Chapter E5: Societal Revealed Preference Approach for Valuing Special Status Fish Species

This chapter presents the results of EPA's evaluation of the economic losses from affected special status fish species and habitats that are associated with impingement and entrainment (I&E) at the Contra Costa and Pittsburg facilities in the San Francisco Estuary.

CHAPTER CONTENTS

E5-1 VALUING SPECIAL STATUS SPECIES

The economic benefits of preservation or restoration of threatened and endangered (T&E), or other fish species designated with a special status, are often derived as nonuse values. The standard benefits transfer approach used for other species often does not apply to special status species because T&E species are protected from recreational or commercial fishing. Other T&E fish have been so depleted that any recent use estimates from angling participation or landings would not be indicative of the species' potential value for direct use (e.g., striped bass or several salmon species). So, while consumptive use benefits for some T&E fish may be estimated when populations recover in the future, for now, use-related benefits are not readily estimable given available data.

Given the lack of direct use value associated with T&E species, nonuse values are therefore the main source for benefit estimation for these species. To estimate nonuse values, one approach is generally available — stated preference methods such as the contingent valuation method (CVM). However, CVM or other primary stated preference approaches are not a feasible approach for EPA to apply in this rulemaking because the time and cost associated with conducting the necessary primary research is beyond resources and time schedule available to the Agency.

As a result, EPA is pursuing an approach that uses actual sums of money which society has dedicated to restoring and preserving T&E species fish as an indication of society's revealed preference valuation for protecting those species. Money set aside in programs designed specifically to protect T&E species or values foregone by water users in taking actions to protect species can be used as an indication of the value that society places on preserving T&E species.

The revealed preference approach to valuing T&E species fish in the bay-delta ecosystem involves several steps. First, the costs that society had demonstrated that it is willing to pay to restore T&E fish species is calculated. For the bay-delta region, a federal- and state-level effort known as the CALFED Bay-Delta Program is a multiyear program that brings together many of the efforts to restore the bay-delta ecosystem. One of the first goals under this program is to protect and restore T&E fish populations. Annual costs to protect T&E fish are estimated from total CALFED costs. In addition, water users are foregoing approximately 3-4 million acre feet (AF) of water per year for improved fish habitat that would normally go to municipal and agricultural water users in Central and Southern California. These values are summed to reveal a total willingness to pay. Second, the number of T&E fish needed to restore populations to predecline levels is calculated. These calculations are based on historical records of abundance of T&E species in the bay-delta area. Target populations based on predecline levels for T&E species are compared with estimates of current abundance to determine the number of fish to be restored. Third, by combining the cost and fish estimates outlined above, a revealed preference dollar per fish value can be calculated. This dollar per fish value can then be used to value age 1 equivalent losses at baseline for I&E at the Pittsburg and Contra Costa facilities.

E5-2 Habitat Restoration Costs

Californians have made significant investments to protect and restore bay-delta native fish populations. Improvements have been made to fish habitats by increasing stream flows, installing screening devices and fish passages, removing dams, changing water flows, and controlling temperatures. These changes in operations and technologies all entail significant costs, which society has shown to be willing to pay for the protection and restoration of healthy fish populations, particularly the threatened and endangered species of the Sacramento and San Joaquin rivers. These investments provide a means to evaluate the loss imposed on society when a portion of these same fisheries are adversely impacted by I&E.

One of the programs through which investments to protect and restore bay-delta fish populations will be made is through the CALFED program. The CALFED program is designed to guide restoration and management of the bay-delta area over the next 30 years or more. The CALFED Ecosystem Restoration Program Plan (ERPP) is one of the interrelated CALFED plans designed to restore the ecological health of the bay-delta ecosystem. The ERPP is designed to improve and restore aquatic and terrestrial habitats and natural processes to support stable, self-sustaining populations of plant and animal species. The ERPP has six strategic goals, the first of which is to recover at-risk native species in the bay-delta ecosystem and to minimize the need for future endangered species listings of native species in the bay-delta ecosystem by reversing downward population trends of native species currently not listed. There are nine special status species identified under the ERPP with a goal of recovering each species. These species are delta smelt, longfin smelt, green sturgeon, Sacramento splittail, Sacramento winter-run chinook salmon, Central Valley spring-run chinook salmon, late-fall-run chinook salmon, fall-run chinook salmon, and Central Valley steelhead.

CALFED implementation will proceed in stages, starting with over $8 billion invested in Stage 1, which covers the first 7 years of the 30 year or more program (CALFED, 2000b). Over $1.4 billion of this total will be spent on the ERPP and environmental water quality. A majority of the amount spent on the ERPP in stage 1 benefits special status species, especially fish. However, because of the interrelated nature of the CALFED process, it is impossible to tell exactly what percentage of funds spent will benefit special status fish species. Table E5-1 shows projected CALFED program costs for Stage 1 for all program elements.

Table E5-1: Estimated Costs for CALFED Program Stage 1 (millions of dollars) (2000 dollars)

Program Element	Program Years							Total
	1	2	3	4	5	6	7	
Ecosystem restoration	$220	$165	$125	$120	$170	$170	$170	$1,140
Environmental water quality	$15	$33	$38	$48	$50	$48	$48	$280
Environmental water account	$50	$50	$50	$50	$0	$0	$0	$200
Water use efficiency	$31	$62	$299	$641	$641	$641	$641	$2,956
Water transfers	$3	$3	$3	$2	$2	$1	$1	$15
Watershed management	$40	$45	$45	$45	$45	$40	$40	$300
Drinking water quality	$41	$78	$82	$110	$116	$120	$128	$675
Levees	$33	$76	$78	$82	$45	$65	$65	$444
Storage	$50	$75	$138	$208	$266	$349	$339	$1,425
Conveyance	$29	$66	$150	$198	$220	$160	$98	$921
CALFED science program	$25	$30	$45	$50	$50	$50	$50	$300
Total	$537	$683	$1,053	$1,554	$1,605	$1,644	$1,580	$8,656

Based on July 2000 numbers in EIS/EIR, updated according to Terry Mills of CALFED.
Environmental water quality separated out of ecosystem restoration cost estimate.
Source: CALFED, 2000b.

An unofficial estimate of the total cost for habitat restoration needed over the life of the CALFED project is $2.5 billion (D. Daniel, CH2MHill, Sacramento office, personal communication, June 2001. Mr. Daniel was involved with design of the ERPP). If the ratio of the Stage 1 habitat restoration costs to the total restoration costs is assumed to apply for all program elements, total CALFED program costs can be estimated. Using this method, total CALFED costs would reach $19 billion over the 30 year or more life of the program.

As the CALFED program progresses, fewer funds will directly benefit special status species fish. At the low end, it is assumed that over the life of the program 40 percent of the ERPP funds, 40 percent of the money spent on environmental water quality, and 90 percent of the Environmental Water Account (EWA) benefit special status fish.[1] This assumption results in an estimated expenditure of $1.64 billion. At the other end of the spectrum, it is assumed that 80 percent of the ERPP funds and the environmental water quality element benefit special status species, and that 10 percent of each of the other CALFED program elements also benefit special status species, except the EWA, where the 90 percent benefit level is maintained. This high cost assumption results in an estimate of costs to restore special status species fish of $4.43 billion.

In order to check estimates for habitat restoration costs by comparison against another cost estimation method, a most likely scenario for allocation of total CALFED program costs to special status species fish was developed. For that scenario, 60 percent of the ERPP and environmental water quality funds, 90 percent of the EWA funds, and 10 percent of the other program categories directly benefit special status species fish. This scenario indicates costs totaling $3.81 billion.

The other approach, developed for comparison purposes, is to estimate the habitat restoration costs directly. Three main categories of costs are considered: 1) cost for fish screens, 2) cost for tidal wetland habitat restoration in the delta, and 3) cost for riparian habitat restoration in streams feeding the delta. This direct approach is developed below.

Approximately 5,000 cfs of diversions are related to large water projects in the delta — the State Water Project (SWP) and the Central Valley Project (CVP). At $10,000 per cfs, the cost to screen these diversions would be $50 million. With another $75 to $80 million to retrofit screens at power plants in the delta, and $100 million to screen smaller diversions for agriculture and other uses, the total for fish screens in the delta is approximately $225 million (Michael Thabault, US Fish and Wildlife Service, personal communication, June 2001).

For tidal wetland restoration in the delta, the cost per acre of restoration is generally expected to range from $10,000 to $100,000, depending on many factors including the density of existing development in the area, comparable real estate costs in the area, and other factors. CALFED estimates that the goal for restoration of tidal wetland and related habitat is approximately 110,000 acres (CALFED, 2000a). Using a tidal wetland restoration value of $30,000 per acre (selected from range of $20,000 to $50,000 suggested by D. Daniel, CH2M Hill, personal communication, June 2001),[2] the total cost would be $3.3 billion.

For stream restoration outside of the delta, restoration costs per acre are approximately $4,000 (Dick Daniel, CH2M Hill, personal communication, June 2001). CALFED estimates that there are approximately 33,200 acres of riparian and riverine aquatic habitat or stream channel meander habitat to restore (CALFED, 2000a). The total cost for riparian habitat would be approximately $132.7 million. Adding the three cost components, the total restoration costs appear to be about $3.6 billion ($296.2 million if annualized over 30 years to match the project life length of the CALFED program, using an interest rate of 7 percent). This direct approach cost estimate is comparable to the revealed preference approach cost estimate derived above ($3.8 billion).

E5-3 Opportunity Costs of Water Use Foregone to Protect Special Status Species Fish

Several actions have been taken to increase stream flows for improved fish habitat. The most significant reduction in water use to meet these increases in stream flows has been experienced by urban and agricultural water users who obtain their supplies from the Bureau of Reclamation. The Bureau has had to cut back on supply to its CVP customers to comply with the various water needs and restrictions of the Federal Endangered Species Act (FESA) and California Endangered Species Act (CESA), the CVP Improvement Act (CVPIA), and the new bay-delta water quality standards issued in 1995 by the State Water Resources Control Board. For these purposes, the Bureau has reduced by 40 percent to 60 percent its usual 7 million AF per year delivered to water users without water rights (Earl Cummings, California Division of Water Resources, Environmental Services Office, personal communication, March 2000; Jeff Sandberg, Central Valley Project, personal

[1] The EWA is set up to provide additional water for protection of fish beyond the regulatory actions required for water project operations. The EWA is a cooperative effort to give water managers the flexibility needed to protect fish as well as maintain water project operations.

[2] The smaller range ($20,000 to $50,000 as compared to $10,000 to $100,000) was used because most of the land acquisition costs to date have been in the low end of the $10,000 to $100,000 range, and values in the high end of the range are not expected until competition increases for land more desirable for development.

communication, March 2000). Thus, the Bureau has foregone 3 to 4 million of acre feet per year for environmental water use intended for the Sacramento and San Joaquin rivers. EPA estimated a range of value to California water users from $155 to $425 per AF (the calculation is explained in Appendix E3, and is a weighted average reflecting agricultural and municipal uses). Using this estimate, the value to California water users of the water the Bureau has foregone ranges from $465 million to $1.7 billion annually.

E5-4 Current Abundance and Restoration Targets

To calculate the number of fish needed to restore T&E species fish, the current abundance of T&E species was estimated and subtracted from target abundance for each species. Estimates of current abundance, target abundance, and number of fish needed to restore T&E fish populations are given in Table E5-2.

Table E5-2: Recovery Goal for Special Status Species Abundance in Bay-Delta Region

Special Status Fish Species	Target Abundance[a]	Current Abundance[b]	Difference[c]
Delta smelt	1,634,065	334,855	1,299,210
Longfin smelt	6,382,913	636,225	5,746,688
Sacramento splittail	24,418	7,973	16,445
Green sturgeon	1,000	739	261
Winter-run chinook salmon	35,929	1,232	34,697
Spring-run chinook salmon	9,248	7,683	1,565
Fall-run chinook salmon	219,394	284,894	–[d]
Late-fall run chinook salmon	19,261	8,078	11,183
Central Valley steelhead	40,000	8,525	31,475
Total	8,366,228	1,290,204	7,141,524

[a] Target abundance are targets for recovery of special status species based on CALFED Ecosystem Restoration Program Plan stated goal to return species abundance to pre-decline levels. All targets for salmon are the median value from the 1970-1974 time period. The values for delta smelt, longfin smelt and Sacramento splittail were set to the median value from 1970 to 1972. The value for steelhead corresponds to the estimated population level in the 1960's and green sturgeon target is identified in the ERPP as the median value from the 1980's.

[b] Current abundance is equal to the median value for the period 1990-2000 or the median of the most recent values available from 1990 onward.

[c] The difference represents the number of fish for each species needed to move from current abundance to target abundance.

[d] The median number of fall-run chinook salmon in the 1990's is greater than the median value from the early 1970's target period. Therefore, the number of fish required for restoration was set to 0.

EPA calculated the current abundance of salmon species from data provided by California Department of Fish and Game, Native Anadromous Fish and Watershed Branch. The median abundance for 1990 to 2000 was taken to be representative of current abundance. Current abundance of Central Valley steelhead was calculated from data provided by California Department of Fish and Game. The median abundance for 1990 to 1996 was taken to be representative of current abundance (values after 1996 were not used because the data were incomplete). Green sturgeon abundance was calculated from data provided by the California Department of Fish and Game, Central Valley Bay-Delta Branch. The median of available values in the 1990's was taken as representative of current abundance.

To estimate the abundance of the Sacramento splittail, longfin smelt, and delta smelt in the delta, data were used from the fall midwater trawl survey. This trawl survey is conducted annually by the California Department of Fish and Game (CDFG) and provides the most accurate index of the abundance of these special status species. Each fall, the CDFG counts the number of striped bass, delta smelt, longfin smelt, American shad, and splittail caught in their 12 ft by 12 ft nets (CDFG, 2002d). This sampling covers a large geographic area within the delta and has been conducted fairly consistently for more than 30 years. Using these abundance indices, along with a technique first introduced by Stevens et al. (1990), EPA was able to estimate the bay-delta population of each species.

In their 1990 report to the California Fish and Game Commission, Stevens et al. (1990) calculated the delta smelt population by using the ratio of juvenile delta smelt to young striped bass caught in the fall trawl. This ratio was multiplied against

striped bass population numbers that were derived from a life table analysis. The resulting population estimate of delta smelt is the only known attempt to approximate total delta smelt populations in the Sacramento-San Joaquin delta. Unfortunately, only 8 years of striped bass populations were presented to the commission. Using the 8 years of available striped bass populations, EPA extrapolated longfin, delta smelt, and splittail populations through the 1990's and into 2000. This extrapolation involved:

- averaging (across the 8 years) the percentage of the total striped bass population caught in the trawling runs; and
- dividing the average percentage of the bass population caught in the trawling runs by the delta smelt, Sacramento splittail, and longfin smelt abundance indices.

Population numbers derived for delta smelt, longfin smelt, and Sacramento splittail using this method are shown in Appendix E3.

CALFED set targets for the restoration of the nine special status fish species included in the ERPP (Table E5-2). In general, the overall goal for each species target is set to restore fish numbers to equal abundance and dispersion in the delta before the major decline in these species. For most species, this means restoring numbers to those recorded in the 1960's and 1970's. Because complete data sets were only available for most species back through 1970, restoration targets for salmon species were set using data from 1970-1974. The median value from this period was used as the restoration target. EPA used specific restoration targets listed in the ERPP of 40,000 steelhead and 1,000 green sturgeon greater than 1 meter (m) long.

Data derived from striped bass populations for delta smelt, longfin smelt, and Sacramento splittail were used to determine restoration targets for those species. The median value from 1970-1972 was used as representative of predecline levels.

Restoration targets were then compared with current fish abundance to calculate the number of fish needed to restore special status species in the bay-delta region. These restoration numbers are also given in Table E5-2. In total, over 7.1 million special status species fish are needed to meet long-term CALFED restoration goals.

E5-5 Total Costs for Special Status Species Fish

Table E5-3 shows total costs to protect special status species fish. Ranges of annual values for habitat restoration and water use foregone are summed. The resulting range is $598 million to $2.06 billion. Dividing by the number of special status species fish required to restore fish populations, the dollar per fish ranges from $84 to $288, with a most likely value of $195.

Table E5-3: Total Annual Costs for Special Status Species Fish (2000 dollars)

	Low	High
Restoration[a]	$133	$359
Water Use Foregone[a]	$465	$1,700
Total[a]	$598	$2,059
$/Fish	$83.72	$288.28

[a] Costs in millions, except $/fish.

Damages from I&E at Pittsburg and Contra Costa power plants

Tables E5-4 and E5-5 show the adult equivalents of special status species fish impinged and entrained, respectively, at the Pittsburg and Contra Costa power plants. The adult equivalents were calculated in Chapter E3. The number of adult equivalent special status species fish impinged at the Pittsburg and Contra Costa facilities was 145,003 fish. The value of impinged fish ranges from $12,139,700 to $41,801,500. The number of adult equivalent special status species fish entrained at the Pittsburg and Contra Costa facilities was 269,334 fish. When the range of values developed earlier is applied, the value of the entrained fish ranges from $22,548,600 to $77,643,600.

Table E5-4: Impingement Losses at the Pittsburg and Contra Costa Facilities (2000 dollars)

Species	Contra Costa	Pittsburgh	Total	Low Losses	High Losses
Chinook salmon	585	493	1,078	$90,250	$310,766
Delta smelt	7,195	11,259	18,454	$1,544,969	$5,319,919
Longfin smelt	13,105	99,184	112,289	$9,400,835	$32,370,673
Sacramento splittail	7,892	5,290	13,182	$1,103,597	$3,800,107
Total special status	28,777	116,226	145,003	$12,139,651	$41,801,465

Table E5-5: Entrainment Losses at the Pittsburg and Contra Costa Facilities (2000 dollars)

Species	Contra Costa	Pittsburgh	Total	Low Losses	High Losses
Chinook salmon	27	61	88	$7,367	$25,369
Delta smelt	67,362	201,512	268,874	$22,510,131	$77,510,131
Longfin smelt	48	285	333	$27,879	$95,997
Sacramento splittail	14	25	39	$3,265	$11,243
Total special status	67,451	201,883	269,334	$22,548,642	$77,643,606

E5-6 CONCLUSIONS

The revealed preference approach allows the use of actual sums of money that society has dedicated to restoration and preservation of T&E species to value those species in situations where applying stated preference valuations methods are not feasible for EPA's rulemaking. In this case, resources dedicated to the CALFED program and foregone water use are taken as indicative of society's willingness to pay for restoration of T&E fish species in the bay-delta region to predecline population levels. The approach indicates that society is willing to pay between $83.72 and $288.28 per fish for restoration of T&E fish populations. When impingement and entrainment losses at the Pittsburg and Contra Costa power plants are valued per fish, total annual impingement losses range from $12,139,700 to $41,801,500 and total entrainment losses range from $22,548,600 to $77,643,600 per year.