

TABLE OF CONTENTS

Section	Page
List of Figures	vii
List of Tables	viii
List of Acronyms	x
Acknowledgments	xiii
Executive Summary	xiv
 1 Introduction	1-1
1.1 Overview	1-2
1.2 Objectives	1-3
1.3 Sensitive Subpopulations	1-6
1.4 Contents of Volume 2	1-10
1.5 Changes to Volume 2	1-13
1.6 Sources	1-14
 2 Risk Assessment Methods	2-1
2.1 Introduction	2-1
2.1.1 Other Information Sources	2-3
2.2 Hazard Identification	2-4
2.2.1 Approach for Fish Contaminants	2-5
2.2.2 Assumptions and Uncertainty Analysis	2-8
2.3 Dose-Response Assessment	2-10
2.3.1 Carcinogenic Effects	2-12
2.3.2 Noncarcinogenic Effects	2-13
2.3.3 Mutagenicity/Genotoxicity	2-19
2.3.4 Multiple Chemical Exposures: Interactive Effects	2-20
2.3.5 Assumptions and Uncertainties	2-22
2.4 Exposure Assessment	2-25
2.4.1 Chemical Occurrences in Fish	2-25
2.4.2 Geographic Distribution of Contaminated Fish	2-27
2.4.3 Individual Exposure Assessment	2-27
2.4.4 Population Exposure Assessments	2-33
2.4.5 Uncertainty and Assumptions	2-39
2.5 Risk Characterization	2-49
2.5.1 Carcinogenic Toxicity	2-51
2.5.2 Noncarcinogenic Toxicity	2-52
2.5.3 Subpopulation Considerations	2-53
2.5.4 Multiple Species and Multiple Contaminant Considerations	2-55

TABLE OF CONTENTS

Section	Page
	2.5.5 Incorporating Considerations of Uncertainty in Consumption Limits 2-55
	2.6 Summarizing Risk Data 2-55
3	Development and Use of Risk-Based Consumption Limits 3-1
3	3.1 Overview and Section Organization 3-1
3	3.2 Equations Used to Develop Risk-Based Consumption Limits 3-2
3	3.2.1 Calculation of Consumption Limits for Carcinogenic Effects 3-2
3	3.2.2 Calculation of Consumption Limits for Noncarcinogenic Effects 3-7
3	3.2.3 Developmental Effects 3-8
3	3.3 Default and Alternative Values for Calculating Consumption Limits 3-9
3	3.3.1 Maximum Acceptable Risk Level 3-10
3	3.3.2 Cancer Potencies and Chronic Reference Doses (q_1^* 's and RfDs) 3-11
3	3.3.3 Consumer Body Weight (BW) 3-11
3	3.3.4 Meal Size 3-12
3	3.3.5 Contaminant Concentration in Fish Tissue 3-14
3	3.3.6 Modifying Time-Averaging Period (T_{ap}) 3-14
3	3.4 Modification of Consumption Limits for a Single Contaminant in a Multispecies Diet 3-15
3	3.4.1 Carcinogenic Effects 3-15
3	3.4.2 Noncarcinogenic Effects 3-16
3	3.5 Modification of Consumption Limits for Multiple Contaminant Exposures 3-17
3	3.5.1 Carcinogenic Effects 3-19
3	3.5.2 Noncarcinogenic Effects 3-20
3	3.5.3 Species-Specific Consumption Limits in a Multiple Species Diet 3-22
4	Risk-Based Consumption Limit Tables 4-1
4	4.1 Overview and Section Organization 4-1
4	4.2 Consumption Limit Tables 4-2
5	Toxicological Profile Summaries for Target Analytes 5-1
5	5.1 Introduction 5-1
5	5.1.1 Categories of Information Provided for Target Analytes 5-1
5	5.1.2 Abbreviations Used and Scientific Notation 5-8
5	5.2 Metals 5-9
5	5.2.1 Arsenic 5-9
5	5.2.2 Cadmium 5-13
5	5.2.3 Mercury 5-18

TABLE OF CONTENTS

Section		Page
5.2.4	Selenium	5-25
5.2.5	Tributyltin Oxide	5-29
5.3	Organochlorine Pesticides	5-33
5.3.1	Chlordane	5-33
5.3.2	DDT, DDE, DDD	5-36
5.3.3	Dicofol (Kelthane)	5-42
5.3.4	Dieldrin	5-44
5.3.5	Endosulfan I, II	5-50
5.3.6	Endrin	5-52
5.3.7	Heptachlor Epoxide	5-55
5.3.8	Hexachlorobenzene	5-58
5.3.9	Lindane (γ -hexachlorocyclohexane)	5-62
5.3.10	Mirex	5-66
5.3.11	Toxaphene	5-69
5.4	Organophosphate Pesticides	5-73
5.4.1	Chlorpyrifos	5-73
5.4.2	Diazinon	5-75
5.4.3	Disulfoton (Disyston)	5-78
5.4.4	Ethion	5-80
5.4.5	Terbufos	5-82
5.5	Chlorophenoxy Herbicides	5-86
5.5.1	Oxyfluorfen	5-86
5.6	Polycyclic Aromatic Hydrocarbons (PAHs)	5-88
5.6.1	Background	5-88
5.6.2	Pharmacokinetics	5-88
5.6.3	Acute Toxicity	5-89
5.6.4	Chronic Toxicity	5-89
5.6.5	Developmental Toxicity	5-90
5.6.6	Mutagenicity	5-90
5.6.7	Carcinogenicity	5-90
5.6.8	Special Susceptibilities	5-92
5.6.9	Interactive Effects	5-92
5.6.10	Critical Data Gaps	5-93
5.6.11	Summary of EPA Health Benchmarks	5-93
5.6.12	Major Sources	5-93
5.7	Polychlorinated Biphenyls (PCBs)	5-94
5.7.1	Background	5-94
5.7.2	Pharmacokinetics	5-94
5.7.3	Acute Toxicity	5-95
5.7.4	Chronic Toxicity	5-95
5.7.5	Developmental Toxicity	5-96
5.7.6	Mutagenicity	5-98
5.7.7	Carcinogenicity	5-98
5.7.8	Special Susceptibilities	5-101
5.7.9	Interactive Effects	5-101

TABLE OF CONTENTS

Section		Page
	5.7.10 Critical Data Gaps	5-101
	5.7.11 Summary of EPA Health Benchmarks	5-101
	5.7.12 Major Sources	5-101
5.8	5.8 Dioxins	5-102
	5.8.1 Background	5-102
	5.8.2 Pharmacokinetics	5-102
	5.8.3 Acute Toxicity	5-103
	5.8.4 Chronic Toxicity	5-103
	5.8.5 Reproductive and Developmental Toxicity	5-104
	5.8.6 Mutagenicity	5-104
	5.8.7 Carcinogenicity	5-104
	5.8.8 Special Susceptibilities	5-105
	5.8.9 Interactive Effects	5-105
	5.8.10 Critical Data Gaps	5-105
	5.8.11 Summary of EPA Health Benchmarks	5-105
	5.8.12 Major Sources	5-105
6	Mapping Tools for Risk Assessment and Risk Management	6-1
	6.1 Overview of Population and Contaminant Mapping	6-1
	6.2 Objectives of Mapping	6-1
	6.3 Basic GIS Concepts for Population and Contaminant Mapping	6-2
	6.4 Internet Sources of Existing Data Files and GIS Coverages	6-5
	6.5 Data Needed for Mapping	6-6
	6.6 Mapping Programs	6-7
	6.7 National Listing of Fish and Wildlife Advisories (NLFWA) Database .	6-8
7	Literature Cited	7-1
Appendix		
A	Reviewers of First Edition of Guidance Document	A-1
B	Population Exposure Assessment—Consumption Patterns and Surveys	B-1
C	Dose Modification Due to Food Preparation and Cooking	C-1
D	Guidance for Risk Characterization	D-1
E	Additional Developmental toxicity Issues	E-1
F	Summary of Limits of Detection for the Recommended Target Analytes	F-1

LIST OF FIGURES

Number		Page
1-1	Series Summary: Guidance for Assessing Chemical Contamination Data for Use in Fish Advisories	1-11
2-1	Elements or Risk assessment and risk management	2-2
2-2	Schematic of exposure categories in upper half of a normal population distribution	2-38
6-1	GIS Data Layers may use raster or vector Representation techniques	6-3
6-2	Examples of GIS Displays from EPA's BASINInfo Maps-on-Demand Facility	6-6
6-3	Map showing active fish and wildlife advisories for a state	6-7

LIST OF TABLES

Number		Page
1-1	Target Analytes Recommended for Fish Sampling Programs	1-3
1-2	Comparison of FDA Action Levels and Tolerances with EPA Screening Values	1-6
1-3	Fish Consumption Rates for Various Fisher Populations	1-9
2-1	Uncertainty Factors and Modifying Factors for Estimating Exposure Limits for Chronic Effects	2-17
2-2	Mean Body Weights of Children and Adults	2-29
2-3	Categories of Information Necessary for a Population Exposure Assessment	2-34
2-4	Exposure Data Template	2-47
2-5	Risk Estimates	2-57
2-6	Risk Characterization	2-58
2-7	Risk Summaries for a Waterbody	2-59
2-8	Risk Summaries for a Geographic Area	2-61
3-1	Risk Values Used in Risk-Based Consumption Limit Tables	3-3
3-2	Input Parameters for Use in Risk Equations	3-6
3-3	Monthly Fish Consumption Limits for Carcinogenic and Noncarcinogenic Health Endpoints—Chlordane	3-10
3-4	Monthly Consumption Limits for Carcinogenic and Noncarcinogenic Health Endpoints- Chlordane	3-11
3-5	Average Body Weights and Associated Multipliers	3-13
4-1	Monthly Fish Consumption Limits for Carcinogenic and Noncarcinogenic Health Endpoints - Arsenic	4-3
4-2	Monthly Fish Consumption Limits for Noncarcinogenic Health Endpoint - Cadmium	4-4
4-3	Monthly Fish Consumption Limits for Noncarcinogenic Health Endpoint - Methylmercury	4-5
4-4	Monthly Fish Consumption Limits for Noncarcinogenic Health Endpoint - Selenium	4-6
4-5	Monthly Fish Consumption Limits for Noncarcinogenic Health Endpoint - Tributyltin	4-7
4-6	Monthly Fish Consumption Limits for Carcinogenic and Noncarcinogenic Health Endpoints - Chlordane	4-8
4-7	Monthly Fish Consumption Limits for Carcinogenic and Noncarcinogenic Health Endpoints - DDT	4-9
4-8	Monthly Fish Consumption Limits for Noncarcinogenic Health Endpoint - Dicofol	4-10

LIST OF TABLES

Number		Page
4-9	Monthly Fish Consumption Limits for Carcinogenic and Noncarcinogenic Health Endpoints -Dieldrin	4-11
4-10	Monthly Fish Consumption Limits for Noncarcinogenic Health Endpoint - Endosulfan	4-12
4-11	Monthly Fish Consumption Limits for Noncarcinogenic Health Endpoint - Endrin	4-13
4-12	Monthly Fish Consumption Limits for Carcinogenic and Noncarcinogenic Health Endpoints - Heptachlor Epoxide	4-14
4-13	Monthly Fish Consumption Limits for Carcinogenic and Noncarcinogenic Health Endpoints - Hexachlorobenzene	4-15
4-14	Monthly Fish Consumption Limits for Carcinogenic and Noncarcinogenic Health Endpoints - Lindane	4-16
4-15	Monthly Fish Consumption Limits for Carcinogenic and Noncarcinogenic Health Endpoints - Mirex	4-17
4-16	Monthly Fish Consumption Limits for Carcinogenic and Noncarcinogenic Health Endpoints - Toxaphene	4-18
4-17	Monthly Fish Consumption Limits for Noncarcinogenic Health Endpoint - Chlorpyrifos	4-19
4-18	Monthly Fish Consumption Limits for Noncarcinogenic Health Endpoint - Diazinon	4-20
4-19	Monthly Fish Consumption Limits for Noncarcinogenic Health Endpoint - Disulfoton	4-21
4-20	Monthly Fish Consumption Limits for Noncarcinogenic Health Endpoint - Ethion	4-22
4-21	Monthly Fish Consumption Limits for Noncarcinogenic Health Endpoint - Terbufos	4-23
4-22	Monthly Fish Consumption Limits for Noncarcinogenic Health Endpoint - Oxyfluorfen	4-24
4-23	Monthly Fish Consumption Limits for Carcinogenic Health Endpoint - PAHs	4-25
4-24	Monthly Fish Consumption Limits for Carcinogenic and Noncarcinogenic Health Endpoints - PCBs	4-26
4-25	Monthly Fish Consumption Limits for Carcinogenic Health Endpoint - Dioxins/Furans	4-27
5-1	Health and Toxicological Data Reviewed for Target Analytes	5-2
5-2	Toxicity Equivalent Factors for Various PAHs	5-91
5-3	Relative Potency Estimates for Various PAHs	5-92
5-4	Reported Concentrations (ppm) of Dioxin-Like Congeners in Commercial Aroclor Mixtures	5-100
5-5	PCB and Dioxin Concentrations (ppb) in Channel Catfish	5-100
6-1	Comparison of Raster- Versus Vector-Based GIS Programs	6-4