to grow large trees for future forest products and riparian. Restore large trees and desired vegetation characteristics in riparian. Reduce density to below 55% of max SDI for 20-30 years; DF spacing 28'-30'. Maintain IC.	Thin with mechanical harvester; underburn; pile burn at landings	Not treated	Thin with mechanical Harvester and tractor endlining; masticate fuels	100
2	26	1.8	General Forest/Riparian Reserve	Fire resilient stand with appropriate species for the site. Reduce density of PP to below 35% of max SDI for PP (for 10-20 years) and increase % of DF, spacing on PP 30-35. Restore large trees and desired vegetation characteristics in riparian.	Thin with mechanical harvester and tractor endlining; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester and tractor endlining; underburn; masticate fuels	11
3	12	0	General Forest/Riparian Reserve	Fire resilient stand with appropriate species for the site. Reduce density of PP to below 35% of max SDI for PP (for 20-30 years), spacing on PP 30-35;	Thin with cable logging; underburn	Same as Alt 2	Same as Alt 2	51

Unit	Acres	Riparian Reserve Acres	Management Area	Treatment Objectives	Alt 2 - Proposed Action	Alt 3 – No New Roads	Alt 4 – Minimized Underburning	Similar Stand Structure and Species Composition
				maintain other species within stand. Restore large trees and desired vegetation characteristics in riparian.				
4	14		General Forest/Partial Retention VQO	Fire resilient stand managed to grow large trees for future forest products. Reduce density to below 55% of max SDI for 20-30 years; DF spacing 28'-30', maintain IC and scattered chinkapin by thinning to allow growing space. Harvest and underburning would raise the crown base height.	Thin with conventional log skidder and tractor endlining; underburn; pile burn at landings	Same as Alt 2	Same as Alt 2	48
6	19	10.0	General Forest/Riparian Reserve	Fire resilient stand managed to grow large trees for future forest products. Restore large trees and desired vegetation characteristics in riparian. Reduce % of PP and WF Reduce density to below 55% of max SDI for 20-30 years; DF spacing 28'-30', PP spacing 30-35'. Harvest and underburning would raise the crown base height.	Thin with cable logging; underburn	Same as Alt 2	Same as Alt 2	48

Unit	Acres	Riparian Reserve Acres	Management Area	Treatment Objectives	Alt 2 - Proposed Action	Alt 3 – No New Roads	Alt 4 – Minimized Underburning	Similar Stand Structure and Species Composition
7	20	4.4	General Forest/Riparian Reserve	Similar to Unit 7	Thin with mechanical harvester and tractor endlining; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester and tractor endlining; underburn; masticate fuels	48
8	10	2.0	General Forest/Riparian Reserve	Fire resilient stand managed to grow large trees for future forest products. Restore large trees and desired vegetation characteristics in riparian. RR had historic rare lilies (habitat needed?) Thin to remove PP and WF. Reduce density to below 55% of max SDI for 20-30 years; DF spacing 28'-30', Maintain some clumps of Chinkapin/BLM (12-20" dbh).	Thin with conventional log skidder and tractor endlining; underburn; pile burn at landings	Same as Alt 2	Same as Alt 2	108
9	19	0.3	General Forest/Riparian Reserve	If merchantable, review options for increasing other conifer species and removing additional small PP.	Thin with conventional log skidder and tractor endlining; underburn; pile burn at landings	Same as Alt 2	Same as Alt 2	48
10	22	0.03	General Forest/Riparian Reserve	Fire resilent stand managed to grow large trees for future forest products. Restore large trees and desired vegetation characteristics in riparian. Reduce density	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; masticate fuels	108

Unit	Acres	Riparian Reserve Acres	Management Area	Treatment Objectives	Alt 2 - Proposed Action	Alt 3 – No New Roads	Alt 4 – Minimized Underburning	Similar Stand Structure and Species Composition
				to below 55% of max SDI for 20-30 years; DF spacing 28'-30'.				
11	12	3.8	General Forest/Riparian Reserve	Thin wide to reduce risk of bark beetles.	Thin with conventional log skidder and tractor endlining; underburn; pile burn at landings	Same as Alt 2	Same as Alt 2	11
12	19	10.0	General Forest/Riparian Reserve	Thin wide to reduce risk of bark beetles.	Thin with mechanical harvester and tractor endlining; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester and tractor endlining; underburn; masticate fuels	11
13	15		General Forest	Fire resilient stand managed to grow large trees for future forest products. Maintain large trees and desired vegetation characteristics in riparian. Reduce density to below 55% of max SDI for 20-30 years; DF spacing 28'-30' with some clumps in patches with pre-plantation residuals.	Thin with mechanical harvester and tractor endlining; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester and tractor endlining; underburn; masticate fuels	31

Unit	Acres	Riparian Reserve Acres	Management Area	Treatment Objectives	Alt 2 - Proposed Action	Alt 3 – No New Roads	Alt 4 – Minimized Underburning	Similar Stand Structure and Species Composition
16	7	0.03	General Forest/Riparian Reserve	Fire resilient stand managed to grow large trees for future forest products. Restore large trees and desired vegetation characteristics in riparian. Reduce the % of PP and WF; enhance the presence of IC where there are trees large enough to maintain in the stand.	Thin with mechanical harvester and tractor endlining; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester and tractor endlining; underburn; masticate fuels	48
18	25	4.3	General Forest/Riparian Reserve	Fire resilient stand managed to grow large trees for future forest products. Restore large trees and desired vegetation characteristics in riparian.	Thin with mechanical harvester and tractor endlining; underburn; pile burn at landings	Not treated	Thin with mechanical harvester and tractor endlining; underburn; masticate fuels	110
19	31	11.5	General Forest/Riparian Reserve/Partial Retention VQO	Fire resilient stand managed to grow large trees for future forest products. Restore large trees and desired vegetation characteristics in riparian.	Thin with mechanical harvester and tractor endlining; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester and tractor endlining; underburn; masticate fuels	31
20	31	6.2	General Forest/Riparian Reserve/Partial Retention VQO	Increase % of DF, enhance conditions for BS and POC. Restore large trees and desired vegetation characteristics in riparian.	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; underburn; masticate fuels	11

Unit	Acres	Riparian Reserve Acres	Management Area	Treatment Objectives	Alt 2 - Proposed Action	Alt 3 – No New Roads	Alt 4 – Minimized Underburning	Similar Stand Structure and Species Composition
21	29		General Forest	Reduce PP stocking to below 55% of max SDI for 20-30 years. Increase % of DF and WF. Snow damage in PP in increasing.	Thin with mechanical harvester and tractor endlining; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester and tractor endlining; underburn; masticate fuels	51
22	23	12.0	Port Orford Cedar/Riparian Reserve/Partial Retention VQO	Enhance POC; thin DF that are suppressing the POC regen and larger residuals. Thin suppressed clumps of POC (1-10" dbh) to produce vigorous trees. Around wet area and springs, approx. 100 resistant POC could be planted after thinning. Thin DF to produce large old trees. (Similar to LS/OG portions of POC Mgt area to south. Reduce % of WF.	Thin with conventional log skidder, handwork and tractor endlining; hand pile fuels	Same as Alt 2	Thin with conventional log skidder, handwork and tractor endlining; underburn; hand pile fuels	100
23	16		General Forest	Fire resilient stand managed to grow large trees for future forest products and other values. Reduce density to below 55% of max SDI for 20-30 years; DF spacing 28'-30'. Many small trees.	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; underburn; masticate fuels	31
24	16	0.5	Late Successional Reserve/Port Orford Cedar/Riparian	Enhance POC; thin DF that are suppressing the POC. Thin DF to produce large old trees and LS/OG habitat with the 100-acre	Thin with mechanical harvester and tractor endlining; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester and tractor endlining;	100

Unit	Acres	Riparian Reserve Acres	Management Area	Treatment Objectives	Alt 2 - Proposed Action	Alt 3 – No New Roads	Alt 4 – Minimized Underburning	Similar Stand Structure and Species Composition
			Reserve/Partial Retention VQO	LSR and riparian. In partial retention, thin to produce fire resilient stand managed to grow large trees for future forest products.			underburn; masticate fuels	
26	13	2.4	Riparian Reserve/Partial Retention VQO	Fire resilient stand managed to grow large trees for future forest products. Restore large trees and desired vegetation characteristics in riparian.	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; underburn; masticate fuels	108
27	21	2.1	Riparian Reserve/Partial Retention VQO	Fire resilient stand managed to grow large trees for future forest products. Restore large trees and desired vegetation characteristics in riparian.	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; underburn; masticate fuels	48
28	7	0.2	Riparian Reserve/Partial Retention VQO	Fire resilient stand managed to grow large trees for future forest products. Restore large trees and desired vegetation characteristics in riparian.	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; underburn; masticate fuels	48
29	22	10.0	Riparian Reserve/Partial Retention VQO	Fire resilient stand managed to grow large trees for future forest products. Restore large trees and desired vegetation characteristics	Thin with conventional log skidder and tractor endlining; underburn; pile burn at landings	Same as Alt 2	Same as Alt 2	31

Unit	Acres	Riparian Reserve Acres	Management Area	Treatment Objectives	Alt 2 - Proposed Action	Alt 3 – No New Roads	Alt 4 – Minimized Underburning	Similar Stand Structure and Species Composition
				in riparian.				
30	20	5.3	General Forest/Riparian Reserve/Partial Retention VQO	Fire resilient stand managed to grow large trees for future forest products. Restore large trees and desired vegetation characteristics in riparian.	Thin with mechanical harvester and tractor endlining; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester and tractor endlining; underburn; masticate fuels	11
31	25	7.6	General Forest/Riparian Reserve	Fire resilient stand managed to grow large trees for future forest products. Below road, favor DF and IC and reduce PP. DF IC spacing 30-33. PP spacing 33-35'. Protect scarp and wet area. In RR, increase the % of DF for long term shade.	Thin with conventional log skidder and tractor endlining; underburn; pile burn at landings	Same as Alt 2	Same as Alt 2	31
32	28		General Forest	Fire resilent stand managed to grow large trees for future forest products. DF spacing 28-29.	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; underburn; masticate fuels	108
33	48	4.5	General Forest/Riparian Reserve	Fire resilient stand managed to grow large trees for future forest products. Especially on steeper slopes, there is an option to leave DF spacing at 33-35'; thin wide leaving SDI below 35% so stand would not have another	Thin with mechanical harvester and tractor end lining; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester and tractor endlining; underburn; masticate fuels	33

Unit	Acres	Riparian Reserve Acres	Management Area	Treatment Objectives	Alt 2 - Proposed Action	Alt 3 – No New Roads	Alt 4 – Minimized Underburning	Similar Stand Structure and Species Composition
				intermediate thinning.				
36	45	2.1	General Forest/Riparian Reserve	Fire resilient stand managed to grow large trees for future forest products. Provides reduced fuel hazard for progeny site. Restore large trees and desired vegetation characteristics in riparian.	Thin with conventional log skidder and tractor endlining; underburn; pile burn at landings	No treatment	Same as Alt 2	31
37	23	2.0	General Forest/Riparian Reserve	Fire resilient stand managed to grow large trees for future forest products. Restore large trees and desired vegetation characteristics in riparian.	Thin with mechanical harvester and tractor endlining; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester and tractor endlining; underburn; masticate fuels	31
38	21	0.1	General Forest/Riparian Reserve	Fire resilient stand managed to grow large trees for future forest products. Restore large trees and desired vegetation characteristics in riparian.	Thin with mechanical harvester and tractor endlining; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester and tractor endlining; underburn; masticate fuels	100
40	10		Partial Retention VQO	Fire resilient stand managed to grow large trees for future forest products. Reduce % of WF. Plantation with many trees less than 10” dbh and patches of brush/hardwood, esp. steeper slopes. Denser,	Thin with conventional log skidder and tractor endlining; underburn; pile burn at landings	Same as Alt 2	Same as Alt 2	33

Unit	Acres	Riparian Reserve Acres	Management Area	Treatment Objectives	Alt 2 - Proposed Action	Alt 3 – No New Roads	Alt 4 – Minimized Underburning	Similar Stand Structure and Species Composition
				larger DF concentrated on old temp roads, skids and benches.				
41	27	2.1	General Forest/Riparian Reserve	Maintain POC where possible. Brewer spruce in area, maintain if in Unit. Reduce % of PP & WF, increase DF & IC. Fire resilient stand managed to grow large trees for future forest products. Restore large trees and desired vegetation characteristics in riparian.	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; underburn; masticate fuels	33
42	5	0.7	General Forest/Riparian Reserve	Fire resilient stand managed to grow large trees for future forest products. Restore large trees and desired vegetation characteristics in riparian. Increase % of DF.	Thin with conventional log skidder and tractor endlining; underburn; pile burn at landings	Same as Alt 2	Same as Alt 2	11
43	7	2.5	General Forest/Riparian Reserve	Fire resilient stand managed to grow large trees for future forest products. Restore large trees and desired vegetation characteristics in riparian. Increase % of DF: clumps of PP have snow damage.	Thin with conventional log skidder and tractor endlining; underburn; pile burn at landings	Same as Alt 2	Same as Alt 2	51

Unit	Acres	Riparian Reserve Acres	Management Area	Treatment Objectives	Alt 2 - Proposed Action	Alt 3 – No New Roads	Alt 4 – Minimized Underburning	Similar Stand Structure and Species Composition
46	7	1.9	General Forest/Riparian Reserve	Fire resilient stand managed to grow large trees for future forest products. Restore large trees and desired vegetation characteristics in riparian. Reduce PP and maintain/encourage DF&IC and some SF regen.	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; underburn; masticate fuels	51
47	23		General Forest	Fire resilient stand managed to grow large trees for future forest product by reducing density. Increase % of DF over WF; encourage IC regeneration.	Thin with mechanical harvester and tractor endlining; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester and tractor endlining; underburn; masticate fuels	48
48	9		General Forest	Fire resilient stand managed to grow large trees for future forest products. Favor DF and IC over WF. Also reduce density in trees less than 10 “ dbh (esp. below road).	Thin with mechanical harvester and tractor endlining; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester and tractor endlining; underburn; masticate fuels	48
49	5		General Forest	Fire resilient stand managed to grow large trees for future forest product by reducing density. Increase % of DF over WF and PP; encourage IC regeneration.	Thin with conventional log skidder and tractor endlining; underburn; pile burn at landings	Same as Alt 2	Same as Alt 2	48

Unit	Acres	Riparian Reserve Acres	Management Area	Treatment Objectives	Alt 2 - Proposed Action	Alt 3 – No New Roads	Alt 4 – Minimized Underburning	Similar Stand Structure and Species Composition
50	9		General Forest	Fire resilient stand managed to grow large trees for future forest product by reducing density. Increase % of DF over WF and PP; encourage IC regeneration	Thin with mechanical harvester and tractor endlining; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester and tractor endlining; underburn; masticate fuels	48
51	2	0.9	General Forest/Riparian Reserve	Reduce density of PP and maintain hardwoods and other conifers. Maintain SDI below 55% of maximum for at least 30 years to allow growing space of other species. Remove snow- damaged PP.	Thin with mechanical harvester and tractor endlining; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester and tractor endlining; underburn; masticate fuels	51
52	9	2.6	General Forest/Riparian Reserve	Fire resilient stand managed to grow large trees for future forest product by reducing density. Increase % of DF and WF over PP; encourage IC regeneration.	Thin with conventional log skidder and tractor endlining; underburn; pile burn at landings	Same as Alt 2	Same as Alt 2	51
53	10		General Forest	Fire resilient stand managed to grow large trees for future forest product. Increase % of DF and WF over PP.	Thin with mechanical harvester and tractor endlining; underburn; pile burn at landings	No treatment	Thin with mechanical harvester and tractor endlining; underburn; masticate fuels	51

Unit	Acres	Riparian Reserve Acres	Management Area	Treatment Objectives	Alt 2 - Proposed Action	Alt 3 – No New Roads	Alt 4 – Minimized Underburning	Similar Stand Structure and Species Composition
54	5		General Forest	Fire resilient stand managed to grow large trees for future forest product. Increase % of DF and WF over PP. Manage DF regeneration. Maintain IC & residual SP.	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; underburn; masticate fuels	51
55	26	6.1	General Forest/Riparian Reserve/Partial Retention VQO	Fire resilient stand managed to grow large trees for future forest products and other values. Restore large trees and desired vegetation characteristics in riparian. Wide spacing in PP pockets to reduce mortality.	Thin with mechanical harvester and tractor endlining; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester and tractor endlining; underburn; masticate fuels	100
56	12	7.4	General Forest/Riparian Reserve	Fire resilient stand managed to grow large trees for future forest products and other values. Restore large trees and desired vegetation characteristics in riparian. Top bench/well stocked area managed at SDI <55% of max. Lower portion (hand work) is mix of trees 6”-18” dbh and regeneration; manage to increase DF and well distributed trees.	Thin with conventional log skidder, handwork and tractor endlining; hand pile fuels	Same as Alt 2	Thin with conventional log skidder, handwork and tractor endlining; hand pile fuels	100

Unit	Acres	Riparian Reserve Acres	Management Area	Treatment Objectives	Alt 2 - Proposed Action	Alt 3 – No New Roads	Alt 4 – Minimized Underburning	Similar Stand Structure and Species Composition
58	3	0.5	General Forest/Riparian Reserve	Fire resilient stand managed to grow large trees for future forest products and other values. Reduce density to be effective for at least 30 years due to poor access.	Thin with conventional log skidder and tractor endlining; underburn; pile burn at landings	Same as Alt 2	Same as Alt 2	51
59	3	0.4	General Forest/Riparian Reserve	Fire resilient stand managed to grow large trees for future forest products and other values. Increase DF and IC over PP and WF.	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; underburn; masticate fuels	33
60	10	0.6	General Forest/Riparian Reserve	Fire resilient stand managed to grow large trees for future forest products and other values. High site DF can be managed 2nd thinning in <30 years.	Thin with cable logging; underburn	Same as Alt 2	Same as Alt 2	108
61	4	1.9	General Forest/Riparian Reserve	Fire resilient stand managed to grow large trees for future forest products and other values. Restore large trees and desired vegetation characteristics in riparian and protect springs. Maintain IC with good crowns and some WF without disease.	Thin with conventional log skidder and tractor endlining; underburn; pile burn at landings	Same as Alt 2	Same as Alt 2	31

Unit	Acres	Riparian Reserve Acres	Management Area	Treatment Objectives	Alt 2 - Proposed Action	Alt 3 – No New Roads	Alt 4 – Minimized Underburning	Similar Stand Structure and Species Composition
62	5		General Forest	Maintain the scattered old growth and relic trees and madrones > 16”. Reduce stand density by thinning suppressed, intermediate and codominant trees. Favor DF and IC over WF.	Thin with cable logging; underburn	Same as Alt 2	Same as Alt 2	31 (understory portion)
63	13	2.3	General Forest/Riparian Reserve unmapped stream	Fire resilient stand managed to grow large trees for future forest products. Maintain IC.	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; underburn; masticate fuels	48
64	9	0.03	Riparian Reserve/Partial Retention VQO	Reduce PP density and remove snow-damaged PP as priority. Increase DF and WF in the stand.	Thin with mechanical harvester and tractor endlining; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester and tractor endlining; underburn; masticate fuels	51
65	6		Partial Retention VQO	Dense young DF stand, most trees > 10” dbh. Fire resilient stand managed to grow large trees for future forest products and other values.	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; underburn; masticate fuels	31
66	41	14.0	General Forest/Riparian Reserve	Reduce density in heavily stocked portions of the stand. Steep slopes (including riparian) have less conifer stocking.	Thin with mechanical harvester and tractor end lining; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester and tractor end lining; underburn; masticate fuels	110

Unit	Acres	Riparian Reserve Acres	Management Area	Treatment Objectives	Alt 2 - Proposed Action	Alt 3 – No New Roads	Alt 4 – Minimized Underburning	Similar Stand Structure and Species Composition
67	45	1.8	General Forest/Riparian Reserve	Dense young DF stand, most trees > 10” dbh. Fire resilient stand managed to grow large trees for future forest products and other values.	Thin with mechanical harvester and tractor endlining; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester and tractor endlining; underburn; masticate fuels	33
68	21	2.5	General Forest/Riparian Reserve	Fire resilient stand managed to grow large trees for future forest products. Restore large trees and desired vegetation characteristics in riparian.	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; underburn; masticate fuels	100
70	16		General Forest	Fire resilient stand managed to grow large trees for future forest products. Opportunities of maintain IC, few open areas, few pines, and some hardwoods.	Thin with mechanical harvester and tractor endlining; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester and tractor endlining; underburn; masticate fuels	110
71	43	11.8	General Forest/Riparian Reserve	Fire resilient stand managed to grow large trees for future forest products. Restore large trees and desired vegetation characteristics in riparian. Thin wide to reduce fuel hazard to progeny site. Free thin some hardwoods and pine.	Thin with mechanical harvester and tractor endlining; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester and tractor endlining; underburn; masticate fuels	31

Unit	Acres	Riparian Reserve Acres	Management Area	Treatment Objectives	Alt 2 - Proposed Action	Alt 3 – No New Roads	Alt 4 – Minimized Underburning	Similar Stand Structure and Species Composition
72	14		General Forest/Partial Retention VQO	Fire resilient stand managed to grow large trees for future forest products.	Thin with cable logging; underburn	Same as Alt 2	Same as Alt 2	108
75	25	9.3	General Forest/Riparian Reserve	Fire resilient stand managed to grow large trees for future forest products. Restore large trees and desired vegetation characteristics in riparian.	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; underburn; masticate fuels	100
76	5		General Forest	Ridge top unit, thin to produce fire resilient stand and to grow large trees for future forest products.	Thin with cable logging; underburn	Same as Alt 2	Same as Alt 2	31
77	8	2.0	General Forest/Riparian Reserve	Fire resilient stand managed to grow large trees for future forest products. Restore large trees and desired vegetation characteristics in riparian. Also reduce number of trees < 10” dbh.	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; underburn; masticate fuels	33
78	5	1.6	General Forest/Riparian Reserve	Fire resilient stand managed to grow large trees for future forest products. Restore large trees and desired vegetation characteristics in riparian. Also reduce the	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; underburn; masticate fuels	33

Unit	Acres	Riparian Reserve Acres	Management Area	Treatment Objectives	Alt 2 - Proposed Action	Alt 3 – No New Roads	Alt 4 – Minimized Underburning	Similar Stand Structure and Species Composition
				number of trees < 10” dbh.				
79	18	0.5	General Forest/Riparian Reserve	Fire resilient stand managed to grow large trees for future forest products. Restore large trees and desired vegetation characteristics in riparian. Fireline from 2007 within unit.	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; underburn; masticate fuels	31
80	20		General Forest	Fire resilient stand managed to grow large trees for future forest products. Restore large trees and desired vegetation characteristics in riparian. Remove/thin trees, <10” where in dense patches; maintain vigorous 8 & 9” trees.	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; underburn; masticate fuels	33
81	6	3.3	General Forest/Riparian Reserve	Reduce density on the small flat on SW corner of unit with harvester. On steeper portions with trees < 10” dbh, reduce stocking with hand treatments, masticator or fire. Maintain and thin POC in draw/wet areas.	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; underburn; masticate fuels	11
83	3	0.1	General Forest/Riparian Reserve	Keep mix of DF/PP. Reduce WF. Fire resilient stand managed to grow large trees for future forest products. Restore large	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; underburn; masticate fuels	31

Unit	Acres	Riparian Reserve Acres	Management Area	Treatment Objectives	Alt 2 - Proposed Action	Alt 3 – No New Roads	Alt 4 – Minimized Underburning	Similar Stand Structure and Species Composition
				trees and desired vegetation characteristics in riparian. Remove/thin trees, <10” where in dense patches				
84	4	1.7	General Forest/Riparian Reserve	Fire resilient stand managed to grow large trees for future forest products. Restore large trees and desired vegetation characteristics in riparian. Remove/thin trees, <10” where in dense patches.	Thin with mechanical harvester and tractor endlining; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester and tractor endlining; underburn; masticate fuels	31
85	2	0.7	General Forest/Riparian Reserve	Fire resilient stand managed to grow large trees for future forest products. Restore large trees and desired vegetation characteristics in riparian. Remove/thin trees, <10” where in dense patches.	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; underburn; masticate fuels	31
86	18	0.3	General Forest/Riparian Reserve	Fire resilient stand managed to grow large trees for future forest products. Restore large trees and desired vegetation characteristics in riparian. Remove/thin trees, <10” where in dense patches. Increase % of DF.	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; underburn; masticate fuels	100

Unit	Acres	Riparian Reserve Acres	Management Area	Treatment Objectives	Alt 2 - Proposed Action	Alt 3 – No New Roads	Alt 4 – Minimized Underburning	Similar Stand Structure and Species Composition
87	9	0.1	General Forest/Riparian Reserve	Fire resilient stand managed to grow large trees for future forest products. Restore large trees and desired vegetation characteristics in riparian. Thin PP to 30-33” spacing; maintain most DF and IC.	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; underburn; masticate fuels	97
88	8	0.9	General Forest/Riparian Reserve	Reduce density and increase % of DF. Decrease the amount of damaged or diseased WF and PP.	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; underburn; masticate fuels	31
89	13	0.2	General Forest/Riparian Reserve	Fire resilient stand managed to grow large trees for future forest products. Restore large trees and desired vegetation characteristics in riparian.	Thin with mechanical harvester and tractor endlining; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester and tractor endlining; underburn; masticate fuels	110
90	3	0.75	General Forest/Riparian Reserve	Fire resilient stand managed to grow large trees for future forest products. Trees are large to thin with hand treatment; would reduce clumps or scattered trees < 10”.	Thin by handwork and hand pile fuels	Same as Alt 2	Same as Alt 2	33
91	13		General Forest	Fire resilient stand managed to grow large trees for future forest products and other values. High site DF to be	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; underburn; masticate fuels	110

Unit	Acres	Riparian Reserve Acres	Management Area	Treatment Objectives	Alt 2 - Proposed Action	Alt 3 – No New Roads	Alt 4 – Minimized Underburning	Similar Stand Structure and Species Composition
				managed at higher densities.				
92	61	3.5	General Forest/Riparian Reserve	Fire resilient stand managed to grow large trees for future forest products and other values. High site DF to be managed at higher densities.	Thin with mechanical harvester and tractor endlining; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester and tractor endlining; underburn; masticate fuels	100
93	10	0.7	General Forest/Riparian Reserve	Fire resilient stand managed to grow large trees for future forest products. Restore large trees and desired vegetation characteristics in riparian.	Thin with mechanical harvester and tractor endlining; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester and tractor endlining; underburn; masticate fuels	33
94	34	7.5	General Forest/Riparian Reserve	Fire resilient stand managed to grow large trees for future forest products. Restore large trees and desired vegetation characteristics in riparian. Thin dense patches of tree < 10” dbh.	Thin with mechanical harvester and tractor endlining; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester and tractor endlining; underburn; masticate fuels	100
95	12	10.0	General Forest/Riparian Reserve	Thin to PP 33'- 35' spacing to allow growing space for DF and IC regen. Consider protecting regen during harvest and fuels treatment; consider other fuels treatment than burning. Regeneration may need precommercial	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; underburn; masticate fuels	11

Unit	Acres	Riparian Reserve Acres	Management Area	Treatment Objectives	Alt 2 - Proposed Action	Alt 3 – No New Roads	Alt 4 – Minimized Underburning	Similar Stand Structure and Species Composition
				thinning after harvest.				
96	6	1.0	General Forest/Riparian Reserve	Thin PP to maintain < 55% of max SDI for 30 years. Maintain other DF, IC and some hardwoods within stand.	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; underburn; masticate fuels	11
97	6		Late Successional Reserve/General Forest	Ridge top unit; manage to produce fire resilient stand managed to grow large trees for late successional characteristics. Thin PP to maintain < 55% of max SDI for 30 years. Maintain other DF, IC and some hardwoods within stand.	Thin with mechanical harvester and tractor endlining; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester and tractor endlining; underburn; masticate fuels	97
99	11		Late Successional Reserve	Most PP are < 20" dbh; thin PP to 33-35' spacing. DF/IC regeneration would replace the off-site PP in the long term. Consider regeneration during harvest and fuel treatment. Adjacent to private.	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; underburn; masticate fuels	11
100	8	5.7	General Forest/Riparian Reserve	Maintain all 20" trees. Thin DF to 28' spacing to keep stand relatively well stocked. Free thin around some madrone.	Thin with mechanical harvester and tractor endlining; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester and tractor endlining; underburn; masticate fuels	100

Unit	Acres	Riparian Reserve Acres	Management Area	Treatment Objectives	Alt 2 - Proposed Action	Alt 3 – No New Roads	Alt 4 – Minimized Underburning	Similar Stand Structure and Species Composition
101	5	0.1	General Forest/Riparian Reserve/Late Successional Reserve	Reduce WF, increase the % of DF. Retain all trees over 20".	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; underburn; masticate fuels	110
102	11		Late Successional Reserve	Fire resilient stand managed to grow large trees for late successional characteristics. Maintain patches of PP at wider spacing. Maintain POC and yew where possible.	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; underburn; masticate fuels	11
103	9		General Forest	Fire resilient stand managed to grow large tree for products and other values. Reduce tree density in well stocked DF patches. Maintain larger hardwoods in open areas and steep areas.	Thin with conventional log skidder and tractor endlining; underburn; pile burn at landings	Same as Alt 2	Same as Alt 2	11
104	7		Late Successional Reserve/General Forest	Maintain as foraging habitat. Manage to reduce density and produce large trees.	Thin with conventional log skidder and tractor endlining; underburn; pile burn at landings	Same as Alt 2	Same as Alt 2	110
105	16	3.0	Late Successional Reserve/Riparian Reserve	Manage to produce foraging habitat. Maintain residual trees including most damaged trees that would live over the long-term. Reduce density in dense patches. Culture existing regeneration in	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; underburn; masticate fuels	100

Unit	Acres	Riparian Reserve Acres	Management Area	Treatment Objectives	Alt 2 - Proposed Action	Alt 3 – No New Roads	Alt 4 – Minimized Underburning	Similar Stand Structure and Species Composition
				open areas. Maintain larger hardwoods.				
106	24	0.8	Late Successional Reserve/Riparian Reserve	Manage to produce foraging habitat. Maintain POC in stand mix (most in ultramafic area below road). Thin out PP and smaller DF to produce larger DF and IC.	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; underburn; masticate fuels	100
108	11		Late Successional Reserve	Maintain as foraging habitat. Manage to reduce density and produce large trees.	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; underburn; masticate fuels	108
109	5	0.1	Late Successional Reserve/Riparian Reserve	Maintain as foraging habitat. Manage to reduce density and produce large trees.	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; underburn; masticate fuels	100
110	13	7.5	Late Successional Reserve/Riparian Reserve	Maintain as foraging habitat. Manage to reduce density and produce large trees.	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; underburn; masticate fuels	110
111	17		Late Successional Reserve	Maintain as foraging habitat. Manage to reduce density and produce large trees.	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; underburn; masticate fuels	100

Unit	Acres	Riparian Reserve Acres	Management Area	Treatment Objectives	Alt 2 - Proposed Action	Alt 3 – No New Roads	Alt 4 – Minimized Underburning	Similar Stand Structure and Species Composition
112	3	1.2	Late Successional Reserve/Riparian Reserve/Partial Retention	Mange NE portion in the 100-acres LSR to produce nesting/Roosting habitat in the long term. Fire resilient stand managed to grow large trees for future forest products and other values. Restore large trees and desired vegetation characteristics in riparian.	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; underburn; masticate fuels	100
113	19	0.2	Riparian Reserve/Partial Retention VQO	Fire resilient stand managed to grow large trees for future forest products and other values. Thin dense patches. Maintain some large PP and hardwoods in the more open areas. Restore large trees and desired vegetation characteristics in riparian.	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; underburn; masticate fuels	31
114	15		Partial Retention VQO	Fire resilient stand managed to grow large trees for future forest products and other values. Thin dense patches. Maintain some large PP and hardwoods in the more open areas. Restore large trees and desired vegetation characteristics in riparian.	Thin with mechanical harvester and tractor endlining; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester and tractor endlining; underburn; masticate fuels	31

Unit	Acres	Riparian Reserve Acres	Management Area	Treatment Objectives	Alt 2 - Proposed Action	Alt 3 – No New Roads	Alt 4 – Minimized Underburning	Similar Stand Structure and Species Composition
115	77	11.1	Riparian Reserve/Partial Retention VQO	Fire resilient stand managed to grow large trees for future forest products and other values. Thin dense patches. Maintain some large PP and hardwoods in the more open areas. Restore large trees and desired vegetation characteristics in riparian.	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; underburn; masticate fuels	100 (50 acres)
116	11	3.2	Riparian Reserve/Partial Retention VQO	Fire resilient stand managed to grow large trees for future forest products and other values. Maintain PP stocking < 55 % of max SDI for at least 30 years. Increase % of DF. Restore large trees and desired vegetation characteristics in riparian.	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; underburn; masticate fuels	97
117	19	0.1	General Forest/LSR/Riparian Reserve/Partial Retention VQO	Fire resilient stand managed to grow large trees for future forest products and other values. Restore large trees and desired vegetation characteristics in riparian.	Thin with mechanical harvester and tractor endlining; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester and tractor endlining; underburn; masticate fuels	97
118	10	3.6	General Forest/Riparian Reserve	Trees mostly < 10” dbh, lower site. Larger residuals in bottom. Fire resilient stand managed to grow large trees for future forest products and other values.	Thin with conventional log skidder and tractor endlining; underburn; pile burn at landings	Same as Alt 2	Same as Alt 2	51

Unit	Acres	Riparian Reserve Acres	Management Area	Treatment Objectives	Alt 2 - Proposed Action	Alt 3 – No New Roads	Alt 4 – Minimized Underburning	Similar Stand Structure and Species Composition
				Restore large trees and desired vegetation characteristics in riparian.				
119	5		LSR/General Forest	Ridge top and west aspect. Manage to produce foraging habitat and a fire resilient stand.	Thin with conventional log skidder and tractor endlining; underburn; pile burn at landings	Same as Alt 2	Same as Alt 2	33
120	3		LSR	Fire resilient stand managed to grow large trees for owl habitat and buffer adjacent old growth. Plantation and natural stand. Reduce % of WF.	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; masticate fuels	108
121	13		General Forest	Fire resilient stand managed to grow large trees for future forest products. Restore large trees and desired vegetation characteristics in riparian.	Thin with cable logging; underburn	No treatment	Same as Alt 2	31
Natural Stands								
200	14		General Forest	Thin lower area to 240 in densest areas and 160 on edges and free thin at least one SP. Option to leave steeper areas as is or to thin a few conifers and maintain more growing space for hardwoods (Madrone, black oak)	Thin with conventional log skidder and tractor endlining; underburn;	Same as Alt 2	Same as Alt 2	201

Unit	Acres	Riparian Reserve Acres	Management Area	Treatment Objectives	Alt 2 - Proposed Action	Alt 3 – No New Roads	Alt 4 – Minimized Underburning	Similar Stand Structure and Species Composition
201	17	2.2	General Forest/Riparian Reserve unmapped stream/wetland	Reduce stocking in densest areas over 400 BA to around 200-240 BA, other well stocked areas to 160 BA. In areas that have dense trees with small diameters, reduce stocking to 120 BA. Reduce the amount of WF including some of the larger trees. Free thin hardwoods and SP in areas where they can maintain room to grow without removing many large DF. Post harvest, review for precommercial thinning of the younger regeneration in previously harvested, more open areas.	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; masticate fuels	201
203	3		General Forest	Fire resilient stand managed to grow large trees for future forest products. Management would include thinning of dense areas of trees < 10” dbh and removal of disease residual trees.	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; masticate fuels	108
205	7	0.2	General Forest/Riparian Reserve/Partial Retention VQO	Reduce stocking to 200-240 BA in dense patches and 140-160 in areas of smaller trees. Maintain largest trees by reducing density.	Thin with cable logging; underburn	Same as Alt 2	Same as Alt 2	206

Unit	Acres	Riparian Reserve Acres	Management Area	Treatment Objectives	Alt 2 - Proposed Action	Alt 3 – No New Roads	Alt 4 – Minimized Underburning	Similar Stand Structure and Species Composition
206	13		General Forest	Fire resilient stand managed to grow large trees for future forest products and other values. Reduce % of WF and manage to maintain a mix of SP, IC, DF, and few of larger hardwoods. Maintain higher BA/ac in older portion of stand on top180-220.	Thin with conventional log skidder and tractor endlining; underburn;	No treatment	Same as Alt 2	206
208	23	7.0	General Forest/Riparian Reserve	Light thinning to 120-140 BA to produce open stand. Previously thinned and underburned;	Thin with mechanical harvester and tractor endlining; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester and tractor endlining; underburn; masticate fuels	225
209	9	3.4	General Forest/Riparian Reserve	Reduce density around some of the large old trees and in areas with smaller diameter trees. Thin from below to 140-180 BA/ac. Maintain shade and riparian vegetation around stream channel.	Thin with mechanical harvester and tractor endlining; underburn; pile burn at landings	No treatment	Thin with mechanical harvester and tractor endlining; underburn; masticate fuels	201
211	17		General Forest/Partial Retention VQO	Reduce density to maintain a vigorous stand, reduce mortality, and produce a more fire resilient stand. Favor DF over WF. Few SP on edges where still some growing space. Vary leave BA dependent on	Thin with cable logging; underburn	No treatment	Same as Alt 2	213

Unit	Acres	Riparian Reserve Acres	Management Area	Treatment Objectives	Alt 2 - Proposed Action	Alt 3 – No New Roads	Alt 4 – Minimized Underburning	Similar Stand Structure and Species Composition
				species and local structure.				
212	3		Partial Retention VQO	Thin form below to 160 BA in more open areas, and 200 BA in densest areas. (canopy likely 55-60% closure post thinning)	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; masticate fuels	213
213	6		Partial Retention VQO	Reduce density to maintain a vigorous stand, reduce mortality, and produce a more fire resilient stand. Favor DF over WF. Vary leave BA dependent on species and local structure.	Thin with cable logging; underburn	Same as Alt 2	Same as Alt 2	213
214	19		General Forest//Partial Retention	Reduce density to maintain a vigorous stand, reduce mortality, and produce a more fire resilient stand. Favor DF over WF. Vary leave BA dependent on species and local structure.	Thin with cable logging; underburn	Same as Alt 2	Same as Alt 2	206
216	7	2.9	Riparian Reserve/Partial Retention VQO	Reduce density to maintain a vigorous stand, reduce mortality, and produce a more fire resilient stand. Favor DF over WF. Vary leave BA dependent on species and local structure. Maintain riparian buffer.	Thin with cable logging; underburn	Same as Alt 2	Same as Alt 2	206
217	3		General Forest	Thin dense pockets from below to maintain the larger trees and increase vigor of the stand.	Thin with conventional log skidder and tractor endlining; underburn;	Same as Alt 2	Same as Alt 2	225

Unit	Acres	Riparian Reserve Acres	Management Area	Treatment Objectives	Alt 2 - Proposed Action	Alt 3 – No New Roads	Alt 4 – Minimized Underburning	Similar Stand Structure and Species Composition
218	3		General Forest	Fire resilient stand managed to grow large trees for future forest products and other values.	Thin with conventional log skidder and tractor endlining; underburn;	Same as Alt 2	Same as Alt 2	206
219	15	1.4	General Forest/Riparian Reserve	Fire resilient stand managed to grow large trees for future forest products and other values. Maintain the few old growth trees. Maintain riparian vegetation.	Thin with cable logging; underburn	No treatment	Same as Alt 2	255
220	12	1.11	Riparian Reserve/Partial Retention VQO	Reduce density in heavily stocked areas. Remove some of diseased trees. Manage existing regeneration in harvest areas to produce large trees. Reduce % of WF.	Thin with conventional log skidder and tractor endlining; underburn;	Same as Alt 2	Same as Alt 2	225
225	6		General Forest	Light thin to reduce density in clumps and free thin around some of the larger trees.	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; masticate fuels	225
226	8		General Forest/Partial Retention VQO	Manage to produce a more fire resilient stand near powerlines. Thin to 140-160 BA but maintain all the large old trees (most not a threat to powerlines).	Thin with conventional log skidder and tractor endlining; underburn;	Same as Alt 2	Same as Alt 2	206
227	10	5.9	Private/Riparian Reserve/Partial Retention VQO	Thin dense patches to reduce pressure on old DF and grow some replacement DF with enough growing space to	Thin with mechanical harvester and tractor endlining; underburn; pile burn at landings	No treatment	Thin with mechanical harvester and tractor endlining;	227

Unit	Acres	Riparian Reserve Acres	Management Area	Treatment Objectives	Alt 2 - Proposed Action	Alt 3 – No New Roads	Alt 4 – Minimized Underburning	Similar Stand Structure and Species Composition
				reach 70" dbh. Reduce % of WF, but keep mix of various species. Remove diseased RF. Maintain small buffer around BS.			underburn; masticate fuels	
228	9		General Forest	Reduce WF stocking (borax stumps) by thinning out around pockets and denser clumps. Make several openings, monitor for DF/IC regen or plant DF/IC in openings	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; masticate fuels	206
229	5		General Forest/Partial Retention VQO	Manage to produce a more fire resilient stand adjacent to serpentine area with powerlines. Remove decadent knobcone pine. Reduce density and provide enough growing space to keep the percent of IC at its present portion in the N ½. Light thin of smaller trees in the S ½.	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; masticate fuels	206
234	9		General Forest	Ridge top unit with previous thinning and underburn. Produce open fire resilient stand. Thin DF to 80-120 BA to enhance area for black oak. Maintain SP.	Thin with conventional log skidder and tractor endlining; underburn;	Same as Alt 2	Same as Alt 2	234

Unit	Acres	Riparian Reserve Acres	Management Area	Treatment Objectives	Alt 2 - Proposed Action	Alt 3 – No New Roads	Alt 4 – Minimized Underburning	Similar Stand Structure and Species Composition
236	2	0.1	General Forest/Riparian Reserve/Partial Retention	Reduce stand density to maintain vigor. Remove some of the DF with Dwarf Mistletoe, especially where infecting young vigorous DF on flat.	Thin with conventional log skidder and tractor endlining; underburn;	Same as Alt 2	Same as Alt 2	206
237	2	0.01	General Forest/Riparian Reserve	Stand was previously harvested with a regeneration prescription, but leaving a border of overstory trees infected with DF dwarf mistletoe. Remove infected overstory trees and infected regeneration. Cultural remaining regeneration to improve growth.	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; masticate fuels	237
238	10	5.0	General Forest/Riparian Reserve	Remove smaller trees in the stand to reduce competition on remaining stand and maintain SP in stand. Leave BA will vary throughout the stand with local structure and vigor.	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; masticate fuels	238
242	6	0.67	General Forest/Riparian Reserve/Partial Retention	Fire resilient stand managed to grow large trees for future forest products and other values. Near Ridge top. Reduce % of WF. Buffer riparian.	Thin with cable logging; underburn	No treatment	Same as Alt 2	255

Unit	Acres	Riparian Reserve Acres	Management Area	Treatment Objectives	Alt 2 - Proposed Action	Alt 3 – No New Roads	Alt 4 – Minimized Underburning	Similar Stand Structure and Species Composition
243	4	0.2	Riparian Reserve/Partial Retention	Fire resilient stand managed to grow large trees for future forest products and other values. Near Ridge top, west aspect. Reduce % of WF. Buffer riparian.	Thin with cable logging; underburn	Same as Alt 2	Same as Alt 2	225
244	16	10.6	General Forest/Riparian Reserve	Leave large old trees and a moderate stocking of cohorts that seeded in about 100 years ago. Maintain a good mix of species. Thin to maintain vigor and produce a fire resilient stand managed to grow large trees for future forest products and maintain stocking on dormant landslide.	Thin with conventional log skidder and tractor endlining; underburn;	No treatment	Same as Alt 2	201
253	28	16.9	General Forest/Riparian Reserve	Reduce stocking in denser groups; light thinning to 120-160 BA. Maintain species mix of DF, SP and IC. Maintain stand with a low fire hazard adjacent to Classic progeny site.	Thin with mechanical harvester and tractor endlining; underburn; pile burn at landings	No treatment	Thin with mechanical harvester and tractor endlining; underburn; masticate fuels	225
254	2		Late Successional Reserve/Partial Retention VQO	Manage portion in 100-acre LSR to produce nest/roosting habitat in the long-term. Manage remainder of stand to produce large trees for forest products and/or	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; masticate fuels	206

Unit	Acres	Riparian Reserve Acres	Management Area	Treatment Objectives	Alt 2 - Proposed Action	Alt 3 – No New Roads	Alt 4 – Minimized Underburning	Similar Stand Structure and Species Composition
				other values.				
255	9	3.0	Riparian Reserve	Reduce density to maintain individual tree vigor and produce large trees for forest products and other values. Reduce the % of WF in stand. Buffer Riparian Reserves.	Thin with mechanical harvester; underburn; pile burn at landings	Same as Alt 2	Thin with mechanical harvester; masticate fuels	255
256	5	3.7	Riparian Reserve	Ground is heavily impact by hydraulic mining. Dense clumps of DF are growing on the deep clay loam soil. Reduce stand density where tree are accessible to maintain vigor.	Thin with mechanical harvester; underburn; pile burn at landings	No treatment	Thin with mechanical harvester; masticate fuels	206
257	5		General Forest	Ground is heavily impact by hydraulic mining. Light to moderate thin to maintain stand vigor and produce wood products. Buffer center mining channel.	Thin with mechanical harvester; underburn; pile burn at landings	No treatment	Thin with mechanical harvester; masticate fuels	206
258	8	3.3	Riparian Reserve	Reduce density around some of the large old trees and in areas with smaller diameter trees. Thin from below to 140-180 BA/ac. Maintain shade and riparian vegetation around stream channel.	Thin with cable logging; underburn	No treatment	Same as Alt 2	201

Unit	Acres	Riparian Reserve Acres	Management Area	Treatment Objectives	Alt 2 - Proposed Action	Alt 3 – No New Roads	Alt 4 – Minimized Underburning	Similar Stand Structure and Species Composition
300	36	2.1	General Forest/Riparian Reserve	Remove some of the DF infected with dwarf mistletoe that are adjacent to plantations or uninfested stands. Remove smaller infested trees by hand methods.	Roadside sanitation using conventional log skidder and tractor endlining; hand work for trees less than 10” dbh; underburn	Same as Alt 2	Same as Alt 2	300
301	44		General Forest	Reduce density; area to be used for supplying products for pole permits.	Roadside pole thinning with handwork; hand pile fuels	Same as Alt 2	Same as Alt 2	301
302	40	1.0	Riparian Reserve/Wildlife Management	Reduce density; area to be used for supplying products for pole permits.	Roadside pole thinning with handwork; hand pile fuels	Same as Alt 2	Same as Alt 2	302
400	18	2.0	General Forest/Riparian Reserve	Manage stand to maintain and increase percentage of oak similar to the historic condition. Remove most of DF except in the few dense patches where site is better. Thin PP, but maintain the largest PP with good crowns. Thin IC and retain the best and largest. Thin near wet area with azalea to reduce conifer encroachment. Block temp road that is presently being used for fire wood cutting. Remove some of the small trees and brush before burning if necessary after harvest.	Hardwood release/enhancement using mechanical harvester; thin smaller vegetation in the understory using hand methods; underburn; pile burning at landings	Same as Alt 2	Same as Alt 2	234

Appendix C – Proposed Logging Systems Descriptions

Logging Systems

Proposed harvest removal systems for the Two Bit project include mechanized falling and skidding, mechanized falling with tractor endline and skyline systems.

Mechanized Falling and Skidding

This system includes mechanical felling of trees using a feller buncher (figure 11). Felled trees would be piled and then skidded to landings using a skidder (figure 12). This type of harvest removal system is generally used for units with average slopes less than 25 percent. The feller buncher generally has a single-pass trail every 60 feet. Skid trails are spaced approximately 200 feet apart. Landings are approximately one-third to one-half acre in size, and occasionally up to three quarters of an acre in size to accommodate slash piles from tree tops. For this project, it was assumed that the tops would be left attached to the trees and then skidded to the landing for processing and disposal. If no biomass market exists at the time of harvest, the tops and slash would be piled and burned at the landing.

Figure 11. Mechanical felling using a feller buncher

Figure 12. Skidder operations

Mechanized Falling with Tractor Endlining

This system includes mechanical felling of trees using a feller buncher. Felled trees would be piled and then skidded to landings using a tracked-skidder (e.g. bulldozer). This type of harvest removal system is generally used for units with average slopes greater than 25 percent. The feller

buncher generally has a single-pass trail every 60 feet. Skid trails are spaced approximately 200 feet apart. Landings are approximately 0.33 to 0.50 acres in size and occasionally up to 0.75 acres in size to accommodate slash piles from tree tops. For this project, it was assumed that the tops would be left attached to the trees and then skidded to the landing for processing and disposal. If no biomass market exists at the time of harvest, the tops and slash would be piled and burned at the landing. It is assumed that 10 percent of the volume in the unit would require hand falling with chainsaws and endlining (winching to the skid trails) in areas with slopes steeper than 35 percent.

Skyline System

This system includes hand falling of trees (using chainsaws). Felled trees would be yarded to landings using a yarder (figure 13). A yarder is a machine with a tower or gantry crane which uses suspended cables to pull the trees to the landing. During the inhaul portion of the yarding cycle (up the corridor to the landing), the leading end of the log is suspended off the ground (partial suspension) to reduce ground disturbance. To minimize damage to residual trees, yarding corridors are mostly parallel on the fall line (straight down the slope) and are located approximately 200 feet apart. This means that the yarder is moved to each corridor. Swing yarders are the preferred yarder for this type of harvest. They are set up on an existing road, generally requiring little or no earthwork at the landing. Trees below the landing may need to be cleared to accommodate the slash pile, with no associated earthwork. Clearings are approximately one-tenth- acre in size, depending on the amount of slash generated. For this project, it was assumed that the tops would be left attached to the trees and then yarded to the landing for processing and disposal. If no biomass market exists at the time of harvest, the tops and slash would be piled and burned at the landing.

Figure 13. Yarder operations

Mastication

Mastication is the operation of reducing forest vegetation in the stand by grinding, shredding or chopping material. This treatment can lower fuel bed depth, raise crown base height, increase fuel-ground contact to promote decomposition, and generate more fine materials.

Figure 14. Mastication equipment

Appendix D – Aquatic Conservation Strategy Compliance

The Klamath National Forest Land and Resource Management Plan (USDA Forest Service 1995b) contains the components, objectives and standards and guidelines for compliance with the Aquatic Conservation Strategy (ACS). Although the ACS Amendment (USDA and USDI 2004) limited the scope of the effects analyses to the long-term at the watershed scale (5th-field), the March 30, 2007 *Pacific Coast Fed. of Fishermen's Assn. et al v. Natl. Marine Fisheries Service, et al and American Forest Resource Council, Civ. No. 04-1299RSM* (W.D. Wash (PCFFA IV)) court case ruled adverse to federal agencies. As a result we must address the nine ACS objectives at the site rather than only at the watershed scale and consider short-term as well as long-term impacts of the proposed action and action alternatives (USDA and USDI 2007).

The four components of the ACS, as given on pages 4-34 through 4-36 of the LRMP, are: 1) Riparian Reserves, 2) Key Watersheds, 3) Watershed Analysis and 4) Watershed Restoration. The Project does not occur in a Key Watershed, the project planning team used information from the Watershed Analysis when locating and designing the proposed activities, and the project is recognized as one step toward overall forest health. Watershed Restoration, which includes fish passage improvement, decommissioning, and storm damage repair, is an ongoing program on the District and the Forest. This project also proposes direct Watershed Restoration through decommissioning of 4.1 miles of Forest system roads. The proposed treatments should reduce the amount of watershed degradation that can occur from a high intensity wildfire in the area by changing vegetative condition classes to reduce the extent and intensity of a wildfire.

Activities in Riparian Reserves were developed to improve, protect or have neutral effects to RRs conditions in the long term. Particular objectives were designed for thinning in RRs (see figure 3 and appendix B). Activities in RRs consist of mechanical thinning, underburning and hand piling, water withdrawal, hazard tree removal, re-construction of temporary road segments maintenance of existing landings, road maintenance, and decommissioning of twelve road stream crossing sites. These activities were evaluated to determine the effects to RRs at the site, reach, and 7th-, 6th- and 5th-field watershed scales in the short and long term to meet the ACS requirements. The effects of these activities were evaluated in detail in the Hydrology Report (Bousfield 2010), the Geology Report (De la Fuente and Bell 2010), the Biological Assessment/Evaluation for effects to anadromous fish (Grunbaum 2010b), and the Fisheries Specialist Report (Grunbaum 2010a). Bousfield, De la Fuente and Bell, and Grunbaum concluded that the activities in RRs met the ACS objectives, as stated on pages 4-6 and 4-7 of the LRMP (USDA 1995). There may be adverse, short term impacts at the site- and reach-scales but there would be no significant adverse changes to stream temperatures or flow and sediment regimes.

The nine Aquatic Conservation Strategy (ACS) objectives listed on pages 4-6 and 4-7 of the LRMP are discussed as applicable to the no-action alternative and as applicable to all action alternatives of the Two Bit Vegetation Management Project. These are addressed individually in the following paragraphs.

No-action Alternative

Maintain and restore the distribution, diversity, and complexity of watershed and landscape-scale features to ensure protection of the aquatic systems to which species, populations and communities are uniquely adapted. The No-action alternative would maintain, but not attempt to actively restore the characteristics listed above. Wildfire could cause high burn severity in overstocked stream course RRs under the no-action alternative.

Maintain and restore spatial and temporal connectivity between watersheds. The No-action alternative would maintain, but not attempt to actively restore the characteristics listed above. Overly dense stands would continue to restrict connectivity for several more decades or until a stand-replacing wildfire occurs.

Maintain and restore the physical integrity of the aquatic system, including shorelines, banks, and bottom configurations. The No-action alternative maintains, but would not actively restore, the characteristics above because there would be no direct or indirect disturbances in these areas.

Maintain and restore water quality necessary to support healthy riparian, aquatic, and wetland ecosystems. The No-action would maintain, but not actively restore riparian, aquatic and wetland ecosystems. The No-action alternative would passively restore water quality due to slow recovery from past disturbances and due to slow recovery from over-densification resulting from decades of fire suppression.

Maintain and restore the sediment regime under which aquatic ecosystems evolved. Elements of the regime include the timing, volume, rate and character of sediment input, storage and transport. The No-action alternative would maintain, but not restore sediment regimes because road impacts would not be reduced and because risk of high intensity wildfire would not be reduced.

Maintain and restore instream flows sufficient to create and sustain riparian, aquatic, and wetland habitats, and to retain patterns of sediment, nutrient, and wood routing. The timing, magnitude, duration, and spatial distribution of peak, high, and low flows must be protected. The No-action alternative would maintain current but not restore instream flows that have likely decreased from reference condition due to higher than reference condition tree density.

Maintain and restore the timing, variability, and duration of floodplain inundation and water table elevation in meadows. The No-action alternative would meet the objective for floodplain inundation, but not water table elevation in meadows. Meadows are currently experiencing conifer encroachment due to wildfire suppression and the conifer encroachment

may be lowering water tables due to increased evapotranspiration. With no-action, conifer encroachment is expected to increase over time in the absence of wildfire.

Maintain and restore the species composition and structural diversity of plant communities in riparian areas. The No-action alternative may meet this objective in the natural stands riparian reserves that would not receive treatment due to the decision tree process outlined in figure 3 of Chapter 2. The other natural stands riparian reserves are experiencing overstocked conditions that may be eventually reduce species composition and structural diversity dues to the absence of creeping ground fires from nearly a century of fire suppression. In the plantation stands, that were clearcut, aggressively tractor piled, burned, and then planted with Douglas fir and off-site pine, the no-action alternative would maintain current poor conditions of species composition and structural diversity of plant communities in riparian areas and would not restore species composition and structural diversity towards reference and desired conditions. With no-action, it will take many decades for species composition and structural diversity of plant communities in riparian areas that were clearcut and replanted to recover.

Maintain and restore habitat to support well distributed populations of native plant and invertebrate riparian dependent species. The No-action alternative may meet this objective in the natural stands riparian reserves that would not receive treatment due to the decision tree process outlined in figure 3 of Chapter 2. The other natural stands riparian reserves are experiencing overstocked conditions that may be undesirable to native plants and invertebrates due to the absence of creeping ground fires from nearly a century of fire suppression. In the plantation stands that were clearcut, aggressively tractor piled, burned, and then planted with Douglas fir and off-site pine, the no-action alternative would maintain current poor conditions of riparian habitat and would not restore riparian habitat towards reference and desired condition. With no-action, it will take many decades for habitat conditions for native plant and invertebrate riparian-dependent species to recover in most of the stands proposed for treatment.

Alternatives 2, 3 and 4

Maintain and restore the distribution, diversity, and complexity of watershed and landscape-scale features to ensure protection of the aquatic systems to which species, populations and communities are uniquely adapted. In the short term, all action alternatives would: (1) insignificantly increase chronic sedimentation due to ground disturbance and/or vegetation removal in stream buffer RRs, and (2) slightly decrease risk of moderate to high intensity wildfire. In the long-term, all action alternatives would maintain and restore the characteristics listed above by: (1) reducing potential for chronic and acute sedimentation of streams through decommissioning of segments of system roads, (2) reducing the density of conifers towards reference conditions by thinning, (3) restoring vegetative species composition towards reference condition by thinning and fuels treatments, (4) reducing fuel loading towards reference condition by thinning and fuel treatments, and (5) slightly decrease adverse effects that

wildfires could cause. Short- and long-term effects on the characteristics listed above would be manifested primarily at the site and reach scale. Effects of the action alternatives would be neutral at the 7th field and larger scales.

Maintain and restore spatial and temporal connectivity between watersheds. In the short-term, all action alternatives would not result in any physical or chemical barrier to migration routes for wildlife species or access to spawning and rearing areas for aquatic species. In the long-term, all action alternatives would improve the characteristics listed above by opening up these dense stands to restore the greater connectivity which was historically present in these watersheds and (2) decommissioning of nine stream crossing (2 perennial and 7 intermittent) to restore the longitudinal connectivity of aquatic species. Long-term effects on the characteristics listed above would be manifested primarily at the site and reach scale, with slight benefits at the 7th field watershed and larger scales.

Maintain and restore the physical integrity of the aquatic system, including shorelines, banks, and bottom configurations. In the short-term, the stream crossing decommissioning would cause minor direct and indirect impacts to the stream channel at the site scale, but the long-term beneficial impacts would greatly outweigh the short-term minor site-scale impacts. In the long-term, action alternatives meet this objective because any direct disturbances (from steam crossing removals) would not cause a measurable change in channel geomorphology at the reach or watershed scales.

Maintain and restore water quality necessary to support healthy riparian, aquatic, and wetland ecosystems. All action alternatives meet this objective. In the short-term, there may be insignificant effects to water quality, sedimentation, and/or channel geomorphology at the site-scale but not at larger scales. In the long-term, decommissioning system roads and accelerating large tree growth in previously clear-cut stream course riparian reserves would improve water quality and outweigh any minor short-term effects. Long-term beneficial effects to water quality would be realized at all scales.

Maintain and restore the sediment regime under which aquatic ecosystems evolved. Elements of the regime include the timing, volume, rate and character of sediment input, storage and transport. Slight short term increase in turbidity and slight increase in potential for mass wasting would negligibly affect the sediment regime at the reach or watershed scale. In the long term, the action alternatives would restore sediment regimes at the site, reach, and watershed scales by decommissioning system roads. Although temporary roads would be constructed or re-constructed their impacts are minor compared to system roads which cause chronic and potentially catastrophic sedimentation. No new temporary roads would be constructed in stream course RRs.

Maintain and restore instream flows sufficient to create and sustain riparian, aquatic, and wetland habitats, and to retain patterns of sediment, nutrient, and wood routing. The timing, magnitude, duration, and spatial distribution of peak, high, and low flows must be protected. All action alternatives meet this objective. Short-term, but not long-term, peak flows

at the site and reach scale may be slightly increased. In the short- and long-term, peak flows at the 7th field and larger scales would not be altered. In the short- and long-term, low flows may actually slightly increase at all scales due to the action alternatives.

Maintain and restore the timing, variability, and duration of floodplain inundation and water table elevation in meadows. All action alternatives would meet this objective. Under all action alternatives, peaks flows causing floodplain inundation would remain unchanged in the short- and long-term. All action alternatives would sustain or restore water table elevation in meadows in the short- and long-term by removing conifers that have been encroaching on these meadows due to decades of fire suppression.

Maintain and restore the species composition and structural diversity of plant communities in riparian areas. All action alternatives would meet this objective. Between 4 and 23 percent of the managed 7th -field watersheds stream course RRs had been clear cut harvested other the last half century. These locations are homogeneous stands with little structural or understory species diversity. With treatments, these stands would begin to have a greater species composition due to additional light reaching the forest floor, and would have greater structural diversity as new seedlings create an understory and as residual trees increase in growth and vigor in response to thinning and underburning. Treatments under all action alternatives would restore species composition and structural diversity of plant communities at the site scale in the short- and long term.

Maintain and restore habitat to support well distributed populations of native plant and invertebrate riparian dependent species. All action alternatives would meet this objective. Most plantations were aggressively tractor piled and burned, followed by planting of Douglas-fir and off-site pine. Native hardwoods and other conifer species may have naturally established, but are scarce in many of the plantation stream course RRs. Treatments would help accelerate the recovery of these altered stream course RRs at the site scale in the short- and long-term. Invertebrates in aggressively burned and tractor-piled plantations may have been destroyed especially in areas were extensive stream clearing of woody debris had taken place. In both plantations and natural stands, treatments would result in more water, nutrients, and sunlight being available for improving the growth, resilience, and vigor of residual trees in the stream course RRs.

Appendix E – Implementation of Best Management Practices for the Two Bit Vegetation Management Project

Introduction

Best Management Practices (BMPs) were developed to comply with Section 208 of the Clean Water Act. BMPs have been certified by the State Water Quality Resources Control Board and approved by the Environmental Protection Agency (EPA) as the most effective way of protecting water quality from impacts stemming from non-point sources of pollution. These practices have been applied in timber sales and road construction projects in watersheds over the last 20 years and have been found to be effective in protecting water quality within the Klamath National Forest. Specifically, effective application of the US Forest Service Region 5 BMPs has been found to maintain water quality that is in conformance with the Water Quality Objectives in the North Coast Regional Water Quality Control Board's (NCRWQCB) Basin Plan.

USFS Region 5 BMPs have been monitored and modified since their original implementation in 1979 to make them more effective. Numerous on-site evaluations by the NCRWQCB have found the practices to be effective in maintaining water quality and protecting beneficial uses/resources (e.g., domestic use, anadromous and resident fish). The Forest monitors the implementation and effectiveness of BMPs on randomly selected projects each year. BMP effectiveness requirements were met on 90-100 percent of the sites sampled in 2000-2007. The success rate for effectiveness has been in the high 80s and 90s each year since 1993.

[Please refer to http://www.fs.fed.us/r5/klamath/projects/forestmanagement/ to view a compilation of KNF annual BMP implementation and effectiveness monitoring reports].

The following list of BMPs was developed for the Two Bit Project and is current as of November 24, 2009. The objective of each BMP is described first then is followed by descriptions of the specific measures or project design features (PDFs) that will be implemented to achieve compliance with each BMP. For additional information on the BMPs and their objectives, see Water Quality Management for Forest System Lands in California, USDA Forest Service, and Pacific Southwest Region (USDA Forest Service 2000b).

Best Management Practices

BMP 1.1 – Timber Sale Planning Process: The objective is to incorporate water quality and hydrologic considerations into the Timber Sale Planning Process. This requires the Interdisciplinary Team (IDT) to consider methods of reducing water quality impacts during the planning phase of a project. PDFs incorporated to reduce water quality impacts include:

- Streams will be protected from commercial thinning with an appropriate width stream buffer. For determining stream-buffer Riparian Reserves (RR) widths, one site potential tree height was designated 170 feet for the project area. Within stream course RRs, a

silvicultural prescription will retain all trees a minimum of 10 feet from ephemeral and intermittent streams, and 25 feet of a perennial streams. However, allow for the sanitation of diseased, pest infested, or off-site pines to meet long term ACS objectives.

- In natural stands a restrictions on commercial harvesting within Riparian Reserves of intermittent streams (that flow into June on an average water year) outside of the above 10-foot no-treatment zone would also apply unless certain criteria are met:
    1. Commercial harvesting would only occur from 10 to 50 feet of the stream if current overstory canopy cover is equal to or greater than 85 percent and this overstory canopy cover would not be reduced below 85 percent
    2. Commercial harvesting would only occur within 50 to170 feet of the stream if current overstory canopy cover is equal to or greater than 65 percent and this overstory canopy cover would not be reduced below 65 percent
    3. If overstory trees are not at their site potential height and/or site conditions do not allow attainment of the above canopy cover percentages then harvesting which would retain current overstory canopy cover or potentially enhance future overstory canopy cover may occur within 10 to 170 feet of the stream, upon consultation with a Hydrologist
- In natural stands a restrictions on commercial harvesting near perennial streams outside of the above 25-foot no-treatment buffer zone would also apply unless certain criteria are met:
    1. Commercial harvesting would only occur within 25 to 75 feet of the stream if current overstory canopy cover is equal to or greater than 85 percent and this overstory canopy cover would not be reduced below 85 percent during harvest
    2. Commercial harvesting would only occur within 75 to170 feet of the stream if: current overstory canopy cover is equal to or greater than 65 percent and this overstory canopy cover would not be reduced below 65 percent during harvest
    3. If overstory trees are not at their site potential height and/or site conditions do not allow attainment of the above canopy cover percentages then harvesting which would retain current overstory canopy cover or potentially enhance future overstory canopy cover may occur within 25 to 170 feet of the stream, upon consultation with a Hydrologist.
- Streams will be protected from ground-disturbing activities with an equipment exclusion buffer. Equipment will be excluded from slopes greater than 35 percent within RR. A minimum equipment exclusion buffer will be 10 feet from ephemeral streams, 25 feet from intermittent, and 50 feet from perennial streams. Minimums may be larger based on site conditions such as continuous slopes (> 25%) leading directly into the stream channel, slope breaks, low soil cover, unstable ground or erosive soils, to be determined by an Earth Scientist during unit layout.
- Commercial thinning and other ground-disturbing activities will not be implemented on ground that is geologic RR (inner gorges, unstable ground, or highly erosive terrains). Exceptions to this would could occur: (1) in situations where a small patch (a few acres or less) of trees in an unstable area is in imminent danger of mortality from insects/disease or is overly dense, in which cases equipment would still be excluded and thinned trees would be endlined out from the unstable area – a Forest geologist must approve all thinning on geologic RRs, and (2) use of existing system roads and/or landings that can be used without significant risk of resource damage.
- Tractor skidding will occur on designated skid trails. Existing skid trails will be re-used whenever possible. Tractors may leave skid trails to access isolated logs if ground conditions permit.

- Tractor yarding is generally limited to slopes less than 35 percent (short sections of skid trails connecting flat benches may exceed 35 percent slope, and endlining from designated skid trails may occur on slopes greater than 35 percent).
- Low ground-pressure track mounted harvesters can operate on slopes up to 45 percent on soils formed from metasediments and ultramafic rock types. On slopes >35 percent equipment will operate perpendicular to the contour and avoid sideslope travel.
- On soils formed from granitic rock types (units 106, 288, 543) ground-based skidders and harvesters are limited to slopes <35 percent.
- Maintain at least 85 percent of the land dedicated to growing vegetation in a condition that meets Forest Plan Standards and Guidelines, as well as Regional Soil Analysis Quality Standards.
- No new constructed, full bench skid trails will be created.
- During Project implementation, temporary roads will be outsloped, covered with slash (where needed), and blocked to vehicle access after the harvest season and before onset of the wet season. Temporary roads will be hydrologically restored upon Project completion using methods given on page 79 of the 2004 NMFS Biological Opinion on programmatic implementation of the KNF Land and Resource Management Plan (USDC 2004).
- Existing landings will be reused whenever possible - minimizing need for new landings. New landings will be kept as small as feasible, yet will meet safe working standards.
- Roads and landings will not be constructed or enlarged in hydrologic and geologic RRs. Existing roads and landings in RRs may be used where suitable facilities currently exist and risk of resource damage is negligible. Existing landings within 30 feet of the slope break to a stream channel or inner gorge will not be used.
- Meet Forest Plan standards and guidelines for soil cover as measured before the fall rainy season. Within all timber sale units, post-treatment soil cover will range from 50-70 percent (where that much currently exists) depending on slope steepness and type of fuel reduction treatments, as measured before the fall rainy season. At least 50 percent cover, as fine organic matter (<3 inch material), would be retained in all timber sale units.

BMP 1.2 – Timber Harvest Unit Design: The objective is to ensure that timber harvest unit design will secure favorable conditions of water quality and quantity while maintaining desirable stream channel characteristics and watershed conditions. The design should consider the size and distribution of natural structures (snag and down logs) as a means of preventing erosion and sedimentation.

- Retain existing course woody debris (CWD) to Forest Plan Standards whenever feasable, providing the amount of CWD does not exceed fuel management objectives.
- Thinning prescriptions leave largest oldest trees that are providing snags and/or are most likely to provide snags and CWD in the near future.
- The IDT reviewed all units to select logging methods (cable, tractor, feller-buncher, yoder) and fuel treatments appropriate to site conditions. Equipment will be kept approximately 10 feet from the break in slope to a wetted stream channel or to the inner gorge of an intermittent stream channel or to hydraulic mining scarps and slumps.
- Trees will not be thinned closer than 10 feet to the edge of the old hydraulic mining scarps.

BMP 1.3 – Determination of Surface Erosion Hazard for Timber Harvest Unit Design: The objective is to identify high erosion hazard areas in order to adjust treatment measures to prevent downstream water quality impacts.

- Based on field review and site data (percent slope distribution, soil texture), a Soil Scientist determined surface erosion hazard for each treatment unit (Walters 2010).
- Selected management activities were designed to achieve predominately low erosion hazard ratings for project implementation in treatment units.

BMP 1.4 – Use of Sale Area Maps (SAM) and/or Project Maps for Designating Water Quality Protection Needs: The objective is to ensure recognition and protection of areas related to water quality protection delineated on a SAM or Project Map.

- All protected springs, wetlands, stream courses, and stream buffer RRs will be shown on the SAM.
- All protected unstable land features (geologic Riparian Reserves) will be shown on the SAM.
- Appropriate logging methods will be shown on SAM.

BMP 1.5 – Limiting the Operating Period (or Sale Operation Schedule) of Timber Sale Activities: The objective is to ensure that the purchasers conduct their operations, including, erosion control work, road maintenance, and so forth, in a timely manner, within the time specified in the Timber Sale Contract.

- Most project operations will be implemented during the normal operating season (NOS) from May 15 to October 15, and in dry periods outside the NOS with earth scientist recommendation and Line Officer approval. Activities will be restricted during periods of wet weather during the NOS.
- The KNF Wet Weather Operation Standards and Guidelines (WWOS – Klamath National Forest, 2002) will be used to guide operations during periods of wet weather. The TSA will examine field conditions to determine when the soil and/or road have dried out enough to enable operations to resume without risk of watershed impacts. The project earth scientist may be called upon to make recommendations to the TSA who will provide direction to the Timber Sale Contractor (TSC) as to when operations may resume to insure that BMPs will be met and adverse impacts avoided.
- All erosion control prevention measures shall be kept current immediately preceding expected seasonal periods of precipitation or when operating outside the NOS. Operations will be suspended when not in compliance with WWOS. Operations will not resume until suitable ground conditions exist.
- Forecast periods will be of a suitable length to allow completion or winterization of the task undertaken before precipitation events occur.

BMP 1.6 – Protection of Unstable Lands: The objective is to provide special treatment of unstable areas to avoid triggering mass slope failure with resultant erosion and sedimentation.

- Project watershed personnel conducted field reviews of all proposed harvest units and identified and documented unstable areas.
- All protected unstable land features (geologic Riparian Reserves) will be shown on the SAM and/or Unit Information Card, and equipment will be excluded from these areas (except for use of existing system roads and/or landings that can be used without significant risk of causing resource damage).
- Equipment will not operate closer than approximately 10 feet to the edge of hydraulic mining scarps. Trees will not be thinned within 10 feet of old hydraulic mining scarps.
- Project watershed personnel will be available for consultation during project implementation when activities occur in or adjacent to unstable areas.

BMP 1.8 – Streamside Management Zone Designation: The objective is to designate a zone along riparian areas, streams and wetlands that will minimize potential for adverse effects from adjacent management activities. Management activities within these zones are designed to improve riparian values.

- Protected stream buffer RRs have been designated and will be shown on the SAM. Equipment exclusion will be designated on the ground as well as in the timber sale contract.
- Water drafting areas for dust abatement will be designated on the SAM by the Forest Service and agreed to by the TSC. Water drafting will be in compliance with NOAA Fisheries 2001 Water Drafting Specifications.
- Existing landings within 30 feet of the slope break to a stream channel or inner gorge will not be used. Landings will not be constructed or enlarged in RRs. There will be no yarding of trees or logs through, in, or across perennial stream channels.

BMP 1.9 – Determining Tractor Loggable Ground: The objective is to minimize erosion and sedimentation resulting from ground disturbance by tractor logging systems.

- A soil scientist field reviewed all the tractor log units to verify that they were reasonable to tractor log from a soil resource perspective based upon the combination of erosion hazard rating for bare soil, soil displacement potential, terrain complexity and the presence and lengths of scarps with slopes >35 percent.

BMP 1.10 – Tractor Skidding Design: The objective is to design skidding patterns to best fit the terrain, the volume, velocity, concentration, and to control the direction of runoff water in a manner that will minimize erosion and sedimentation.

- Skid trail locations will be determined on site by agreement between the contractor and the TSA.
- Skid trails will be laid out on slopes generally less than 35 percent. Where needed, earth scientists will assist the TSA in skid trail location.
- Existing skid trails will be reused whenever practical.
- New skid trails would be limited to slopes less than 35 percent except where necessary to cross short steeper sections that connect flatter benches. No new constructed (full bench) skid trails will be created.

- Main skid trails will be spaced to minimize the number of trails, minimizing the amount of ground affected.
- The use of existing, or the location of new skid trails across any intermittent or ephemeral channel will be by agreement between the Timber Sale Contractor, the TSA, and an earth scientist. The channel's shape at skid trail crossing will be restored per BMP 1.17. Skid trails will not cross perennial streams.
- Linear depressions perpendicular to the contour (up and down the slope – such as ephemeral draws or remnant channels) that can concentrate runoff will not be used for skid trails.
- Skid trails that intersect Forest Roads will be blocked or hydrologically restored at the intersection to prevent unauthorized traffic, prevent surface flow, and hydrologic connectivity.

BMP 1.11 - Suspended Log Yarding in Timber Harvesting: The objective is to protect the soil mantle from excessive disturbance; to maintain the integrity of the streamside management zone (SMZ) and other sensitive watershed areas, and to control erosion on cable corridors.

- Ground-based skidding and skyline yarding will require front-end suspension of logs. Front-end suspension is not used for endlining.
- Full suspension cable yarding would be used over stream channels and within 10 feet of stream channels and one-end suspension cable yarding would be used in the remainder of the surrounding stream course Riparian Reserves.

BMP 1.12 – Log Landing Location: The objective is to locate new landings or reuse old landings in such a way as to avoid watershed impacts and associated water quality degradation.

- New and old landings would be selected for use that involves the least amount of excavation, and the least erosion potential.
- Existing landings will be used to the maximum extent possible.
- Existing landings within 30 feet of the slope break to a stream channel or inner gorge will not be used.
- Landings will not be constructed or enlarged in RRs.

BMP 1.13 – Erosion Prevention and Control Measures during Timber Sale Operations: The objective is to insure that the purchaser's operations will be conducted reasonably to minimize soil erosion.

- Erosion control measures are discussed during the pre-operations meeting with the TSC and/or purchaser and the Forest Service. They are updated throughout the operations phase of the timber sale.
- During project implementation, final locations and design characteristics for landings and new temporary roads will be reviewed by earth science personnel prior to construction as needed.
- TSAs are responsible for administering the Forest Service Timber Sale Contract and will periodically inspect the contractor's operations to assure that erosion control measures are implemented in a timely manner.

- The Project earth scientist will make periodic inspections of the sale to insure that the erosion control measures are having the desired effect and are in compliance with BMPs. The earth scientist will make recommendations to the TSA or Forest Service Representative as to any action needed to comply with BMPs.
- The Klamath WWOS (USDA-FS KNF 2002) will be used.
- All erosion control prevention measures shall be kept current immediately preceding expected seasonal periods of precipitation or when operating outside the Normal Operating Season. Operations will be suspended when not in compliance with Wet Weather Operating Guidelines. Operations will not resume until suitable ground conditions exist.
- Also see BMP 1.5 and 1.11.

BMP 1.14 – Special Erosion Prevention Measures on Disturbed Land: The objective is to provide appropriate erosion and sedimentation protection for disturbed areas.

- Main skid trails in RR will have slash spread on them as necessary to control surface erosion.
- Slash will be spread on disturbed ground as necessary, according to the Sale Administraor's descresion in order to minimize erosion.

BMP 1.15 – Revegetation of Areas Disturbed by Harvest Activities: The objective is to establish a vegetative ground cover on disturbed sites to prevent erosion and sedimentation.

- Landings that will not be used again will be contoured ripped to break up compaction so that brush and trees can revegetate the area and thrive.

BMP 1.16 – Log Landing Erosion Control: The objective is to reduce the impacts of erosion and subsequent sedimentation associated with log landings by use of mitigating measures.

- New and old landings would be selected for use that involves the least amount of excavation, and the least erosion potential.
- New landings and expansion of existing landings will not be constructed within RRs.
- New and expanded landings will be kept as small as possible to meet OSHA safety standards of operating.
- Landing areas within 30 feet of the slope break to a stream channel or inner gorge will not be used.
- Landings will be shaped to disperse drainage and direct runoff away from watercourses at the time of construction. Rock armoring and silt fences with straw bales may be used as necessary to direct water to areas of suitable drainage and to capture sediment. Where necessary to prevent excessive erosion, new landing cut and fill slopes will be covered with slash and the slash layer will be maintained throughout the life of the project.
- Landings will be covered with slash as necessary to minimize surface erosion.

BMP 1.17 – Erosion Control on Skid Trails: The objective is to protect water quality by minimizing erosion and sedimentation derived from skid trails.

- Skid trails will be water-barred in accordance with TSA Handbook.

- Where special erosions prevention measures are needed and identified the spreading of slash will be applied to surface disturbed areas to minimize soil erosion.
- Skid trails that intersect Forest Roads will be blocked or hydrologically restored at the intersection.
- Skid trails that cross ephemeral or intermittent channelswill be restored before any storm with the potential for rain arrives. This will be done with consultation with an earth scientist and generally consists of removing excess soil, reshaping and waterbarring former approaches, and spreading slash on former crossing approaches.
- Cable yarding corridors with exposed soil will be waterbarred and or covered with slash.

BMP 1.18 – Meadow Protection During Timber Harvesting: The objective is to avoid damage to ground cover, soil, and hydrologic function of meadows.

- Meadows within and adjacent to commercial timber units will be identified on the SAM and equipment will be excluded from operating in the meadow areas.

BMP 1.19 – Stream Course and Aquatic Protection: The objective is to conduct management actions within these areas in a manner that maintains or improves riparian and aquatic values; to provide unobstructed passage of stormflows; to control sediment and other pollutants entering streamcourses; and to restore the natural course of any stream as soon as practicable, where diversion of the stream has resulted from timber management activities.

- Service landings are located away from channels. Fuel containment systems will be used at service landings according to contract specifications.
- Purchaser shall furnish oil-absorbing mats for use under equipment being serviced to prevent petroleum-based products from contaminating soil and water resources.
- Straw bales, rock, and containment dikes may be used as needed at water drafting sites and service landings to capture any spilled water and prevent runoff to streams.
- Same as first bullet under BMP 1.1.
- BMPs 2.12, 2.13, 2.21, 2.23, 5.10, and 5.11 are also applicable

BMP 1.20 – Erosion Control Structure Maintenance: This objective is to ensure that constructed erosion control structures are stabilized and working.

- All waterbars will be maintained during the period of the Timber Sale Contract for at least one year after their construction.
- A barrier to prevent vehicle traffic use will be placed at all temporary road takeoffs at the end of the operating season.

BMP 1.21 – Acceptance of Timber Sale Erosion Control Measures before Sale Closure: The objective is to ensure the adequacy of required erosion control work on timber sales.

- During the final contract inspection, Forest Service personnel will inspect erosion control measures and make sure they are working as intended before releasing the purchaser from the contract responsibility.

BMP 1.25 – Modification of the Timber Sale Contract: The objective is to modify the Timber Sale Contract if new circumstances or conditions indicate that the timber sale will damage soil, water, or watershed values.

- The contract will be modified as needed to insure maintenance of water quality in the event of unforeseen circumstances that could result in resource impacts.

BMP 2.1 – General Guidelines for the Location and Design of Roads: The objective is to locate and design roads with minimal resource damage.

- Potential locations for temporary roads were identified on the Project planning map and these areas were field evaluated by earth scientists.
- New temporary road will not be constructed on unstable ground geologic RRs or within stream buffer RRs.
- New temporary road construction will be located on gentle ground or on or near ridges and will require little to no cut and fill. New temporary road will be constructed so that runoff is dispersed not concentrated. Water will be drained toward the downhill side of the road not into an inboard ditch.

BMP 2.2 - Erosion Control Plan: The objective is to limit and mitigate erosion and sedimentation through effective planning prior to initiation of construction activities and through effective contract administration during construction.

- PDFs developed by the IDT to protect Forest resources and other ecosystem components will be incorporated into timber sale contract specifications and provisions.
- During the timber sale pre-operations meeting, the Forest Service and the timber sale contractor and/or purchaser will reach agreement on a project erosion control plan that includes the PDFs developed by the IDT. This plan is implemented during the operations phase of the Project.
- TSAs are responsible for administering the Timber Sale Contract including the erosion control plan, and ensuring compliance with the plan and all other applicable standards and guidelines.

BMP 2.3 - Timing of Construction Activities: The objective is to minimize erosion by conducting operations during minimal runoff periods.

- **See BMP 1.5: Limiting Operating Period of Timber Sale.**
- All landing construction and road work will be conducted during appropriate periods of weather and soil moisture to insure BMP attainment and the avoidance of adverse watershed effects. Forecast periods will also be of a suitable length to allow completion or winterization of the task undertaken before precipitation events occur.

BMP 2.4 – Stabilization of Road Slope Surfaces and Spoil Disposal Areas: The objective is to minimize erosion from exposed cut slopes, fill slopes, and spoil disposal areas.

- As necessary to attain stabilization of landing and temporary road fill slopes, erosion control measures such as out-sloping, drainage dips, and water bars shall be

implemented. Where special erosions prevention measures are needed and identified, the spreading of slash may be applied to minimize erosion of exposed soils.

BMP 2.5 - Road Slope Stabilization Construction Practices: The objective is to reduce sedimentation by minimizing erosion from road slopes and slope failures along roads.

- New temporary road will not be constructed on steep, erosive, and/or unstable ground, or within inner gorges.
- Roads would be surfaced as needed to minimize surface erosion and road wear that can concentrate runoff and cause gullying or failure of road fill.
- Temporary road drainage will be handled by outsloping the road surface so that runoff is not concentrated and drainage is self-maintaining.
- Temporary roads used in the project would be opened and constructed with minimal clearing limits.

BMP 2.7 – Control of Road Drainage: The objective is to minimize the erosive effects of water concentrated by road drainage features; to disperse runoff from disturbances within the road clearing limits; to lessen the sediment yield from roaded areas; and to minimize erosion of the road prism by runoff from road surfaces and from uphill areas.

- Existing drainage and surfacing problems on System roads to be used by the Project will be repaired before commercial thinning is initiated. The Project will maintain roads used for implementation in acceptable functioning condition throughout Project use, so that addition resource damage does not occur
- Temporary road drainage will be handled by outsloping the road surface so that runoff is not concentrated and drainage is self-maintaining.

BMP 2.11 - Control of Sidecast Material during Construction and Maintenance: The objective is to minimize sediment production originating from sidecast material during road construction or maintenance.

- Sidecasting during road maintenance and clearing operations should not extend beyond the road prism of any road, or into any streamside management zone.
- During road blading, loose material should be incorporated back into the road prism and utilized in the road subgrade to the maximum extent possible, or deposited at designated disposal sites.

BMP 2.12 - Servicing and Refueling of Equipment: The objective is to prevent pollutants such as fuels, lubricants, bitumens and other harmful materials from being discharged into or near rivers, streams and impoundments, or into natural or man-made channels.

- Fuel containment systems will be in place on landings as necessary.
- Oil-absorbing mats will be used under equipment being serviced to prevent petroleum-based products from contaminating soil and water resources.
- Refueling and maintenance of Project motorized equipment will occur at least 200 feet away from any channel.

BMP 2.13 – Control of Construction and Maintenance Activities Adjacent to Streamside Management Zones: The objective is to protect water quality by controlling construction and maintenance actions within and adjacent to any streamside management zone so that the following functions are not impaired: 1) Effectively filtering sediment generated by erosion from bare surfaces, road fills, dust drift, and oil traces; 2) Maintaining shade, riparian habitat (aquatic and terrestrial), and stabilizing the channel; 3) Keeping the floodplain surface in a resistant, undisturbed condition to slow water velocities and limit erosion by flood flows.

- New landings and expansion of existing landings will not be constructed within RRs.
- Existing landing areas within 30 feet of the slope break to a stream channel or inner gorge will not be used.
- Earth Scientists and Engineers will determine appropriate treatments when re-opened maintenance level 1 roads pose a high risk to watershed health. Treatments on re-opened roads may include spot rocking of wet areas, rolling dip construction on stream crossings with diversion potential, and rip-rap placement on spillways of "shotgun" culverts.

BMP 2.14 – Controlling In-channel Excavation: The objective is to minimize stream channel disturbances and related sediment production.

- Culverts will be replaced at existing temporary and existing system stream crossing, where none currently exist. Stream channels were culverts are scheduled to be pulled, post project implementation, will be realigned to restore natural stream flow.
- Excavation will occur where culverts will be removed during decommissioning. Mitigation measures are incorporated into the contract by design engineers. Contract specifications and operating plans will be adhered to during excavation activities.

BMP 2.15 Diversion of Flows Around Construction Sites: To ensure that all stream diversions are carefully planned, to nimimize downstream sedimentation, and to restore stream channels to their natural grade, condition, and alignment as soon as possible.

- On decommissioned system roads,the streamflow will be diverted for all live streams prior to construction activities. Mitigation measures are incorporated into the contract by design engineers. No existing temporary road crossings have perennial streams, so no streamflow diversion is required.

BMP 2.16 – Stream Crossings on Temporary Roads

- Culverts will be replaced at existing temporary and existing system stream crossing, where none currently exist. Stream channels were culverts are scheduled to be pulled, post project implementation, will be realigned to restore natural stream flow. No new temporary roads will cross streams.

BMP 2.17 – Bridge and Culvert Installation: To minimize sedimentation and turbidity resulting from excavation for in-channel structures.

- Excavated materials should be kept out of channels, and removed from floodplains prior to the rainy season. Mitigation measures are incorporated into the contract by design engineers.

BMP 2.19 – Disposal of Right-of-Way and Roadside Debris: The objective is to ensure that organic debris generated during road construction is kept out of streams so that channels and downstream facilities are not obstructed. Also, to ensure debris dams are not formed which obstruct fish passage, or fish could result in downstream damage from high water flow surges after dam failure.

- Slash and debris created in RR as a result of reopening roads will be either piled and burned in the riparian or removed to a disposal site.
- Pile burning will not occur within 25 feet of any stream course.

BMP 2.21 - Water Source Development Consistent with Water Quality Protection: The objective is to supply water for roads and fire protection while maintaining existing water quality.

- Straw bales, rock surfacing, and containment dikes will be used as needed to prevent surface erosion and sedimentation runoff back into a stream.
- Water will be drafted in accordance with NOAA Fisheries 2001 Water Drafting Specifications designed to avoid adverse effects to water quality and anadromous fish.

BMP 2.22 – Maintenance of Roads: The objective is to maintain roads in a manner which provides for water quality protection by minimizing rutting, failures, sidecasting, and blockage of drainage facilities all of which can cause erosion and sedimentation, and deteriorating watershed conditions.

- Road surfaces will be watered and/or rocked as needed to reduce road wear and minimize loss of road fines.
- Road drainage (ditches, culverts, dips) facilities will be kept in acceptable functioning condition during the life of the TSC, so that additional resource damage does not occur.
- The Klamath WWOs guidelines will be followed.
- Earth Scientists and Engineers will determine appropriate treatments when re-opened maintenance level 1 roads pose a high risk to watershed health. Treatments on re-opened roads may include spot rocking of wet areas, rolling dip construction on stream crossings with diversion potential, and rip-rap placement on spillways of "shotgun" culverts.

BMP 2.23 – Road Surface Treatment to Prevent Loss of Materials: The objective is to minimize the erosion of road surface materials and consequently reduce the likelihood of sediment production from those areas.

- Road surfaces will be watered and/or rocked as needed to reduce road wear and minimize loss of road fines.
- Temporary road drainage will be handled by outsloping the road surface so that runoff is not concentrated and drainage is self-maintaining.

BMP 2.24 – Traffic Control during Wet Periods: The objective is to reduce road surface disturbances and rutting of roads and to minimize sediment washing from disturbed road surfaces.

- The Klamath WWOs guidelines will be followed.

BMP 2.26 – Obliteration or Decommissioning of Roads: The objective is to reduce sediment generated from temporary roads, unneeded system (classified) and temporary (unclassified) roads by obliterating or decommissioning them at the completion of the intended use.

- This BMP applies to all temporary roads used in this project.
- Temporary roads will be water-barred as needed when not in use during project implementation.
- Temporary roads will be decommissioned (hydrologically restored) at the end of the Project by outsloping to return the road prism to near natural hydrologic function.
- Road prisms requiring more sediment reduction would be stabilized through appropriate special treatment such as covering with slash.
- Road take-offs would be hydrologically restored or effectively blocked to vehicle access.
- As a part of this project all or portions the following roads will be decommissioned; 17N02, 17N02A, 17N04, 17N28, 18N43, and 18N43A.

BMP 5.6 – Soil Moisture Limitations for Mechanical Equipment Operations: The objective is to prevent soil compaction, rutting, and gulling with resultant sediment production and turbidity.

- Ground-based equipment operation will only be permitted when soil moisture is determined to be dry enough to avoid negative soil and watershed impacts. Site-specific direction will be given by the TSA in conjunction with an earth scientist using the Wet Weather Operating Standards as guidance. Refer to BMP 1.17.
- Low ground-pressure equipment (feller bunchers) may operate off skid trails when the soil moisture is dry enough to avoid negative soil and watershed impacts. Site-specific direction will be at the discretion of the TSA with advice from an earth scientist using the Wet Weather Operating Standards as guidance.

BMP 5.7 – Pesticide Use Planning Process: The objective is to introduce water quality and hydrologic considerations into the pesticide use planning process.

- Application of Sporax® (borax) to fresh cut true fir stumps will be done in compliance with all label directions.

BMP 5.8 – Pesticide Application According to Label Directions and Applicable Legal Requirements: The objective is to avoid water contamination by complying with all label instructions and restrictions for use.

- Application of Sporax® (borax) to fresh cut true fir stumps will be done in compliance with all label directions.

- No effluent containing boron products will be discharged into any waterbody. No such effluent may be discharged into sewer systems without previously notifying the local sewage treatment plant authority.

BMP 5.9 – Pesticide Application Monitoring and Evaluation: The objectives are: 1) to determine whether pesticides have been applied safely, restricted to intended target areas, and have not resulted in unexpected non-target effects; 2) to document and provide early warning of possible hazardous conditions resulting from possible contamination of water or other non-target areas by pesticides; and 3) to determine the extent, severity, and possible duration of any potential hazard that might exist.

- The need for a monitoring and evaluation plan was considered as part of the environmental and analysis process. Given the risk level once BMP 5.8, 5.10 and 5.11 are implemented; only compliance monitoring will be required.
- Contract inspectors will be on-site during pesticide applications and will monitor the work for contract specification and label requirement compliance.

BMP 5.10 – Pesticide Spill Contingency Planning: The objective is to reduce contamination of water by accidental pesticide spills.

- A Project Safety Plan will be prepared that includes pesticide spill contingency measures as part of the contract requirements.

BMP 5.11 – Cleaning and Disposal of Pesticide Containers and Equipment: The objective is to prevent water contamination resulting from cleaning or disposal of pesticide containers.

- Cleaning, storage, and disposal of containers will be done in accordance with Federal, State, and local laws, regulations and directives.

BMP 6.1 – Fire and Fuel Management Activities: The objective is to reduce public and private losses and environmental impacts which result from wildfires and/or subsequent flooding and erosion by reducing or managing the frequency, intensity and extent of wildfire.

- Project fuels staff and fire suppression staff determined acceptable levels of slash to retain on the site following harvest activities, and identified areas and methods where slash and/or existing fuels need to be reduced to prevent unacceptable fire risk.
- On-going fire management work maintains fire access plans and restricts public activities, such as woodcutting, on days when fire weather predictions indicate significant risk from such activities in the Project Area. Project activities, such as chainsaw use, can also be restricted during periods of high fire danger.

BMP 6.2 – Consideration of Water Quality in Formulating Fire Prescriptions: The objective is to provide for water quality while achieving management objectives through the use of prescribed fire.

- Different fuel reduction treatments are prescribed to protect soil and water resources. Review project design features for harvest unit and underburn unit specific recommendations and mitigations.
- All burning will be done under an approved Burn Plan that specifies a burn prescription for each area. These prescriptions will account for fuel loading, fuel moisture, soil moisture, slope, aspect, etc., and will result in the desired quantity of fuel consumed for each prescribed burn. A fuel management specialist, who may utilize recommendations from a soil or earth scientist, will prepare prescriptions.
- Hand and landing piles will be burned under safe conditions to prevent fire spread or excessive scorching of surrounding vegetation.
- Underburning will be accomplished in conditions that allow safe burning. Fire crews, equipped to control fire spread, will monitor underburning.

BMP 6.3 – Protection of Water Quality from Prescribed Burning Effects: The objective is to maintain soil productivity, minimize erosion, and minimize ash, sediment, nutrients, and debris from entering water bodies.

- Retain soil cover amounts recommended by Project soil scientist (Walters 2010) to meet Forest plan standards. Burn plan prescriptions are designed to retain desired levels of soil cover.
- Maintain the functionality of riparian vegetation and stream buffer RRs.
- Use of prescribed fire in stream buffer RRs will predominately result in low intensity burns except for burning small (six by six foot) isolated hand piles where higher intensities occur when piled slash is consumed. Pile burning will not occur within 25 feet of any stream course.
- Low-intensity prescribed fire should be allowed to back down into stream buffer RRs.
- Prescribed fire will be ignited in stream buffer RRs only in situations where necessary to minimize the potential for burning material to roll down into a RR that could start a moderate or high intensity burn. Prescribed fire backed into or ignited within stream buffer RR will be controlled to maintain a low-intensity burn.
- If it is determined necessary for a handline to be constructed as a control point within a stream buffer RR, it should be constructed no closer than 30 feet to a watercourse. Handline construction in stream buffer RRs shall be avoided where practical.
- Prescribed fire backed into wet meadows will be controlled to maintain a low-intensity burn.

BMP 7.8 – Cumulative Off-Site Watershed Effects: The objective is to protect the identified beneficial uses of water from the combined effects of multiple management activities which individually may not create unacceptable effects but collectively may result in degraded water quality conditions.

- A cumulative watershed effects analysis was completed for the Project, as summarized in the Water section of Chapter 3 and in appendix F. The Project does slightly increase modeled CWE risk ratios in the analyzed 7th –field watersheds but no watersheds are at or over threshold in the model due to Project implementation.

Appendix F – Cumulative Watershed Effects Modeling Summary

Introduction

Cumulative watershed effects (CWE) are analyzed on the Klamath National Forest using three models. The USLE model predicts sediment volume delivered to stream courses by surface soil erosion and the GEO model predicts sediment volume delivered to stream courses by mass-wasting (e.g. landslides). The third model, equivalent roaded area (ERA), is a Forest Service Region 5 standard that scales vegetative disturbances as being equivalent to a road. These models are briefly discussed in Chapter 3 under in the water, soils and geology sections.

Potential increases in sedimentation were evaluated through the degree of change in CWE-modeled risk ratios for accelerated surface soil erosion (USLE model) and mass-wasting (GEO model). Altered channel geomorphology was evaluated by the degree of peak flow increase which can be indirectly measured using the ERA model. Risk ratios greater than or equal to 1.00 indicates a threshold of concern.

Klamath National Forest GIS layers of roads, past vegetative disturbances (wildfires and management), and the actions proposed under Alternatives 2, 3 and 4 for the Two Bit Project were used in these three models. The models assessed the cumulative watershed effects in the twelve 7th field watersheds within four 6th field watersheds within the Indian Creek 5th field watershed. Proposed treatment units occur within nine of the twelve 7th field watersheds: Indian Creek Headwaters, West Branch Indian Creek, Indian/Mill Creek, Coon-Wagner, Little SF Indian Creek, Cole-Clauson, East Fork Indian Creek, Luther-Ikes and Indian/Doolittle Creek. All twelve 7th fields were analyzed since they represent the combined cumulative watershed effects in the Indian Creek watershed as a whole. Detailed results of this analysis are contained in the Two Bit Hydrology Report (Bousfield 2010). Table 72 below displays USLE, GEO and ERA modeling results for the existing condition compared to conditions after implementation of Alternatives 2, 3 and 4. Table 73 below displays the risk ratios from the USLE, GEO and ERA modeling results for the existing condition compared to conditions after implementation of Alternatives 2, 3 and 4.

Existing conditions in the Indian Creek Watershed were modeled based on past and recent projects, some of which are not yet completed on the ground, but for which NEPA decisions have been signed. Past and in-progress/current actions include timber harvest, wildfires, fuels treatments, roads and mining activities and are summarized in Table 16 in Chapter 3. No other future actions are planned for the project area.

While models are useful tools in determining the potential for effects, results are not absolute; in other words modeling results are most useful as a relative comparison between alternatives and should not be considered absolute predictions of sediment generated or of risk

ratios; results should be used with caution and as a general comparison between the existing condition and the predicted impacts of Alternatives 2, 3 and 4.

Summary of Findings

Existing conditions, with past and present/current actions

Prior to modeling the results of proposed actions for Alternatives 2, 3 and 4, existing conditions (all past actions plus all current/in-progress actions) in the twelve 7th field watersheds were modeled (Tables 72 and 73). Existing conditions for 7th field watersheds in the project area based on modeling results showed:

- Perkins-Happy Camp 7th field watershed was over threshold for surface soil erosion (USLE model value 1.36)
- None were over the threshold of concern for mass-wasting (GEO model)
- None were over the threshold of concern for ERA

Existing condition modeling also showed that none of the 6th field watersheds or the Indian Creek 5th field watershed was over the threshold of concern for any of the three models.

Alternatives

After the inclusion of actions proposed for Alternatives 2, 3 and 4, the models indicated (Tables 72 and 73) that of the twelve 7th field watersheds:

- None exceeded or further exceeded the threshold of concern for surface soil erosion (USLE)
- None exceeded the threshold of concern for mass-wasting (GEO)
- None exceeded the threshold of concern for ERA

Modeling proposed actions under Alternatives 2, 3 and 4 combined with existing conditions and all past/current actions also showed that none of the 6th field watersheds or the Indian Creek 5th field watershed exceeded the threshold of concern for any of the three models. Alternatives 2, 3 and 4 would all result in some increases in sediment delivery to streams and in equivalent roaded acres (Table 72) but these changes would be small and would all be below thresholds of concern, meaning that implementation of any of the three action alternatives would add little to cumulative watershed effects within Indian Creek.

Table 74. Modeled sediment delivery and equivalent roaded acres for the existing condition (Alternative 1) and Alternatives 2, 3 and 4

Watershed	Model											
	USLE – sediment delivery in cubic yards per year				GEO – sediment delivery in cubic yards per decade				ERA – acres			
	Existing Condition	Alt 2	Alt 3	Alt 4	Existing Condition	Alt 2	Alt 3	Alt 4	Existing Condition	Alt 2	Alt 3	Alt 4
7th Field Watershed												
Indian Creek Headwaters	472.4	563.1	560.4	508.1	44,867	45,798	45,566	45,798	286.9	375.0	365.8	378.7
West Branch Indian Creek	486.7	544.3	541.9	491.6	31,285	31,390	31,221	31,390	188.1	226.4	220.5	232.3
Indian/Mill Creek	278.0	290.4	288.8	287.8	22,565	23,081	22,968	23,081	158.3	178.9	173.1	185.1
Coon-Wagner	600.1	697.7	692.4	624.2	46,438	47,291	47,049	47,291	267.4	336.0	323.0	322.7
Upper South Fork Indian Creek	444.3	444.3	444.3	444.3	34,921	34,921	34,921	34,921	118.9	118.9	118.9	118.9
Twin Valley Creek	549.8	549.8	549.8	549.8	15,513	15,513	15,513	15,513	0.10	0.10	0.10	0.10
Little South Fork Indian Creek	408.9	456.4	455.8	413.5	31,661	31,879	31,846	31,879	142.1	186.0	185.2	171.8
Cole-Clauson	447.8	496.1	495.8	458.1	50,292	50,487	50,484	50,487	317.4	350.2	346.9	344.5
East Fork Indian Creek	600.0	602.3	602.3	601.2	51,037	51,189	51,189	51,189	266.4	270.9	270.9	271.6
Luther-Ikes	384.7	386.2	386.2	386.0	35,950	36,032	36,032	36,032	354.3	359.2	359.2	359.3
Indian/Doolittle Creek	532.3	566.9	564.8	556.4	52,335	51,527	51,464	51,527	266.2	293.5	291.1	289.5
Perkins-Happy Camp	227.1	227.1	227.1	227.1	6,100	6,100	6,100	6,100	110.0	110.0	110.0	110.0
6th – Field Watershed												
Upper Indian Creek	1837.1	2095.6	2083.5	1911.7	145,155	147,560	146,805	147,560	900.7	1116.3	1082.4	1118.8
South Fork	1850.8	1946.6	1945.7	1865.6	132,388	132,801	132,765	132,801	578.4	655.2	651.2	635.3

Watershed	Model											
	USLE – sediment delivery in cubic yards per year				GEO – sediment delivery in cubic yards per decade				ERA – acres			
	Existing Condition	Alt 2	Alt 3	Alt 4	Existing Condition	Alt 2	Alt 3	Alt 4	Existing Condition	Alt 2	Alt 3	Alt 4
Indian Creek												
East Fork Indian Creek	600.0	602.3	602.3	601.2	51,037	51,189	51,189	51,189	266.4	270.9	270.9	271.6
Lower Indian Creek	1144.2	1180.2	1178.2	1169.5	94,385	93,658	93,595	93,658	730.5	762.7	760.3	758.7
5th – Field Watershed												
Indian Creek	5432.0	5842.6	5809.6	5548.1	422,964	425,207	424,354	425,207	2476.0	2805.0	2764.7	2784.4

Table 75. Cumulative watershed effects risk ratios for the existing condition and Alternatives 2, 3 and 4

Watershed	Model											
	USLE				GEO				ERA			
	Existing Condition	Alt 2	Alt 3	Alt 4	Existing Condition	Alt 2	Alt 3	Alt 4	Existing Condition	Alt 2	Alt 3	Alt 4
7th Field Watershed												
Indian Creek Headwaters	0.33	0.44	0.44	0.37	0.43	0.45	0.45	0.45	0.48	0.63	0.61	0.63
West Branch Indian Creek	0.68	0.78	0.78	0.68	0.36	0.36	0.36	0.36	0.70	0.84	0.82	0.87
Indian/Mill Creek	0.23	0.25	0.25	0.25	0.45	0.48	0.47	0.48	0.32	0.36	0.35	0.37
Coon-Wagner	0.52	0.64	0.63	0.55	0.79	0.82	0.81	0.82	0.67	0.85	0.81	0.81
Upper South Fork Indian Creek	0.09	0.09	0.09	0.09	0.22	0.22	0.22	0.22	0.26	0.26	0.26	0.26
Twin Valley Creek	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Little South Fork Indian	0.34	0.40	0.40	0.34	0.34	0.35	0.35	0.35	0.36	0.47	0.47	0.43

Watershed	Model											
	USLE				GEO				ERA			
	Existing Condition	Alt 2	Alt 3	Alt 4	Existing Condition	Alt 2	Alt 3	Alt 4	Existing Condition	Alt 2	Alt 3	Alt 4
Creek												
Cole-Clauson	0.18	0.23	0.23	0.19	0.55	0.55	0.55	0.55	0.49	0.54	0.53	0.53
East Fork Indian Creek	0.15	0.15	0.15	0.15	0.81	0.81	0.81	0.81	0.28	0.29	0.29	0.29
Luther-Ikes	0.39	0.39	0.39	0.39	0.75	0.75	0.75	0.75	0.60	0.61	0.61	0.61
Indian/Doolittle Creek	0.80	0.87	0.87	0.85	0.76	0.74	0.74	0.74	0.60	0.67	0.66	0.66
Perkins-Happy Camp	1.36	1.36	1.36	1.36	0.54	0.54	0.54	0.54	0.59	0.59	0.59	0.59
6th – Field Watershed												
Upper Indian Creek	0.43	0.52	0.52	0.46	0.51	0.52	0.52	0.52	0.50	0.63	0.61	0.63
South Fork Indian Creek	0.10	0.12	0.12	0.11	0.30	0.30	0.30	0.30	0.29	0.32	0.32	0.31
East Fork Indian Creek	0.15	0.15	0.15	0.15	0.81	0.81	0.81	0.81	0.28	0.29	0.29	0.29
Lower Indian Creek	0.67	0.69	0.69	0.69	0.74	0.73	0.73	0.73	0.59	0.61	0.61	0.61
5th – Field Watershed												
Indian Creek	0.26	0.30	0.29	0.27	0.50	0.50	0.50	0.50	0.46	0.52	0.51	0.52