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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
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DEC 15 1993

To Interested Parties:

Enclosed for your review is a copy of the "Draft Regulatory Impact Assessment of the Proposed Water Quality Standards for the San Francisco Bay/Delta and Critical Habitat Requirements for the Delta Smelt".

The U.S. Environmental Protection Agency (USEPA) Region 9 will be accepting written comments regarding this report through March 11, 1994. Please send your comments to:

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This draft Regulatory Impact Assessment (RIA) was prepared to meet the requirements established by the Office of Management and Budget. The analysis focuses on the key issues and assumptions needed to assess the economic impacts of the proposed federal actions. Although USEPA believes that the information presented is correct and the results represent a reasonable assessment of the costs and benefits of its proposal, USEPA welcomes information and comments. USEPA has identified areas of uncertainty and expects that public comment will provide valuable insights regarding the assessment and minimization of economic impacts.

USEPA encourages public comment on both the analytic assessment of economic impacts (e.g. methodology and information) and innovative mechanisms to assure the most cost-effective method for implementation.

Thank you for your interest in the draft RIA. If you have any questions, please call Palma Risler of my staff at (415) 744-2017.

Sincerely,

Harry Seraydarian, Director
Water Management Division

Enclosure

Draft
Regulatory Impact Assessment of the Proposed Water Quality Standards for the San Francisco Bay/Delta and Critical Habitat Requirements for the Delta Smelt

U.S. Environmental Protection Agency
Region 9
Water Management Division
75 Hawthorne Street
San Francisco, CA 94105

Draft for public comment
December 15, 1993

Draft
Regulatory Impact Assessment of the Proposed Water Quality Standards for the San Francisco Bay/Delta and Critical Habitat Requirements for the Delta Smelt

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December 15, 1993

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Executive Summary

BACKGROUND

This draft regulatory impact assessment (RIA) has been prepared in compliance with Executive Order 12866 (E.O. 12866), which requires federal agencies to assess the costs and benefits of each significant rule they propose or promulgate. This RIA addresses two interrelated regulatory actions, the U.S. Environmental Protection Agency's (USEPA's) proposed water quality standards for the San Francisco Bay/Sacramento-San Joaquin River Delta estuary (Bay/Delta estuary) under the Clean Water Act (CWA) and the U.S. Fish and Wildlife Service's (USFWS's) proposed designation of critical habitat for the Delta smelt under the federal Endangered Species Act (ESA).

The principal requirements of the executive order are that the agencies define the need for the regulation, analyze alternative approaches to the regulation, and perform an analysis comparing the benefits of the regulation with the costs that the regulation imposes. It is important to note that USEPA's proposed action consists not of an implementation plan, but of proposed water quality criteria. Under the CWA, the state has the lead in developing an implementation plan. This RIA does not analyze the state's implementation plan; however, different implementation scenarios were developed for use in the RIA analysis to assist USEPA in understanding the economic impacts of its actions as required by E.O. 12866.

USEPA believes that the information and analysis presented in this draft RIA are correct and that the results represent a reasonable assessment of the costs and benefits of its proposal; however, USEPA welcomes information and comments on this draft RIA. USEPA has identified areas of uncertainty and expects that public review will greatly assist in assessing and minimizing economic impacts. In preparing the promulgation of the final regulation, USEPA also is requesting comments on the modifications of standards that may change the water supply impacts. The RIA will be revised for the final regulatory action.

USEPA gratefully acknowledges the assistance of a number of researchers from the University of California in preparing this RIA. Drs. David Zilberman, Richard Howitt, and David Sunding developed important information for the RIA in their report Economic Impacts of Water Quality Regulations in the San Francisco Bay and Delta. Drs. Chris Dumas, W. Michael Hanemann, and John Loomis contributed to the RIA through their report Economic Benefits of USEPA's proposed Bay-Delta Standards.

NEED FOR REGULATION

The Bay/Delta estuary is the largest estuary along the west coast of the United States. It encompasses roughly 1,600 square miles and drains more than 40% of the water in California. The Bay/Delta estuary is the point of convergence of California's two major river systems: the Sacramento River system, which drains a large part of northern California, and the San Joaquin River system, which drains a large part of central California. The Bay/Delta estuary constitutes one of the largest habitats for fish in the United States, supporting more than 120 fish species, including the Delta smelt. The Bay/Delta also comprises one of the largest waterfowl habitats in the United States, providing stopover or homes for more than one-half of the waterfowl and shorebirds migrating on the Pacific Flyway.

The Bay/Delta estuary is the hub of California's two major water distribution systems: the State Water Project (SWP), operated by the California Department of Water Resources (DWR), and the Central Valley Project (CVP), operated by the U.S. Bureau of Reclamation (Reclamation). Both convey water from northern California to southern California through the Bay/Delta estuary.

In 1978, the California State Water Resources Control Board (SWRCB) adopted and submitted to USEPA a water quality control plan containing a comprehensive set of water quality standards for the Bay/Delta estuary. The key SWRCB criteria intended to protect fish and wildlife uses were the striped bass spawning and survival criteria. These criteria were established to provide minimum salinity and flow conditions at critical points in the Bay/Delta estuary to protect the fishery at levels that would have existed in the absence of the SWP and CVP. Since the 1978 plan was adopted, the standards have not accomplished the intended goal of maintaining the striped bass fishery at the levels that would have existed in the absence of the SWP and CVP. The precipitous decline in striped bass is also indicative of the poor health of other aquatic species, including the chinook salmon, Sacramento splittail, longfin smelt, and Delta smelt.

The 1978 SWRCB water quality control plan, adopted to meet CWA Section 303 water quality standards, was accompanied by a water right decision (D-1485) that placed permit conditions on the operation of the SWP and CVP. USEPA's approval of the plan was conditioned on the state's commitment to revise the standard, if necessary, to maintain historical levels of the fisheries. In 1987, USEPA notified the state that the 1978 plan standards were inadequate to protect the estuary. Rather than imposing federal standards, USEPA agreed to wait until the state completed a 3-year hearing process to revise the 1978 plan. In 1988, the state proposed and then withdrew a draft plan. In May 1991, the state adopted a revised water quality control plan. The 1991 plan made only minor changes to the 1978 plan standards and postponed consideration of any standards that would significantly affect freshwater flows. On September 3, 1991, USEPA disapproved the standards in the 1991 plan for failure to protect the designated uses of the estuary. In April 1992, the governor of California directed the SWRCB to adopt "interim" standards by the end of 1992. Under direction of the governor of California, the state released interim standards in its draft decision (D-1630) in December 1992 that would have reduced exports from the Delta by about 10%. However, in April 1993, the governor reversed his position on the need for interim standards and stated that ongoing federal actions under the ESA to protect Delta smelt and winter-run salmon would make the state's process irrelevant. In response to the governor's announcement, USEPA, USFWS, Reclamation, and the National Marine Fisheries Service (NMFS) have been developing a comprehensive integrated strategy for fish and wildlife protection and federal water allocations in the Bay/Delta estuary. USEPA has found that the proposed water quality criteria are necessary to meet the requirements of the CWA and is proposing water quality criteria that will be applicable to California waters.

Because of the continuing decline of Delta smelt populations, in 1991, in an action separate from the development of water quality standards, USFWS published a proposal to list the Delta smelt as threatened under the ESA. In March 1993, USFWS determined the Delta smelt to be a threatened species, finding that the regulatory mechanisms currently in effect do not provide adequate protection for the Delta smelt or its habitat.

ALTERNATIVES CONSIDERED

The key objectives of establishing water quality standards are to maintain and protect the Bay/Delta estuarine habitat, to protect salmon, and to protect striped bass spawning habitat. The RIA briefly describes the alternatives that were considered in developing the proposals and the approaches selected that would reach these objectives. These approaches will:

- reflect estuarine habitat conditions prior to the precipitous decline of the estuary's biological populations and therefore serve as a useful definition of healthy fishery resources,
- provide more consistent smolt survival levels and minimize situations in which extraordinary measures are necessary to preserve salmon runs, and
- fully protect the historical spawning range of striped bass on the lower San Joaquin River consistent with the natural variability in salinity levels in different water years.

In addition, the USFWS action, designation of the critical habitat for the Delta smelt, has the objective of maintaining the habitat conditions necessary for the survival and recovery of the Delta smelt.

Implementation Actions

Under the CWA, the state has the primary responsibility for establishing and implementing water quality standards. Although the implementation plan of the state has not yet been developed, USEPA analyzed alternative scenarios as part of USEPA's responsibility for preparing an RIA on proposed regulations. The analysis is based on the following assumptions:

- The primary method for implementing the combined federal proposals will be increases in Delta outflow. The proposed requirements were modeled by DWR and water supply reductions are estimated to be 0.54 million acre-feet (maf) on average and 1.1 maf in a critically dry year. These water supply impacts are not directly additive to the existing water requirements for the winter-run salmon because the water requirements for the species and habitat overlap.

- Increased Delta outflow would be accomplished through reductions in water supply to other users. Reductions would be implemented and enforced through agreements involving various federal and state agencies and special districts.

- The analysis uses an initial distribution of water supply reductions between agriculture and urban users. The analysis assumes that the water supply impacts of the regulations would be borne 80% by agriculture and 20% by urban water users.

- For agricultural users, key implementation issues that determine the level of the economic impact include water trading opportunities, the extent of geographic distribution of water supply reductions, and crop shifting opportunities. Three scenarios were developed to illustrate the varying cost impacts of different implementation plans. Under Scenario 1, there are no trading opportunities and the impacts are borne by a small geographic area south of the Delta. Under Scenario 2, there are trading opportunities and the impacts are borne by a larger geographic area south of the Delta. Under Scenario 3, a very efficient market exists and the water supply reductions are distributed throughout the entire Central Valley.

- For urban users, the availability of water transfers from agricultural areas is a key implementation issue. Three scenarios were developed to illustrate the varying cost impacts of different implementation plans. Scenario 1, the highest cost scenario, estimates surplus losses if no drought water bank or water transfer opportunities exist but water reclamation programs are available. The consumer surplus losses were derived from drought studies and measure the monetary compensation necessary to leave consumers no worse off than they were before implementation of the proposal. Scenario 2 consists of a combination of consumer surplus losses from drought studies and a limited drought water bank;

water reclamation opportunities are assumed to replace Delta supplies in years other than drought years. Scenario 3 consists of a drought water bank and water transfers. In general, the urban analysis is considered more uncertain than the agricultural analysis.

ANALYSIS OF COSTS

Achieving compliance with the proposed regulations will require reallocating water from agriculture and urban uses to instream use for fish and wildlife enhancement. Compliance with the proposed water quality standards will result in costs to the agricultural and urban sectors. Costs other than water supply impacts are also described for the designation of critical habitat for the Delta smelt.

Agricultural Sector

The costs associated with changes in agricultural water use include resource allocation costs, welfare losses, and decreased value of labor and equipment resources. The analysis focuses on the producer surplus losses, which are the net revenue losses to agriculture. The analysis did not consider irrigation efficiency improvements or additional groundwater pumping in projecting economic impacts. Labor displacement is not expected to change the unemployment rate.

Following are summaries of the results of the agricultural sector cost analysis:

- Reductions in consumers' surplus were determined to be insignificant because food prices are not expected to rise.

- Implementation choices on the size of the affected region and opportunities for water trading between agricultural districts will account for significant differences in producers' surplus reductions (net revenue losses). Three implementation scenarios were analyzed:

  - Scenario 2 represents a middle-range distribution of supply impacts that includes water trading. Under Scenario 2, producers' surplus losses vary from $14 million for average water supply reductions to $86 million in a critically dry year. Costs attributed to the USEPA proposal are estimated to average $20 million. Gross revenue losses are approximately twice this size. Projected labor displacement ranges from 314 person-years for average water supply impacts to 1,927 person-years in critically dry years. Labor displacement is not expected to change the unemployment rate.

- Under Scenario 3, the supply reductions are distributed over the entire Central Valley and affect only low-value crops (because an efficient water market is operating). Under these assumptions, net revenue losses are projected to be $8 million for average water supply impacts and $48 million in critically dry years. Labor displacement is estimated at 213 person-years for average water supply impacts.

- Under Scenario 1, in which no trading opportunities exist and the water reductions are borne by the smallest geographic area, net revenue losses are estimated to range from $40 million for average water years to $147 million in critically dry years. Producer surplus losses attributed to the USEPA's proposal are estimated to average $44 million annually if no trading opportunities exist. Labor displacement is estimated at 828 person-years with average water supply impacts and at 3,240 person-years in critically dry years.

Urban Sector

Analysis of costs to the urban sector was based on the potential for urban areas to compensate for reductions in water supply with other potential water sources. There is a higher level of uncertainty in the analysis of impacts on urban users than in the analysis of impacts on agricultural users because of the lack of previous studies and significant data uncertainties. Three scenarios were developed to project the economic impacts based on different assumptions and implementation choices. Key implementation choices are the availability of water transfers and the extent of a drought water bank.

Scenario 1 assumes that urban water districts have little flexibility to increase supplies during dry water years except through drought management techniques and that water transfers and/or a water bank are not available. Scenario 2 assumes that reductions in supply can be compensated for through new reclamation projects, except during critically dry years in which water districts use a combination of drought management techniques and a drought water bank. Scenario 3 assumes that urban water districts are able to compensate for the supply reductions in all years through water transfers or a drought water bank.

Following are summaries of results of the analysis of urban sector costs:

- Water transfers and a drought water bank are key to minimizing impacts on urban users, given increased environmental needs. Under Scenario 3, impacts on urban users attributed to USEPA's proposed action were projected to be $25 million for an average of all year types. The impacts range from $14 million to $40 million in most types of water years.

- Under Scenario 2, in which a more limited drought water bank is assumed and water reclamation meets urban supply needs, impacts attributed to USEPA's proposed action average approximately $50-54 million with a range of $31-77 million in most types of water years. Under Scenario 1, in which less reclamation is available, impacts are projected to average $79 million.

- Impacts are greatest in drought years, given increased environmental needs. Scenario 3 projects a continuation of the 1991 drought water bank, resulting in costs to the urban sector of $70 million in a critically dry year, substantially lower than the impacts under the other two scenarios. Estimating the economic value of drought management measures, such as conservation targets, is difficult. For this study, economists measured "consumer surplus losses" using the implied short-run value for water derived from drought studies. These values should be interpreted as an implied value, not as out-of-pocket costs. An undetermined portion of these estimates reflects the value of changes in behavior, such as personal implementation of conservation measures. Under Scenario 2, estimates of consumer surplus losses for a critically dry year are $184-223 million. Under Scenario 1, without a drought water bank, consumer surplus losses are estimated at $451 million.

Cost to Comply with the Designation of Critical Habitat for the Delta Smelt

Certain economic activities other than water supply reductions would be restricted by the critical habitat designation. The restrictions are in addition to those resulting in a determination of jeopardy for a species. Activities that could be restricted or modified as a result of the critical habitat designation are sand and gravel extraction in river channels or marshes, diking and dredging for agricultural operations, levee maintenance, Montezuma Slough control structure operations, and marina construction.

Following are summaries of the discussion of costs of compliance with the designation of critical habitat:

- Increased costs associated with restrictions placed on sand and gravel mining operations would likely be minor, given the relatively small amount of sand and gravel production occurring in the Delta.

- The primary economic costs associated with restrictions placed on diking and dredging for agricultural operations would be forgone agricultural income; however, the amount of potential future losses would be small because a limited number of developable tracts would be affected by critical habitat designation.

- The designation of critical habitat is not expected to substantially affect levee maintenance operations because of protection measures currently being enforced by federal agencies.

- Increased costs associated with restrictions placed on marina construction could result from limiting the timing of construction or expansion activities and requiring the use of best management practices and replacement of destroyed habitat.

ANALYSIS OF BENEFITS

Benefits associated with the proposed federal actions are described qualitatively for most ecosystem benefits; however, fish population increases for some species were monetized.

Following are conclusions of the analysis of benefits:

- The benefits of the proposed actions are an increase in biological productivity and ecosystem health for the Bay/Delta ecosystem. This increase includes protecting unique species from extinction.

- Well-established relationships between estuarine conditions and populations exist for many estuarine species. The extent of the low-salinity habitat in the estuary is closely associated with the abundance and distribution of estuarine species at all trophic levels. Increased populations are estimated for salmon, starry flounder, and striped bass. In addition, population increases are expected for other game species of green and white sturgeon, bay shrimp, American shad, and white catfish.

- A portion of these population increases will be reflected in benefits to the recreational or commercial fisheries. At least $9-11 million annually are estimated, with many benefits again not estimated in dollar value. The majority of this monetary estimate is in the commercial salmon fishery. Employment gains in the salmon fishery are estimated to increase by 300-360 jobs annually. In addition, benefits to the commercial and recreational fisheries include the avoided costs of further declines.

- Enhancing the natural environment of the Bay/Delta would have nonuse social benefits. Although these benefits could not be quantified, it is believed that they constitute the largest portion of the total benefit to society of implementing the proposed regulations.

Other Benefits

- Enhancing water quality in the Bay/Delta could result in other benefits associated with avoiding the listing of species and avoiding further reductions in the recreational and commercial fisheries industries. Continued declines may result in reduced flexibility and reliability of water supplies in the Delta.

COMPARISON OF COSTS AND BENEFITS

As discussed above, the costs of the combined proposed federal actions depend on how the actions are implemented. If the state implements the proposals in a flexible manner, with wide distribution of water supply impacts and facilitation of water trading, the costs and associated impacts would be at the low end of the impact range. Monetized social costs and benefits of the proposed actions are not directly compared in this analysis because none of the nonuse benefits of ecological improvement and species diversity and only some use benefits could be estimated. However, several conclusions can be drawn:

- If the state pursues a cost-effective implementation plan, under which a water market is facilitated and a drought water bank continues, the average estimated costs to agriculture are $20 million annually and the estimated costs to the urban sector are $25 million annually. These estimates are not additive, as they do not account for the increases in income in the agricultural sector resulting from urban water purchases. The minimum annual estimated benefits are $10 million, with many benefits not estimated.

- Benefits are difficult to estimate because of the nonmarginal nature of ecosystem protection. These benefits, including the prevention of extinction of several candidate or listed species and the prevention of further ecosystem declines, account for the majority of the benefits.

- Given both the monetary estimates of benefits and the qualitative information on benefits not expressed in dollar value, USEPA believes that the proposal can be implemented in a cost-effective manner, resulting in a healthy estuary and fisheries coexisting with a strong agricultural and urban sector. Given all the available information, the benefits are commensurate with the costs.

- Several methods to reduce the costs of the proposed rule have been suggested. USEPA will pursue analysis of these methods in the context of providing ecological protection. Suggestions have included changes in the number of days of compliance, use of a sliding scale (rather than discrete water-year types) for expressing the standards, and use of a fee system and other flexible implementation methods. USEPA expects to discuss these issues during the public comment period for the proposed rule.

INITIAL REGULATORY FLEXIBILITY ANALYSIS

To comply with the Regulatory Flexibility Act, this RIA includes an abbreviated regulatory flexibility analysis of the impact of the proposed rule on small entities. Small entities are defined in this analysis as farms with annual sales of less than $500,000. Impacts on small entities and the alternatives to regulating them were not fully analyzed because USEPA action is not an implementation plan and thus has no mechanism for affecting or mitigating impacts on small farms. Under the CWA, the state has the primary responsibility for implementation. USEPA believes that the impacts on small farms can be minimized by developing the least costly implementation plan that distributes water supply reductions widely and facilitates trading between water districts. Allocation of water at the farm level depends primarily on decisions at the irrigation district level. Therefore, determining which size farm would experience water supply impacts will also be difficult at the state level, given the role of water districts.

Chapter 1. Introduction

PURPOSE OF REPORT AND REQUIRED CONTENTS

This regulatory impact assessment (RIA) has been prepared to comply with Executive Order 12866 (E.O. 12866), which requires federal agencies to assess costs and benefits of each significant regulatory action they propose or promulgate. The two interrelated regulatory actions addressed in this report meet the order's definition of significant rules. The first regulatory action, proposed by the U.S. Environmental Protection Agency (USEPA), seeks to establish water quality standards for the San Francisco Bay/Sacramento-San Joaquin River Delta estuary (Bay/Delta estuary) under the federal Clean Water Act (CWA). The second regulatory action, proposed by the U.S. Fish and Wildlife Service (USFWS), seeks to designate critical habitat for the Delta smelt under the federal Endangered Species Act (ESA).

E.O. 12866 requires federal agencies to identify the need for the proposed regulations, assess the potential costs and benefits, and analyze alternative approaches. Wherever possible, the costs and benefits of the regulation are to be expressed in monetary terms. The five major sections of this RIA address:

- Need for Regulation,
- Alternatives Considered,
- Analysis of Costs,
- Analysis of Benefits, and
- Comparing Costs and Benefits.

REPORT ORGANIZATION

Chapter 2, "Need for Regulation", discusses the environmental problems that have triggered the two federal regulatory actions and describes the statutory authority for these actions. Also, the chapter highlights the importance of the Bay/Delta estuarine environment for a variety of designated uses, the effects of water export and consumptive use on water flows and quality, and the failure of other regulatory actions to meet CWA requirements.

Chapter 3, "Alternatives Considered", describes alternative approaches to establishing water quality standards, evaluates alternative implementation measures, and identifies USEPA's rationale for selecting water quality criteria as proposed federal rules.

Chapter 4, "Analysis of Costs", provides an analysis of costs to the agricultural sector and costs to the urban sector.

Chapter 5, "Analysis of Benefits", provides an analysis of potential benefits from the proposed regulations.

Chapter 6, "Comparing Costs and Benefits", compares costs and benefits from two perspectives: cost effectiveness and regional economic effects.

Chapter 7, "Initial Regulatory Flexibility Analysis", provides an analysis of the potential impacts of the proposed rule on small entities, focusing on small farms.

Chapter 8, "Citations", provides references to the published documents and personal communications cited in this report.

ACKNOWLEDGMENTS

USEPA gratefully acknowledges the assistance of a number of researchers from the University of California in preparing this RIA. Drs. David Zilberman, Richard Howitt, and David Sunding developed important information for the RIA in their report Economic Impacts of Water Quality Regulations in the San Francisco Bay and Delta. Drs. Chris Dumas, W. Michael Hanemann, and John Loomis contributed to the RIA through their report Economic Benefits of USEPA's proposed Bay-Delta Standards.

Chapter 2. Need for Regulation

As part of the requirement of E.O. 12866, federal agencies are required to identify the need for a proposed regulation. This chapter describes environmental problems that have led federal agencies to propose criteria to protect the designated uses of the Bay/Delta estuary and the designation of critical habitat for the Delta smelt. Also, the chapter highlights the importance of the Bay/Delta estuarine environment for a variety of designated uses, the effects of water export and consumptive use on water flows and quality, and the failure of other regulatory actions to meet CWA requirements. Finally, the chapter details the statutory authority for the proposed federal actions.

NATURE OF THE ENVIRONMENTAL PROBLEM

Location, Setting, and Functions of the Bay/Delta Estuary

The Bay/Delta estuary (Figure 2-1) is the largest estuary along the west coast of the United States. It encompasses roughly 1,600 square miles and drains more than 40% of the water in California. The Bay/Delta estuary is the point of convergence of California's two major river systems: the Sacramento River system, which drains a large part of northern California, and the San Joaquin River system, which drains a large part of central California. The mouths of these two rivers form a triangular network of channels and islands, approximately 90 miles on each side, known as the Sacramento-San Joaquin River Delta. The rivers ultimately converge at the western tip of the Delta and together flow through a series of bays, channels, shoals, and marshes into San Francisco Bay and the Pacific Ocean.

The Bay/Delta estuary constitutes the largest estuarine environment on the west coast of the Americas and supports more than 120 fishes, including estuarine-dependent and anadromous species. The Delta smelt is endemic to the upper Bay/Delta estuary and, under existing conditions, relies on Suisun Bay for suitable nursery habitat. Surrounding Suisun Bay is Suisun Marsh, the largest remaining brackish marsh on the west coast. The Bay/Delta estuary also comprises one of the largest waterfowl habitats in the United States, providing essential habitat for more than one-half of the waterfowl and shorebirds migrating on the Pacific Flyway.

The Bay/Delta estuary is also the hub of California's two major water distribution systems: the State Water Project (SWP), operated by the California Department of Water

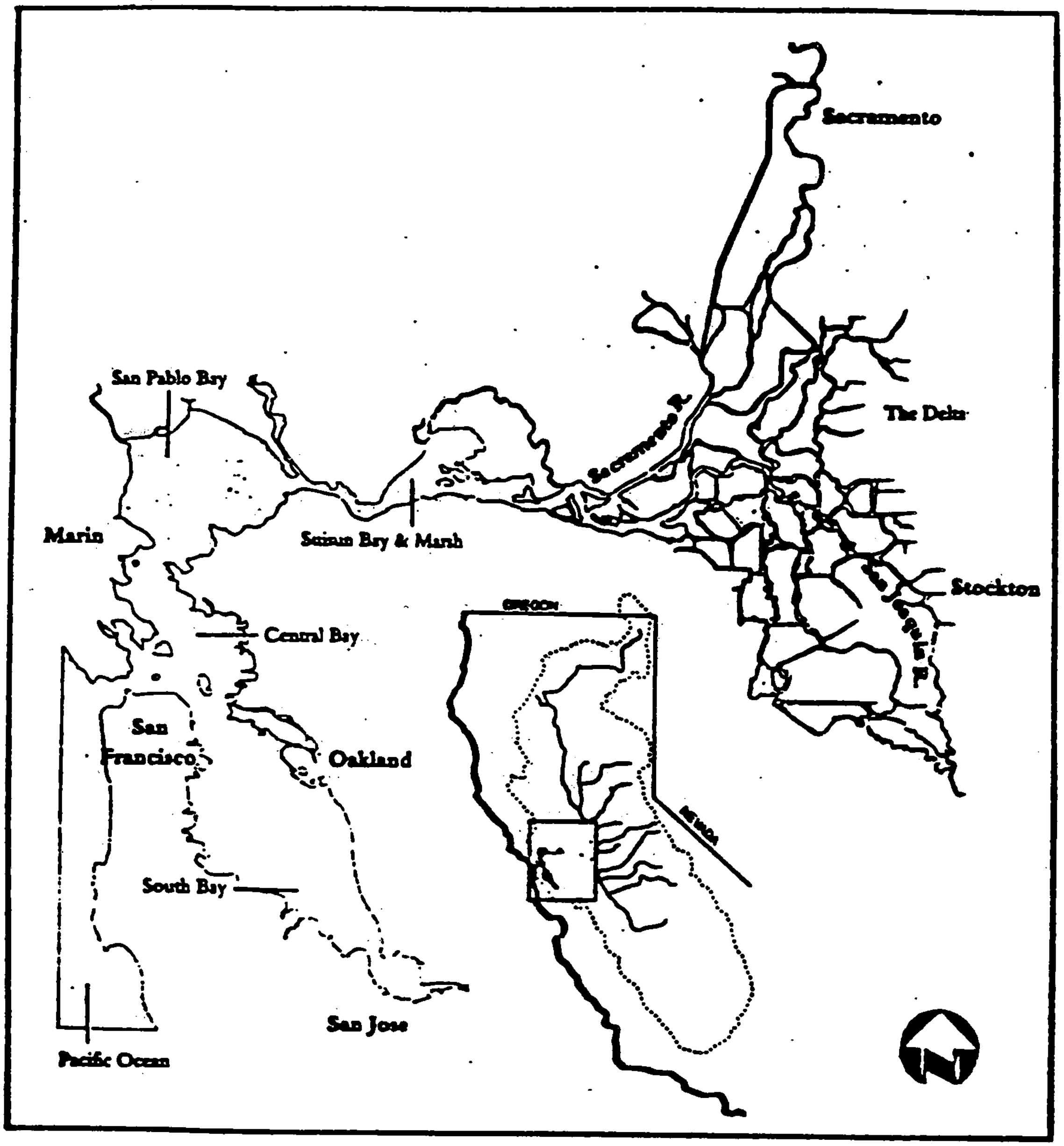

Figure 2-1. San Francisco Bay/Sacramento-San Joaquin Delta Estuary

Resources (DWR), and the Central Valley Project (CVP), operated by the U.S. Bureau of Reclamation (Reclamation). Both systems convey water from northern California to southern California through an elaborate network of reservoirs, canals, and pumping facilities. The CVP and SWP, approximately 1,800 local irrigation districts, and cities such as Tracy, Antioch, and Concord draw water from the Delta to supply two-thirds of the state's population and 4.5 million acres of irrigated farmlands.

In general, the California water system has been developed to move water from areas with abundant precipitation to arid regions of the state. For example, the north coast normally receives 27% of the state's precipitation, but uses only 3% of the water. Conversely, the San Joaquin Valley region, with 12% of the precipitation, accounts for 19% of California's consumption.

Not all water being transported in the state is moved through the Bay/Delta. Other major water transportation facilities include the Los Angeles Aqueduct, which supplies the City of Los Angeles with water from the eastern slope of the Sierra Nevada; the Colorado River Aqueduct, which supplies the Metropolitan Water District of Southern California with water from the Colorado River; and the Hetch Hetchy and Mokelumne River Aqueducts, which supply the San Francisco Bay Area with water from the western slope of the Sierra Nevada.

Most of the water stored and transported by the CVP is used for agricultural crops within its 3.8-million-acre service area. The CVP also supplies municipal and industrial water to portions of the Central Valley and San Francisco Bay Area. In 1991, a drought year, the CVP supplied 3.6 million acre-feet (maf) of water (U.S. Bureau of Reclamation 1992). In normal water years the CVP delivers about 7 maf. Approximately 90% of the water delivered by the CVP is used for agriculture.

Water stored and transported by the SWP is primarily used for municipal and industrial uses and the production of agricultural crops. The SWP service area includes portions of the San Francisco Bay Area, the southern San Joaquin Valley, and southern California metropolitan areas. The maximum contract entitlement for the SWP is 4.2 maf per year. In 1993, the SWP is expected to deliver 2.8 maf, with approximately 55% of the water for municipal and industrial uses, mostly to urban areas of southern California.

Historically, water prices for agricultural uses have been low compared with prices for urban uses. Urban water must meet higher quality standards and be conveyed in more sophisticated transmission systems than agricultural water. Prices of agricultural water delivered by the CVP have historically been lower than those of agricultural water delivered by the SWP.

Environmental Factors Necessitating Federal Actions

Bay/Delta Habitats, Flora, and Fauna

The estuary supports 108 known species imperiled by habitat loss, including eight fish, ten birds, nine mammals, three reptiles, three amphibians, 21 invertebrates, and 54 plants. Twenty-five of these species are listed or are candidates for listing under the federal ESA (California Department of Water Resources 1993a). The imperilment of species reflects the continued deterioration of the estuarine environment and the shortcomings of the current regulatory regime. The California Department of Fish and Game (DFG) indicates that virtually all of the estuary's major fish populations are declining. Numerous species relying on estuarine habitat are suffering depressed levels of abundance and survival; some of these have received attention under the federal and state ESAs. One recent report suggests that longfin smelt, spring-run chinook salmon, Sacramento splittail, green sturgeon, and Red Hills roach qualify for immediate listing under the federal ESA, in addition to the already listed winter-run chinook salmon and Delta smelt (Moyle and Yoshiyama 1992).

Within the Bay/Delta there are seven types of wetland/deepwater habitats and seven types of upland habitats. The wetland/deepwater habitats include open water; intertidal mudflats and rocky shores; tidal salt, brackish, and freshwater marshes; seasonal wetlands; riparian woodland; salt ponds; and lakes and ponds. Upland habitats include grassland, coastal scrub, mixed chaparral, oak woodland, broad-leaved evergreen, agricultural, and urban. (U.S. Fish and Wildlife Service 1992a.)

These habitats are valued for their recreational, scientific, educational, aesthetic, and ecological aspects (U.S. Fish and Wildlife Service 1992a). Recreational uses include consumptive activities such as boating, hunting, and fishing; nonconsumptive activities include wildlife observation. Recreation in the Delta accounted for an estimated 12 million user days in 1993 (California Department of Water Resources 1993a). The habitats of the estuary and the associated biota possess intrinsic values related to the ecological processes and properties of the Bay/Delta "bioregion". In addition, these resources provide unique opportunities for scientific research and environmental education that are largely unexploited.

Development and operation of the water projects have contributed to losses in biological productivity by drastically altering the flow and salinity conditions to which the indigenous organisms are adapted. Effects of diversions include the dislocation of low-salinity habitat and estuarine-dependent species from Suisun Bay nursery areas upstream into Delta channels where riverine and wetland habitats have been severely degraded. This dislocation also leaves aquatic organisms vulnerable to entrainment by the powerful diversion pumps of the CVP and SWP in the south Delta.

During periods of high pumping or low outflow, water in the Delta channels and the San Joaquin River flows upstream, resulting in the disorientation and mortality of anadromous and estuarine-dependent fishes. This phenomenon is known as "reverse flows". In addition, the water facilities entrain and destroy millions of fish eggs, larvae, and juveniles; and other food web components such as nutrients, phytoplankton, and zooplankton. Existing fish screens and salvage facilities at the pumping plants have not effectively curbed entrainment losses. As part of the existing salvage practices, workers gather those organisms collected by the screens and transport them by trucks downstream for placement in the Delta. On the average, 20%-60% of the organisms that survive entrainment die during the process of handling and trucking.

In addition to water sent south by the CVP and SWP, water is also diverted directly from the Delta for local use and export. In the Delta alone, there are approximately 1,800 agricultural diversions that divert flows ranging from several cubic feet per second (cfs) to several hundred cfs; only a few are screened. At industrial facilities where estuarine waters are used for cooling, aquatic organisms are entrained in the intake systems or impinged on the surface of fish screens.

Federal Clean Water Act and Endangered Species Act Requirements

The Bay/Delta estuary is subject to the water quality control jurisdiction of the California State Water Resources Control Board (SWRCB) and two regional boards, the Central Valley and the San Francisco Regional Water Quality Control Boards. In 1978, the SWRCB adopted and submitted to USEPA a water quality control plan containing a comprehensive set of water quality standards for three categories of designated uses for the Bay/Delta estuary: municipal and industrial, agriculture, and fish and wildlife (including specific uses for cold and warm freshwater habitat, estuarine habitat, fish migration, fish spawning, ocean commercial and sport fishing, preservation of rare and endangered species, shellfish harvesting, and wildlife habitat).

SWRCB used the striped bass spawning and survival criteria as the key criteria intended to protect fish and wildlife resources. These criteria were established to provide minimum salinity and flow conditions at critical points in the Bay/Delta estuary to protect the fishery at levels that would have existed in the absence of the SWP and CVP. The striped bass survival criteria were based on a statistical correlation between Delta outflow and Delta diversions, expressed by the striped bass index (SBI), a measure of the abundance of young striped bass in the estuary. The 1978 plan emphasized striped bass standards as a surrogate for protection of other species.

Since the 1978 SWRCB plan was adopted, the standards have not accomplished the intended goal of maintaining the striped bass fishery at the levels that would have existed in the absence of the SWP and CVP (as measured by an SBI value of 79). During the 1980s, the actual SBI averaged approximately 7.5 and in 1983 and 1985 reached the lows of 1.2 and 2.2, respectively. The precipitous decline in striped bass is also indicative of the poor health of other aquatic resources in the Bay/Delta estuary. Similar declines have been experienced by several species, including the chinook salmon (the winter-run chinook salmon is listed as a threatened species under the federal ESA and is currently proposed for reclassification as endangered), the Delta smelt (recently listed as a threatened species under the federal ESA), and the Sacramento splittail and longfin smelt (both of which are currently under petition for listing as endangered species under the federal ESA).

Regulatory History

Section 303 of the CWA requires each state to adopt water quality standards specifying designated uses and instream water criteria to protect those uses for all "waters of the United States" located within their state. Section 303(c) of the CWA provides that states shall review and, if appropriate, revise the water quality standards at least once every 3 years. Any new and revised standards adopted by a state are required to be reviewed and approved or disapproved by USEPA.

The 1978 SWRCB water quality control plan, adopted to meet the CWA requirement, was accompanied by a water right decision (D-1485) that placed permit conditions on the SWP and CVP to meet the water quality standards through releases of water from reservoirs and limits on exports from the Delta. USEPA's approval of the plan was conditioned on the state's commitment to revise the standards, if necessary, to maintain historical levels of the fisheries.

In the years following the adoption of the 1978 plan, fish populations sharply declined as exports from the Delta increased. Striped bass and salmon populations dropped to less than one-third of historical levels. Despite repeated requests from USEPA, the state did not revise its standards during the subsequent triennial reviews. In 1986, a landmark state court ruling known as the "Racanelli Decision" directed the state to revise its standards.

Finally, in 1987, USEPA notified the state that the 1978 plan standards were inadequate to protect the estuary. Rather than disapproving the state standards and imposing federal standards, USEPA agreed to wait until the state completed a 3-year hearing process to revise the 1978 plan.

Following the first phase of the hearings, the state issued a draft plan in 1988 that would have significantly increased protection for the estuary. The draft plan was quickly withdrawn, however, because of opposition from both urban and agricultural sectors concerned about its limits on exports and from environmental groups that pressed for more protective standards.

The state then began a more limited review of its standards and, in May 1991, adopted a revised water quality control plan. The 1991 plan made only minor changes to the 1978 plan standards and postponed consideration of any standards that would significantly affect freshwater flows. On September 3, 1991, USEPA disapproved the standards in the 1991 plan for failure to protect the designated uses of the estuary.

In April 1992, the governor of California issued a new statewide water policy, which included forming a task force to develop long-term solutions to the state's water problems over a 5-year period, and directed the SWRCB to adopt "interim" standards by the end of 1992.

In summer 1992, the state held hearings on its interim standards. USEPA participated in those hearings, rather than immediately proposing federal standards, in the hope that the hearings would result in state adoption of approvable standards and preclude the need for a federal rule making. USEPA also joined with USFWS and the National Marine Fisheries Service (NMFS) in submitting an interagency statement of principles. The joint statement recommended that the state shift its focus from species-specific measures to a habitat- and ecosystem-based approach, and provided a framework for standards that would satisfy CWA requirements.

In December 1992, the state released its draft decision (D-1630). The draft decision would have reduced exports from the Delta by about 10%, mandated urban and agricultural water conservation measures, and established a $300 million restoration fund to provide state matching funds required by the CVP Improvement Act (Title 34, P.L. 102-575). On January 13, 1993, USEPA praised the draft decision as a positive step toward stabilizing fish populations, but stated that additional measures would be necessary to meet CWA requirements and protect fish spawning and nursery habitat.

On April 1, 1993, the governor reversed the state position on the need for interim state standards and stated that ongoing federal actions under the federal ESA to protect Delta smelt and winter-run salmon would make the state's process irrelevant. In response to the governor's announcement, the four concerned federal agencies (USEPA, USFWS, Reclamation, and NMFS) have been developing a comprehensive integrated strategy for fish and wildlife protection and federal water allocations in the Bay/Delta estuary. A key element of this strategy is a coordinated, ecosystem-based approach to the development of federal water quality standards and designation of critical habitat for the Delta smelt.

In 1991, in an action separate from the development of water quality standards, the USFWS published a proposal to list the Delta smelt as threatened under the federal ESA. On March 5, 1993, USFWS determined that the Delta smelt was a threatened species and found that present regulatory mechanisms do not ensure flows into Suisun Bay and the western Bay/Delta estuary that are adequate to maintain the mixing zone for the benefit of Delta smelt and other organisms. Also, USFWS stated that current state standards are inconsistently implemented and frequently violated because of operational constraints.

In a 1990 decision at the state level, the California Fish and Game Commission rejected a recommendation from the DFG to list the Delta smelt as a threatened species and ruled that a petition to list the species was not warranted. USFWS recognized that a state listing would have provided some measure of protection to the species but that state-listing would not have precluded the federal actions. However, in August 1993, the California Fish and Game Commission issued a new ruling to list the Delta smelt as a threatened species under the California ESA.

STATUTORY AUTHORITY FOR REGULATORY ACTIONS

USEPA's Proposed Water Quality Standards

Section 303(c) of the CWA requires that state water quality standards "be such as to protect the public health or welfare, enhance the quality of water and serve the purposes of this Act. Such standards shall be established taking into consideration their use and value for propagation of fish and wildlife". Key concerns of this statutory provision are the enhancement of water quality and the protection of the propagation of fish. The ultimate purpose of water quality standards, as of the other sections of the CWA, is to restore and maintain the chemical, physical, and biological integrity of the nation's waters. (CWA Section 101[a].)

As previously stated, the CWA gives the states primary responsibility for the adoption of water quality standards. After adopting its initial water quality standards, a state is required to review those standards at least every 3 years and to modify them, if necessary. Under Section 303(c)(1) of the CWA, the results of these triennial reviews are to be submitted to USEPA for review and approval or disapproval.

USEPA's Water Quality Standards regulations (40 CFR 131.11[a]) specify the requirements for water quality criteria:

> States must adopt those water quality criteria that protect the designated use. Such criteria must be based on sound scientific rationale and must contain sufficient parameters or constituents to protect the designated use. For waters with multiple use designations, the criteria shall support the most sensitive use.

Additionally, a state's criteria must be consistent with the state's antidegradation policy, which provides, at a minimum, that "[e]xisting instream water uses [those existing in the water body at any time on or after November 28, 1975] and the level of water quality necessary to protect the existing uses shall be maintained and protected" (40 CFR 131.12[a][1]). In order to approve a state's water quality criteria, USEPA must determine that the state has adopted "water quality criteria [that are] sufficient to protect the designated uses" (40 CFR 131.6[c]).

Section 303(c)(4) of the CWA provides that USEPA shall promptly prepare and publish proposed regulations establishing a new or revised standard in either of two situations: first, when USEPA has disapproved a state standard under Section 303(c)(3) and the state has not taken corrective action within 90 days and, second, in any case in which USEPA determines that a revised or new standard is necessary to meet the requirements of the CWA. Once promulgated, the federal regulations are applicable to the state's waters and, if they are more stringent than the state's standards, they apply to the water body in question. However, the federal regulations will be withdrawn at any time if a state adopts and submits approvable standards meeting the requirements of the CWA.

USEPA has attempted to accommodate the SWRCB procedural processes, generally deferring to the SWRCB schedules for review and revision of proposed water quality standards, even though this process has continued for almost a decade. Similarly, USEPA is attempting to accommodate the state's interest substantively in the proposed regulation. Although SWRCB adopted explicit flow criteria in the 1978 water quality control plan, USEPA refrained from proposing direct revisions to the flow criteria. Instead, USEPA proposed criteria that describe the habitat conditions necessary to protect the designated uses of the Bay/Delta estuary. The SWRCB still has full discretion to develop implementation measures to attain those habitat conditions and still retains full discretion over the allocation of water necessary to achieve the criteria. Finally, USEPA has fully considered the record developed in the SWRCB's 1992 water right hearings and, to the extent possible, has incorporated into the proposed criteria the scientific information presented in those hearings.

SWRCB's adoptions of the 1978 water quality control plan and the revised 1991 work plan were intended to meet the state's obligations to establish water quality standards under the CWA. Pursuant to its mandate under Section 303(c)(3) of the CWA, on September 3, 1991, USEPA disapproved several criteria contained in the SWRCB plan. Accordingly, pursuant to Sections 303(c)(3) and 303(c)(4) of the CWA, the USEPA administrator is proposing water quality criteria that will be applicable to California waters.

USFWS's Proposed Designation of Critical Habitat for Delta Smelt

On March 5, 1993, USFWS determined that the Delta smelt should be classified as a threatened species, pursuant to Section 4 of the federal ESA. Section 4(a)(3) of the ESA requires that, to the maximum extent prudent and determinable, USFWS designate critical habitat at the time a species is determined to be endangered or threatened; USFWS can defer critical habitat designation for 1 year. Section 4(b)(2) of the ESA requires USFWS to consider economic and other impacts of designating a particular area as critical habitat. By definition, economic analysis for critical habitat addresses only those incremental costs of designating, and therefore protecting, critical habitat that are above the cost of the actual decision to list the species. However, because of the proposed integration of ESA actions with CWA actions, the economic analysis of the designation of critical habitat is presented together with the economic analysis of the designated water quality standards to most completely represent possible economic impacts.

Relationship between USEPA and USFWS Actions

The CWA and the federal ESA do not specify how government actions should be coordinated or agency conflicts should be resolved. However, because the involved federal agencies recognize opportunities for integration and streamlining of the proposed actions, they are working closely to provide a comprehensive, ecosystem-based approach to resource protection in an effort to avoid the need for listing of additional species.

Section 7 of the ESA requires that all federal agencies, in consultation with USFWS and/or NMFS, ensure that their actions do not jeopardize the continued existence of listed species or adversely modify listed species' critical habitat. USEPA's proposed action to designate water quality standards must comply with the Section 7 requirement. USEPA, NMFS, and USFWS have initiated a formal consultation process under Section 7. Additionally, the CWA requires protection of the most sensitive use within each category of designated uses. Protection of endangered species is considered a designated use within the meaning of the CWA; thus, a species listing under the ESA provides one method to identify the most sensitive use within the designated uses of a water body.

USEPA's proposed salinity criteria are substantively linked with the proposed designation of critical habitat for the Delta smelt. Analysis of available data indicates that, throughout the year, the farther downstream the isohaline of near-bottom salinity (2 parts per thousand [ppt]) moves, the greater the resulting abundance and survival of an array of estuarine-dependent and anadromous fishes representing different trophic levels and life histories. In separate studies, USFWS identified a 2-ppt salinity regime in Suisun Bay as a critical habitat parameter in its proposal to list the Delta smelt as endangered. USEPA's proposed criteria for seasonal positioning of a 2-ppt salinity regime are designed for consistency with USFWS's proposed designation of critical habitat for the Delta smelt.

Chapter 3. Alternatives Considered

This chapter describes alternative approaches to establishing water quality standards, evaluates alternative implementation measures, and identifies USEPA's rationale for selecting water quality criteria as proposed federal rules.

E.O. 12866 obligates USEPA to evaluate potential economic impacts of the proposed actions in an RIA. For this evaluation, USEPA developed assumptions about how the state might respond to the proposed federal actions with alternative implementation plans. These assumptions should not be construed as federal recommendations to the state regarding specific implementation measures. Furthermore, the economic analysis of the RIA should be considered preliminary because the state has not yet developed an implementation plan.

USEPA evaluated alternative water quality criteria for their effectiveness in protecting and restoring estuarine habitat, salmon populations, and striped bass spawning habitat. The alternative implementation scenarios differed in the allocation of water supply impacts between different sectors (i.e., along geographical boundaries and urban versus agricultural sectors) and by different policies (e.g., market-based water transfers and use of the drought water bank).

ALTERNATIVE WATER QUALITY STANDARDS

Alternatives Considered to Protect and Restore Estuarine Habitat

In part, USEPA's proposed criteria are based on the findings reported in Managing Freshwater Discharge to the San Francisco Bay/Sacramento-San Joaquin Delta Estuary: the Scientific Basis for an Estuarine Standard (San Francisco Estuary Project 1993). The report concludes that salinity is a useful index of Bay/Delta habitat conditions and that this index could provide the basis for an estuarine standard to protect living resources. Salinity was selected because it is of direct ecological importance to many species; it integrates a number of important estuarine processes and properties; it can be measured accurately, directly and economically; and it has meaning for both scientists and nonspecialists. Furthermore, the extent of low-salinity habitat in the estuary corresponds with the levels of survival and abundance of an array of species at different trophic levels.

To protect and restore estuarine habitat, USEPA recommends the positioning of a 2-ppt isohaline at specific locations of the estuary (i.e., Collinsville, Chipps Island, and Roe Island) for specific periods during February through June. The report concluded that the probability of survival and abundance for an array of species increases as the 2-ppt isohaline moves downstream from the Collinsville area. USEPA's proposed criteria are coupled with hydrologic conditions resulting from different water-year types; thus, the 2-ppt isohaline would be positioned in different locations corresponding with different rainfall patterns.

The report also concluded that any proposed standards should be linked to environmental goals and recommended that these goals be expressed in terms of restoring estuarine conditions to conditions characteristic of specific historical times.

USEPA's proposed criteria are designed to achieve estuarine habitat conditions that existed in the late 1960s and early 1970s. In July 1992, this approach was endorsed by USEPA, USFWS, and NMFS in a joint policy statement of principals submitted to SWRCB. The proposed target period preceded the recent precipitous declines of fish populations and therefore serves as a useful target for restoration. This target is less protective than the "without project" target (i.e., pre-CVP and -SWP) that served as the basis of the state's 1978 water quality standards. USEPA appreciates the goal of fully offsetting CVP and SWP impacts; however, this goal apparently cannot be attained in the shortterm because of the limitations of existing water supply facilities and operations.

This goal-setting approach based on historical conditions is consistent with USEPA's guidance, Biological Criteria: National Program Guidance for Surface Waters (U.S. Environmental Protection Agency 1990). This guidance recommends that aquatic communities in water bodies subject to anthropogenic disturbance be assessed relative to similar, but unimpaired, water bodies or relative to historical conditions. A reference water body is not available for the Bay/Delta estuary; consequently, historical information is used to establish reference conditions.

Alternatives Considered to Protect Fall-Run Salmon

USEPA disapproved the state temperature criteria designed to protect fall-run salmon because the SWRCB did not demonstrate that the temperature criteria in its 1991 Water Quality Control Plan would be sufficient to protect coldwater habitat for salmon. A lower temperature criterion was considered as an alternative because temperature has been consistently used nationwide as a basis for water quality criteria, and because there is strong scientific evidence that temperature affects survival of salmon smolts as they move through the Delta. However, after reviewing existing data and models, USEPA concluded that it would not be appropriate to set more specific temperature criteria at this time because historical temperature levels have been highly variable and because there is insufficient information on the effectiveness and feasibility of various methods of lowering temperature.

Alternatively, USEPA is proposing "smolt survival criteria" for protecting salmon in the Bay/Delta estuary. These criteria are based on a smolt survival index that quantifies and predicts the survival of salmon migrating through the Delta. The main alternatives considered by USEPA relate to the level of protection. Consistent with the level of protection in the 2-ppt standard, USEPA is relying primarily on the goal of restoring habitat conditions to those existing in the late 1960s and early 1970s. Table 3-1 shows predicted salmon smolt survival indices for different water-year types under different historical conditions.

These indices were adjusted to better reflect achievable implementation measures developed by a five-agency management group. Incorporating the implementation measures into smolt survival index models results in a value similar to the mean for the historical period most closely approximating the late 1960s/early 1970s goal; however, conditions during dry years will be better protected and conditions during wet years will be less protected. This approach is expected to provide more consistent smolt survival levels and minimize situations in which extraordinary measures are necessary to preserve runs, especially in the San Joaquin River tributaries.

Alternatives Considered to Protect Striped Bass Spawning Habitat

USEPA disapproved the SWRCB's salinity criteria for the lower San Joaquin River because the criteria are not considered adequate to protect striped bass spawning habitat in the reach from Prisoners Point upstream to Vernalis. Salinity in the San Joaquin River increases upstream of Prisoners Point because of reduced freshwater inflow and agricultural return flows. Consequently, high salinity levels above Prisoners Point effectively establish a barrier to adult migration and spawning farther upstream.

USEPA considered several salinity concentrations and locations for different water years to develop these criteria. In the 1991 disapproval letter, USEPA recommended a salinity criterion of 0.44 millimhos per centimeter (mmhos/cm) electrical conductivity (EC) in the reach from Jersey Point to Vernalis, based on scientific evidence developed by DFG. According to DFG, striped bass spawn successfully only in fresh water of less than 0.44 mmhos/cm EC and prefer to spawn in waters of less than 0.33 mmhos/cm EC. Conductivities greater than 0.55 mmhos/cm appear to block the upstream migration of adult spawners. In order to protect the historical spawning range of striped bass and other aquatic resources on the lower San Joaquin River, the proposed criteria are coupled with different water-year types to reflect the variability of historical conditions.

Table 3-1. Predicted Salmon Smolt Survival Indices for the Sacramento and San Joaquin River Portions of the Delta, by Type of Water Year

Goal by River	Proportion Surviving, by Type of Water Year: Wet	Above Normal	Below Normal	Dry	Critically Dry	Mean Estimate of All Water Years
Sacramento River						
1940 level of development	.76	.81	.77	.63	.44	.68
1956-1970 historical	.56	.45*	.35	.26	.20*	.36
1960-1988 historical	.44	.43	.31	.25	.19	.32
1978-1990 historical	.39	.32*	.28*	.22	.16	.27
San Joaquin River						
1940 level of development	.58	.50	.52	.47	.39	.49
1956-1970 historical	.61	.25*	.18	.17	.15*	.27
1960-1988 historical	.43	.12	.17	.13	.12	.19
1978-1990 historical	.48	.15*	.09*	.06	.07	.17

Note: Numbers represent proportion of the fall-run salmon production that survives after migration through the Delta.

* Interpolated: there were no water years in these categories during the relevant historical period.

Source: U.S. Fish and Wildlife Service 1992b.

ALTERNATIVE IMPLEMENTATION ACTIONS

In preparing this RIA, USEPA considered different implementation scenarios that the state might pursue in response to the proposed federal actions. In the first regulatory action, USEPA seeks to establish water quality criteria for the Bay/Delta estuary. In the second action, USFWS seeks to designate critical habitat for the Delta smelt under the federal ESA.

It is assumed that the primary method for implementing the combined federal proposals will be to increase Delta outflow. This follows the SWRCB approach of implementing Delta water quality requirements by changing the requirements in water right permits. Additional measures may be necessary to protect critical habitat for the Delta smelt under the federal ESA. These measures are expected to affect activities other than water use, such as levee maintenance and agricultural dredging.

Determining the range of water supply impacts of the combined federal proposals has been a major activity of the Federal Ecosystem Directorate (Club FED), an interagency management-level work group that includes USEPA, NMFS, USFWS, and Reclamation. Club FED calculated water supply impacts of the combined federal proposals using the DWR operations model known as DWRSIM. After much discussion with DWR regarding the level of demand assumed by the model and assumptions on compliance with the standards, Club FED estimated that the proposed USEPA criteria would require, in all water-year types, an average of 540,000 acre-feet (af) of water. In an average of critically dry years, the water supply impacts were estimated at 1.1 maf.

The primary purpose of this RIA is to evaluate the economic impacts of USEPA's proposed criteria; however, the water supply effects of the winter-run salmon requirements were also modeled, separately and together with the effects of the proposed water quality criteria, to establish the extent of the pre-existing economic impacts resulting from the winter-run salmon listing. The RIA analysis estimated that, on average, the incremental burden of USEPA's proposed criteria would constitute 80% of the total water supply impacts of both actions (i.e., 0.54 maf/0.7 maf) (Table 3-2).

Table 3-2. Estimated Water Supply Impacts Related to Federal Actions (in Million Acre-Feet)

Type of Water Year	USEPA Standards and Winter-Run Salmon Requirements	USEPA Standards and Designation of Critical Habitat for Delta Smelt
Average all year types	0.7	0.54
Average of critically dry years	1.4	1.10
Wet	0.4	NA
Above normal	0.4	NA
Below normal	0.5	NA
Dry	1.0	NA

Note: The estimated water supply impacts related to USEPA's 2-ppt salinity criterion already account for the amount of water needed to satisfy the requirements of the critical habitat designation for Delta smelt.

Discussions continue on the interaction of water supply impacts and USEPA's water quality standards. In the proposed action, USEPA is requesting information for several modifications to the standards that may change the water supply impacts.

Analysis of Impacts

The RIA analysis assessed potential impacts on the agricultural and urban sectors. Approximately 80% of the water supply reductions to result from implementation of the proposed action is expected to be absorbed by the agricultural sector, and the urban sector is expected to absorb the remaining 20%. This assumption is generally consistent with the current allocations of total water usage in the state. The assumed percentages are also consistent with the Coordinated Operations Agreement between the CVP and SWP that allocates 75% of responsibility for meeting in-basin water quality requirements to CVP and 25% to SWP. More than 90% of CVP water is used for agriculture and about 50% of SWP water is used by the urban sector. Although it would be useful to know how the allocation ratio would change if water supply reductions were spread to all Delta diverters on a pro rata basis, such analysis was not possible in preparation of this RIA because data appeared to be limited to water right information and reservoir capacities and did not fully characterize current consumption patterns.

Because it has not yet been determined how environmental requirements will apply to different user groups under each, this analysis assumes that water supply reductions will be proportional to use. However, policies at the SWP mandate reductions in allocations to agricultural users first in some years, and CVP policies may contain similar requirements. The policy regarding reductions in allocations between user groups should become clearer in the coming months and can be adjusted for the final report.

Three implementation scenarios were developed for each sector; these are described below. The RIA analysis evaluated the burden of water supply reductions falling on various water users (i.e., few users or many users). There is some flexibility at the state level to determine this distribution. Because of the hydrological linkages across the vast Bay/Delta region, many areas of the state could be affected by the proposed federal actions. The extent of impacts of potential water supply reductions on the agricultural and urban sectors depends on the structure of the state's implementation plan and the ability of consumers to adjust to the reductions. The analysis of agricultural impacts was based on a large volume of data and models. In contrast, the urban analysis drew from a much smaller data set and should be considered less reliable.

Scenarios for the Agricultural Sector

For agricultural users, key implementation issues influencing the level of impacts include water trading opportunities and geographic distribution among agricultural regions. Water transfers between agricultural districts allow for efficiencies in water reallocations by moving water from low-value crops to higher value crops. Without water trading opportunities, water supply and demand are likely to be unbalanced: willing buyers and sellers would not be able to accomplish exchanges at mutually agreeable prices. Limiting trades has the effect of displacing relatively high-valued crops.

Although a variety of methods are available to farmers for responding to surface water reductions, the analysis did not model all the potential responses and did not incorporate improvements in irrigation technology. This variable, however, could be studied with the use of a model developed by Dinar (Zilberman et al. 1993) that includes an irrigation component. Although groundwater is usually more costly to obtain than is surface water, groundwater can usually be substituted for surface water without affecting crop production or gross crop revenues. In the analysis, the models restricted groundwater pumping for surface water replacement because of concerns regarding the sustainability of groundwater resources.

The models allowed for two different assumptions regarding choices for shifting crops. One model assumes a lack of opportunities for crop shifting because of the level of investment in current cropping practices, contracts, machinery, and labor procurement. The other model allows for crop shifting, given the evidence collected during the recent drought that increased acreage was devoted to relatively lower water use crops such as fruits and vegetables.

The following three scenarios were developed to portray potential economic impacts on the agricultural sector resulting from different implementation measures:

- Scenario 1: narrow geographic distribution of water supply reductions, no water trading, and no crop shifting;
- Scenario 2: wider geographic distribution of reductions plus water trading; and
- Scenario 3: distribution of impacts across the entire Central Valley.

Scenarios for the Urban Sector

For urban users, key implementation issues influencing the level of impacts include water transfers and opportunities presented by a drought water bank. For the urban analysis, aggregate information was not available regarding the number and cost of water supply replacement measures (e.g., conservation, reclamation, pricing, and water transfers). However, recent events illustrate the potential availability of these measures. In 1991, approximately 655,000 af of water was made available to the state water bank mostly through fallowing of land in the Sacramento and northern San Joaquin Valleys. Eighty-five percent of the water was sold to urban water agencies at a price of $175 per af. The federal CVP Improvement Act provides another opportunity for transfer of CVP water outside the CVP service area. Thus, the "market" for water is increasing. One recent study concluded that legal barriers to water transfers are not the constraining factor; however, institutional barriers continue to limit transfer opportunities (Gray in Zilberman et al. 1993).

The following three scenarios were developed to portray potential economic impacts on the urban sector resulting from different implementation measures:

- Scenario 1: no drought water bank or transfers, drought management techniques, and reclamation meeting or reducing urban demand;
- Scenario 2: a combination of a water bank and drought management techniques in critically dry years and reclamation opportunities meeting or reducing urban demand in other years; and
- Scenario 3: a more extensive drought water bank and water transfers meeting urban needs in all years.

The analysis concentrates on key implementation issues and the primary users of water. Alternative implementation programs that can reduce economic costs include conjunctive use programs, allowing flexibility and/or trading of obligations in water right permits for meeting instream requirements, restoration funds, various water conservation measures, and drought planning programs.

Finally, the potential for the federal actions to affect costs in other water supply areas, specifically water treatment costs for urban users of Delta water and electric power producers will depend on more detailed implementation plans and are possible topics of further research. These potential impacts will be influenced by the relationship of reservoir releases and export pumping reductions.

Chapter 4. Analysis of Costs

Achieving compliance with the proposed regulations will require increased freshwater flows through the Delta and, thus, a reallocation of water from agriculture and urban uses to instream use for fish and wildlife habitat enhancement. This chapter assesses the costs of compliance with the proposed water quality regulations and of designating critical habitat for the Delta smelt.

COSTS TO COMPLY WITH THE FEDERAL PROPOSALS

Compliance with the federal proposals will result in costs to the agricultural and urban sectors. Different scenarios are used to describe potential costs associated with implementing the regulations. These scenarios reflect a likely range in costs associated with agricultural and urban users' ability to adjust to the reductions over time. As indicated, key factors affecting the costs to agricultural users are their ability to use interdistrict transfers, access to groundwater, increased irrigation efficiencies, and crop shifting opportunities. The models used in this analysis did not take into account increased irrigation efficiencies or increased groundwater pumping. For urban users, the availability of water transfers and degree of water conservation or reclamation potential are key factors in determining costs. For both types of users, state implementation decisions concerning the size of the region to be affected will significantly affect the magnitude of cost impacts.

Agriculture Sector

This section assesses the possible agriculture-related costs that may result from implementing the proposed regulations. The costs associated with changes in agricultural water supply include resource allocation costs, welfare losses, decreased value of displaced labor and equipment resources, and government regulatory costs.

Baseline Conditions

Three major regions of the state could be affected by reductions in water deliveries to farmers: the Sacramento Valley, the San Joaquin Valley, and southern California (Figure 4-1). Table 4-1 provides baseline agricultural production values for selected groups of agricultural commodities for the three affected regions, based on the 1987 Census of

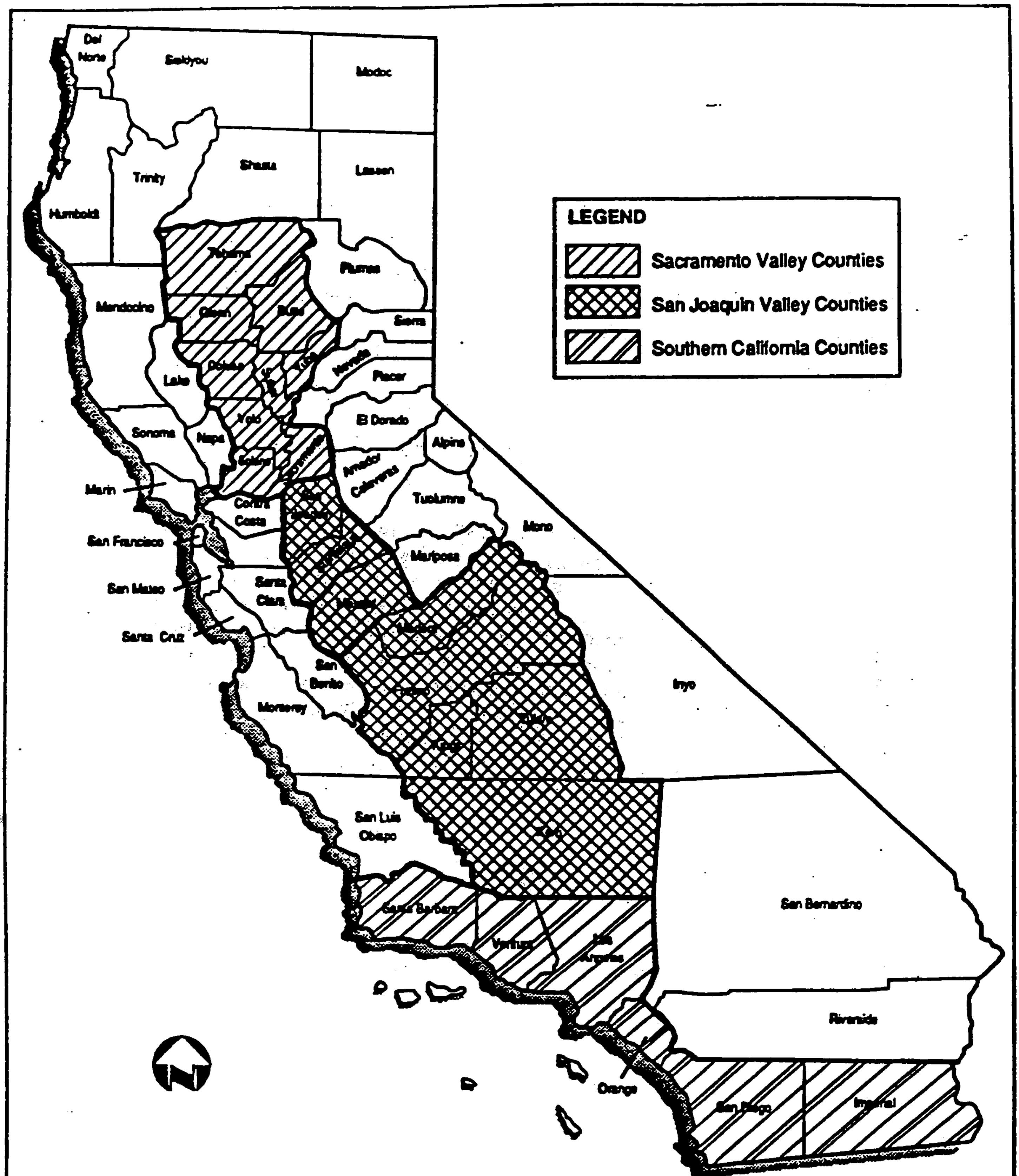

Figure 4-1. Major Farming Regions of California

Table 4-1. Baseline Regional Agricultural Production Value (1987)

Region	Market Value of Agricultural Products Sold (1,000 1987 Dollars)						
	Grains	Cotton and Cottonseed	Hay, Silage, and Field Seeds	Vegetables, Sweet Corn, and Melons	Fruits, Nuts, and Berries	Cattle and Calves	Total
Statewide	513,112	928,742	469,655	1,850,589	3,769,441	1,450,175	8,981,714
Sacramento Valley	286,234	0	40,775	158,480	418,843	127,390	1,031,722
San Joaquin Valley	170,062	891,159	244,914	528,053	2,275,120	558,877	4,668,185
Southern California	22,776	19,267	111,315	497,234	467,422	378,158	1,496,172

Notes: Sacramento Valley includes Tehama, Glenn, Butte, Colusa, Sutter, Yuba, Yolo, Solano, and Sacramento Counties.
San Joaquin Valley includes San Joaquin, Stanislaus, Merced, Madera, Fresno, Kings, Tulare, and Kern Counties.
Southern California includes Santa Barbara, Ventura, Los Angeles, Orange, San Diego, and Imperial Counties.

Source: U.S. Department of Commerce 1989.

Agriculture (U.S. Department of Commerce 1989). These regions generate approximately 75% of California's total agricultural production value. Although most of the agricultural production value shown in Table 4-1 is associated with irrigated lands, some production is supported by nonirrigated lands. Approximately 90% of harvested cropland in California in 1987 was irrigated.

Over the past 5 years, total cash receipts from farming in California have ranged from $17 billion in 1988 to $18.5 billion in 1990 (California Department of Food and Agriculture 1992). The stability of agricultural production values during the recent prolonged drought indicates the resilience of the state's farming economy in response to temporary water shortages.

Resource Allocation Costs

Reducing the amount of water available for agriculture would result in two major types of resource reallocations that impose costs on the agriculture sector: capital investments in more efficient irrigation technologies and practices and changes in farm production values resulting from land fallowing and shifts to less water-intensive crops. Increasing water scarcity creates incentives for farmers to adopt less water-consumptive irrigation and cropping practices. Adopting such practices, however, requires time, capital, and expertise. In the short term, affected farmers are likely to respond to reduced water availability primarily by fallowing their least productive croplands.

Over time, some farmers could install more efficient irrigation systems and produce crops that require less water. In the long term, some farmers could achieve increased profits relative to the current situation by producing more valuable crops and reducing water purchases. To realize such opportunities, however, farmers would require increased amounts of capital. Farmers' credit access also is discussed in this chapter.

Changes in Crop Production Values. Reducing agricultural water deliveries would result in changes in crop production values through fallowing of croplands and shifting of farmlands to different crops. The following section describes the methodology used to analyze the costs of displaced crop production; the subsequent section reports the results of the analysis.

Methodology. Changes in crop production values resulting from complying with the proposed regulations would depend on how the regulations are implemented. This analysis draws primarily on previous analyses by researchers at the University of California (Zilberman et al. 1993). The aspects of the implementation program that would most affect crop production value are:

- the size of the region within which cropping changes occur,
- the ability of water districts to conduct interdistrict water trades, and
- opportunities for farmers to switch crops and crop rotations.

This cost assessment considers three implementation scenarios representing different combinations of the above program aspects applied to water supply impacts estimated by DWR. Scenario 1 assumes that farmers and irrigation districts have few opportunities to reduce the costs of compliance by adjusting farming and irrigation practices in response to water supply reductions. In particular, it assumes that water supply reductions occur within a 1.4-million-acre portion of the CVP service area in the San Joaquin Valley (Figure 4-2), that no interdistrict water trades occur, and that crop switching is infeasible (i.e., fallowing is the only available alternative to current cropping patterns).

Scenario 2 assumes that several adjustment opportunities are available to farmers and irrigation districts. Specifically, it assumes that the reductions occur within a 1.9-million-acre portion of the San Joaquin Valley (Figure 4-2) and that water trading and crop switching occur.

Scenario 3 assumes that the implementation program is economically efficient in that the only crops affected by the regulations are irrigated hay and pasture, the crops that yield the lowest revenue per unit of water applied, and production changes occur throughout the Central Valley (Figure 4-2, Table 4-2). This scenario was developed to project economic impacts in a low-cost scenario, where all diverters are affected through initial allocations, a water market, or some type of fee system.

Crop production could also change substantially depending on the type of water year. Changes in crop production values are estimated using two estimates of water supply impacts: those for an average of all year types and those for critically dry years. In actuality, water supply impacts are lower than the average in wet, above normal and below normal years, and thus economic impacts are overestimated. However, these water supply impacts were not available in time to conduct extensive modeling runs.

The models were run using the cumulative reductions in agricultural water deliveries from USEPA standards, Delta smelt endangered species actions, and the winter-run salmon endangered species action. The initial reduction to agriculture was assumed to be 80%. The water supply estimates used were 0.6 maf, which is 80% of 0.7 maf, for the average of all year types and 1.1 maf in critically dry years. In addition, to account for deficiencies already existing in critically dry years, models were run to account for an existing water supply shortage of 1.0 maf.

Effects on crop production were analyzed using two models. Cropping changes under Scenario 2 and Scenario 3 were projected using a modified version of the California Agricultural Resources Management (CARM) model. CARM is an optimization model developed by researchers at the University of California that assigns crops or crop rotations to available land to maximize farmers' net operating revenues subject to constraints such as limited water availability. The model allows for crop shifting between high- and low-value crops. Although the model can allow for increased groundwater pumping to compensate for surface water reductions, the model runs for this study did not include increased groundwater pumping.

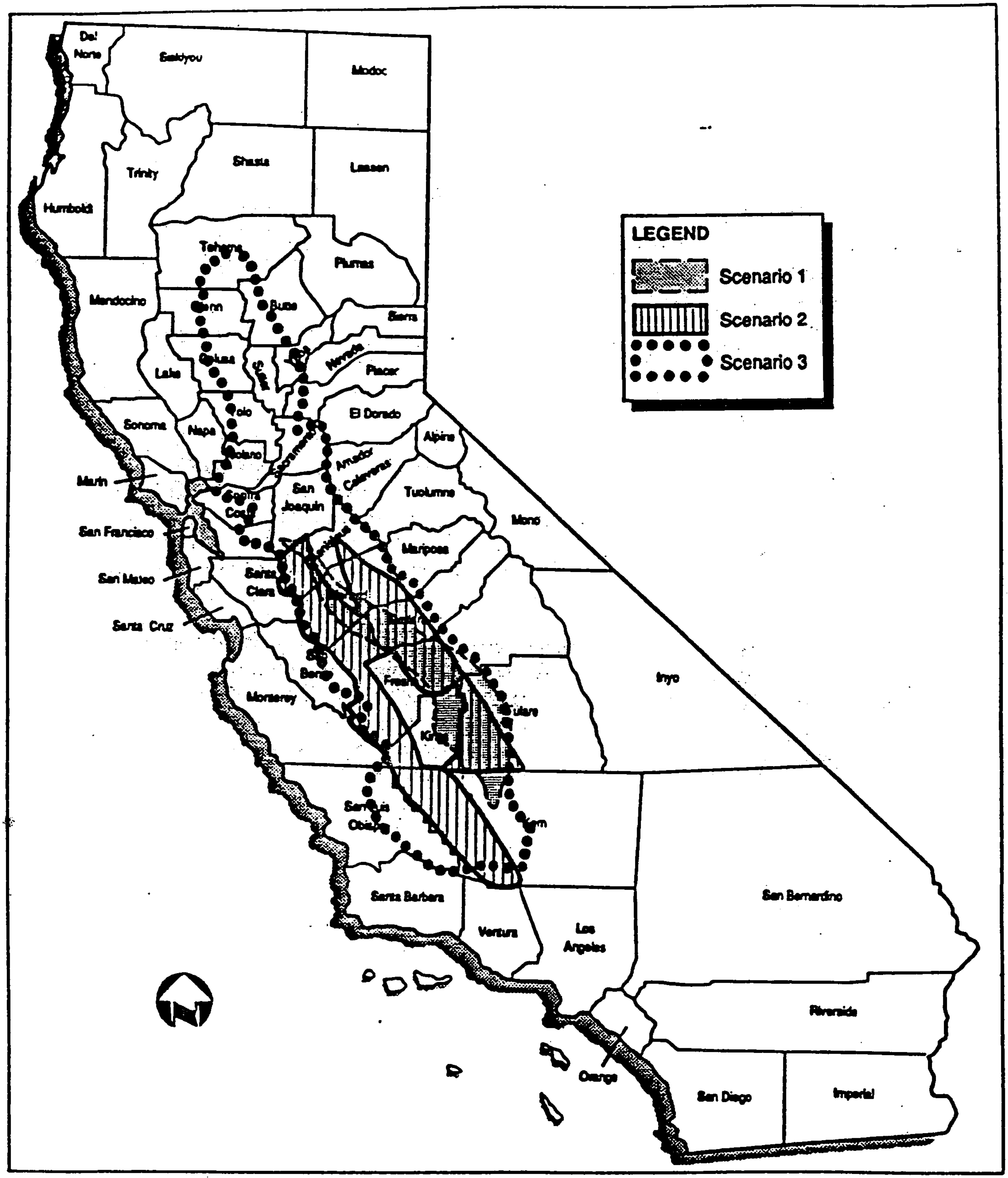

Figure 4-2. Areas within Which Cropping Changes Would Occur under Three Scenarios

Table 4-2. Average Revenue Product of Applied Irrigation Water by Crop Type

Crop Type	Crop Revenue ($/af)	
	Minimum	Maximum
Pasture and hay	3	19
Wheat, cotton, and rice	44	259
Other field crops	64	230
Vegetables	197	1,573
Fruits	207	5,590

Source: Zilberman et al. 1993.

The second model used is a rationing model developed by Zilberman of the University of California that projected cropping changes for Scenario 1 by allocating water to crops in relation to their average revenue products for applied irrigation water. The rationing model ranks cropping areas in order of increasing returns to irrigation and assumes that lands are fallowed in areas with the lowest returns to irrigation until enough water is displaced to meet the regulations. The model assumes that shifting land between high- and low-value crops is not feasible. Details on these analytical models are described in a report by Zilberman et al. (1993). This report also describes additional model runs using an agricultural model designed by Dinar and indicates that the models provide results that are comparable.

Results. Table 4-3 shows the results of the production value analysis (e.g., gross revenue losses). Under Scenario 1, wheat, cotton, and rice account for most of the displacement of harvested acreage and crop value for both types of water years. Under Scenario 3, hay and pasture are assumed to account for all cropping effects.

Under Scenario 1, in which water supply reductions are taken from the smallest geographic area, economic impacts are the largest. The amount of cropland fallowed ranges from 213,000 acres with an annual production value of $80 million for average water supply impacts to 277,000 acres at a cost of $293 million during critically dry years.

Under Scenario 2, in which trading among districts is projected, economic costs drop and cropping changes result in a reduction of $28 million for average water supply reductions. During critically dry years, the amount of cropland fallowed is estimated to be 200,000 acres, with a value of $173 million.

The per-acre cost of crop production displacement is higher during critically dry years than with average water supply impacts because of a preexisting water deficit in California of approximately 1 maf that results in extensive fallowing of low-value croplands during critically dry years. This implies that in critically dry years implementation of the proposed regulations would result in displacement of crops that have higher average value than those that would be displaced in wetter years, because low-value cropland has, in effect, already been fallowed. Scenarios 1 and 2 assume that no land in pasture or hay is available within their respective San Joaquin Valley regions for fallowing to provide the necessary 1.3 maf to comply with the regulations. To the extent that irrigated hay and pasture are currently produced in these regions during critically dry years, Scenarios 1 and 2 overestimate the costs of regulatory compliance because they underestimate the volume of water that could be reallocated from low-value croplands.

Under Scenario 3, where only low-value crops (per af of water) are affected, complying with the federal requirements results in fallowing of 130,000 acres with a value of $10 million for average water supply impacts. Critically dry year impacts were projected to be $48 million. In contrast with the other scenarios, Scenario 3 assumes that water reductions resulting from implementation of the regulations occur throughout the Central

Table 4-3. Projected Changes in Area Harvested and Annual Crop Production Values (Gross Revenue losses) for Three Scenarios

Precipitation Years and Crop Types	Scenario 1 (smallest area, no trading)		Scenario 2 (larger area, trading)		Scenario 3 (entire valley, trading)	
	Change in Area Harvested[a]	Change in Production Value[b]	Change in Area Harvested[a]	Change in Production Value[b]	Change in Area Harvested[a]	Change in Production Value[b]
Average water supply impacts						
Pasture and hay	(36)	(3)	NA	NA	(130)	(10)
Wheat, cotton, and rice	(109)	(55)	NA	NA	0	0
Other field crops	(60)	(18)	NA	NA	0	0
Vegetables	(8)	(4)	NA	NA	0	0
Fruits	0	0	NA	NA	0	0
Total	(213)	(80)	NA	(28)	(130)	(10)
Critically dry years						
Pasture and hay	NA	NA	NA	NA	NA	NA
Wheat, cotton, and rice	NA	NA	NA	NA	NA	NA
Other field crops	NA	NA	NA	NA	NA	NA
Vegetables	NA	NA	NA	NA	NA	NA
Fruits	NA	NA	NA	NA	NA	NA
Total	(277)	(293)	(200)	(173)	NA	48

Note: Negative changes shown in parentheses.
Columns may not total correctly because of rounding.

[a] in thousands of acres.
[b] in millions of 1990 dollars.

Valley, where the amount of water currently allocated for hay and pasture production exceeds the volume needed to comply with the regulations, even in critically dry years.

Projected displacement of crop production value (gross revenues) is thus very dependent on the implementation choices in the extent of distributing water supply reductions and on water trading between agricultural districts. Gross revenue costs are the highest in drought years, in which supply reductions are distributed over the smallest area. Economic impacts this high can be avoided by distribution of the water supply reductions over a wider area and facilitation of transfers between districts. The lowest possible economic impacts were projected under a scenario in which the water supply reductions were distributed throughout the Central Valley through an implementation scheme that could include widespread allocations and/or a water market. Actual economic impacts will depend on future hydrology (the amount of rainfall) and the implementation plan of the state.

Welfare Losses

Welfare losses include changes in consumers' and producers' surpluses resulting from implementation of the regulations. Consumers' and producers' surplus are the economic measures used in cost/benefit analysis to determine the social welfare impacts of changes in price and income. Producers' surplus is the measure used for producers (businesses) and is defined in this analysis as net crop revenues.

Other potential impacts of reductions in agricultural production can include reductions in government subsidies to agriculture. This effect was not estimated for this RIA; however, this is a possible topic of future analysis.

Consumers' Surplus. Consumers' surplus would decline in relation to the amounts by which food prices increase as a result of regulatory compliance. Food prices are unlikely to increase substantially due to production displacements resulting from implementing the regulations, because the prices of most commodities expected to be affected are federally supported (e.g., cotton and grains) or determined in international markets (e.g., beef) and are thus insensitive to quantities produced in California. Regulatory compliance is therefore expected to have a small effect on consumers' surplus.

Producers' Surplus. Producers' surplus would be affected by implementation of the federal proposals through changes in net operating revenues and agricultural land rents that are associated with crop production changes.

Methodology. Net operating revenues consist of producers' crop revenues less costs, including operating costs and land rents. Operating costs considered in this analysis include annual expenditures for labor, fuel, seed, fertilizers, pesticides, etc.; they also include annualized expenses for equipment and land. Land rent is the annualized value of the land (i.e., the rate at which a farm owner would be willing to lease land of a specified quality to a tenant farmer). Net operating revenues decline with fallowing of cropland because gross revenues decrease more than operating costs. Fallowing of cropland is the response of agricultural producers to reduced surface water supplies.

The value of most California cropland is highly dependent on the availability of irrigation water. For example, in 1991 the average value of irrigated cropland in the San Joaquin Valley ranged from $2,200 per acre for land producing rice to $3,800 per acre for land producing vegetables. In contrast, unirrigated rangeland in the San Joaquin Valley was worth an average of $600 per acre. Reducing water available to croplands could thus eventually result in declines in farmland value. Annual rents received from leasing farmland would decline proportionately. Such declines in land values would occur gradually and would only occur if no alternative water sources were available to support irrigation. (U.S. Department of Agriculture 1991.)

Changes in land rent have a dual effect on producers' surplus. In addition to the negative welfare effect of lower land values resulting from the unavailability of irrigation water, reduced land values have a positive effect on net operating revenues corresponding to reduced costs for land rental. In other words, changes in land value have offsetting effects on net operating revenues and on land rents, the two components of producers' surplus considered in this analysis. This offsetting relationship means that changes in producers' surplus resulting from implementation of the regulations can be assessed by estimating changes in crop revenues less nonland operating expenses; this approach was used in this RIA.

Producers' surplus, defined as gross crop revenues less nonland operating costs, was estimated by Zilberman et al. (1993) for several scenarios involving a wide range of cropping patterns and farming regions. In all these examples, producers' surplus accounted for 48%-52% of gross crop revenues; for this RIA, producers' surplus was assumed to equal 50% of gross crop revenues.

Results. Projected changes in producers' surplus resulting from implementation of the regulations are shown in Table 4-4. Again, differences between implementation scenarios in the extent of distribution of water supply impacts and trading opportunities account for the range of impacts projected. Under Scenario 1, in which no trading is projected and the smallest geographic area is affected, producers' surplus would range from $40 million for average water supply reductions to $147 million during critically dry years. Under Scenario 2, in which trading is projected and a larger area is affected, producers' surplus would range from $14 million for average water supply impacts to $86 million in critically dry years. Under Scenario 3, the decline in producers' surplus would range from $5 million for average water supply impacts to $48 million in critically dry years. As indicated by the wide range of effects, the costs are highly dependent on the implementation plan selected. In particular, an implementation plan that restricts the size of the region in which reductions occur or limits farmers' ability to transfer water greatly increases the cost of protecting the environment.

Table 4-4. Annual Changes in Producers' Surplus (Net Revenues) by Type of Water Year for Three Scenarios (Millions of 1990 Dollars)

Type of Water Year	Scenario 1 (small area, no trading)	Scenario 2 (larger area, trading)	Scenario 3 (entire valley, trading)
Average annual water supply impacts[a]	40	14	5
Weighted average of all proposed federal actions	55	25	11
Weighted average of proposed EPA and USFWS actions only (80% of total impacts)	44	20	8
Critically dry years	147	86	48

[a] The estimates pertaining to average water supply impacts were modeled assuming a 600,000 acre-foot reduction.

Displaced Resources

Farm equipment and labor would be temporarily idled if complying with the regulations resulted in substantial cropland fallowing.

Equipment Displacement. Idling of farming equipment would be temporary in most cases because the equipment could eventually be used elsewhere in the San Joaquin Valley or another farming region. There are no available estimates of the decline in the value of farming equipment that would result from reduced water supplies, but it is assumed to be relatively small.

Displacement of Labor. Labor resources displaced by cropland fallowing include hired farm workers and farm owners and their families.

Methodology. Displaced labor resources were estimated based on crop-specific labor requirements reported in the Impact Analysis for Planning (IMPLAN) database. IMPLAN is an input-output model of the economies of all U.S. counties. Labor requirements in the IMPLAN database are expressed in person-years of employment per million dollars of output value. They were estimated using U.S. Department of Commerce data on employment and output levels for each sector of the economy. Other research estimates employment multipliers that differ from those reported for the IMPLAN model (Stroh pers. comm.) and may be used in future analysis of sensitivity of employment to cropland fallowing. As discussed in Chapter 6, "Comparing Costs and Benefits", IMPLAN was also used to estimate the secondary effects of crop production changes (e.g., unemployment occurring in sectors that sell their output to the agriculture sector). Labor displacement analyzed in this section only includes direct effects (i.e., unemployment in the agriculture sector).

Results. Employment displacement resulting directly from crop fallowing depends on the labor intensity of the affected crops' production processes. As shown in Table 4-5, labor requirements for crop types that would be displaced by implementation of the regulations range from 4.8 person-years of employment per million dollars of production of "other field crops" (i.e., field crops other than wheat, cotton, and rice) to 21.3 person-years per million dollars of pasture and hay production. Rice, wheat, and cotton, which are relatively labor-intensive field crops, require an average of 11.7 person-years per million dollars of output; under Scenario 1, these three crops account for more than three-fourths of the direct labor displacement that would result from implementation of the regulations.

Under Scenario 1, in which trading does not occur and implementation limits water supply reductions to a small area, direct labor displacement is projected to range from 828 person-years with average water supply impacts to 3,290 person-years in critically dry years. Under Scenario 2, in which trading occurs and a larger area is affected, projected direct labor displacement would range from 314 person-years with average water supply impacts to 1,927 person-years in critically dry years. Under Scenario 3, direct labor displacement

Table 4-5. Direct Annual Employment Displacement Resulting from Cropping Changes for Three Implementation Scenarios

Precipitation Year and Crop Type	Labor Requirement (person-years per million dollars)	Scenario 1 (small area, no trading): Reduction in Crop Value (million dollars)	Scenario 1 (small area, no trading): Employment Displacement (person-years)	Scenario 2 (larger area, trading): Reduction in Crop Value (million dollars)	Scenario 2 (larger area, trading): Employment Displacement (person-years)	Scenario 3 (entire valley, trading): Reduction in Crop Value (million dollars)	Scenario 3 (entire valley, trading): Employment Displacement (person-years)
Average water supply							
Pasture and hay	21.3	3	64	NA	NA	10	213
Wheat, cotton, and rice	11.7	55	644	NA	NA	0	0
Other field crops	4.8	18	86	NA	NA	0	0
Vegetables	8.4	4	34	NA	NA	0	0
Fruits	19.9	0	0	NA	NA	0	0
		80	828	28	314[a]	10	213
Critically dry							
Pasture and hay	21.3	NA	NA	NA	NA	NA	NA
Wheat, cotton, and rice	11.7	NA	NA	NA	NA	NA	NA
Other field crops	4.8	NA	NA	NA	NA	NA	NA
Vegetables	8.4	NA	NA	NA	NA	NA	NA
Fruits	19.9	NA	NA	NA	NA	NA	NA
		294	3,290[a]	172	1,927[a]	48	538[a]

[a] Based on a multiplier of 11.2 person-years per $1 million in crop value, as derived from preliminary analyses.

is projected to range from 213 person-years with average water supply impacts to 538 person-years in critically dry years.

The results of this analysis are not predictions of the actual number of persons that would become unemployed because the analysis is a partial equilibrium analysis (it does not account for mitigating factors of labor mobility and labor supply characteristics).

Government Regulatory Costs

Administering the agricultural water reductions required by the proposed regulations may impose some additional costs on Reclamation, DWR, and local irrigation and urban water districts above those required to comply with existing water quality standards. These could include the costs of establishing new monitoring programs for fish populations and water quality. However, it is not expected that these additional costs would be substantial.

Impacts on Farmers' Access to Credit

Background. Farmers need two types of loans: short-term production loans and long-term loans for the acquisition of land, equipment, and other assets. Annual production loans are obtained by farmers to purchase seed, fuel, labor, and other materials for crop production. These loans are paid off at the end of the year with crop proceeds. Long-term loans are generally amortized over 7-30 years depending on the life of the asset financed. This type of loan usually requires an investment of 25% or more from the borrower. The ability of farmers to obtain both types of loans will be affected by reductions in water allocations to farmers.

Because of recent changes in how banks analyze loans to farmers, water allocations are closely evaluated in assessing such loans. These recent changes include:

- use of an income-based rather than equity-based loan analysis,
- the increased cost to banks of processing loans, and
- more rigorous evaluation of debt coverage capabilities of the borrower.

Income-based lending practices were introduced in response to the recent high percentage of loan defaults and because of increased federal scrutiny of banks' commercial loan portfolios. Income analysis assesses the degree of risk in the production of specific crops and the management ability of the farmer. The probability of loss is calculated by analyzing financial data for each crop grown in a county and evaluating the experience that farmers have growing a particular crop. Obtaining loans for crops with high probability for loss has become more difficult.

Increased staff time to perform financial analysis of loans and the need for more extensive documentation has increased the cost to banks to make loans. Small loans are often not profitable for banks, especially farm loans that require the loan officer to analyze more than one crop produced by the same farm. Each crop needs to be analyzed for its own level of income and profitability. Production of various crops may occur in different areas of the county or region, further compounding the difficulty and duration of the analysis.

Banks now routinely evaluate the debt coverage of the borrower. Debt coverage is the total amount of short-term and long-term debt divided by the total value of assets. This ratio is used to assess how much the bank has invested in the operation compared with how much has been invested by the business. When the ratio is high, banks will require more protection from secondary (nonfarm) sources of loan repayment, thereby reducing the number of qualified applicants.

Effects of Water Allocation Reductions. During a recent conference, "Financing Agriculture in California's New Risk Environment", participants reported that, during the last few years, banks have been using water availability as a consideration in loan analysis. Further research is necessary to determine how water allocation reductions resulting from increased environmental demands will be assessed. However, reducing water deliveries to farmers is expected to increase the need for new water application technologies or improvement of irrigation systems and the switching from high water-use low-value crops to lower water-use high-value crops. Both effects are expected to increase the demand for loans.

Farmers constructing and installing new water application technologies or making substantial improvements in existing irrigation systems will need access to long-term financing. The increase in long-term debt may increase debt-leverage ratios to unacceptable levels, resulting in loans being denied. If the loan requested is small, the added factor of low profitability for the bank increases the chances of the loan being denied. Farmers may encounter a similar problem by attempting to switch to less water-intensive high-value crops, such as orchards that require investments in land, equipment, and seedlings. Access to long-term loans is further restricted when down payment requirements result in the need for substantial cash investment.

Farmers who switch production to crops that they have not grown previously may have credit problems with production loans. Reduced water allocations may contribute to higher risk because of unsuitable soil conditions for growing different crops or low levels of past production in the area. Loans also may be denied because the farmer has little experience in growing that crop. Uncertainty over water allocations can also increase the time for loan analysis, which can disrupt the production process either by reducing the amount of land planted or by discontinuing crop production altogether.

Problems in obtaining needed credit that result from reductions in water allocations may cause farmers to allow land to lie fallow. Smaller farming operations lacking substantial equity or access to capital may be sold to larger farming operations that have internal sources of capital. The overall extent of the change cannot be determined at this time.

URBAN SECTOR

This section describes the costs to urban water suppliers and their users associated with implementation of the federal proposals.

Baseline Conditions

Urban water suppliers throughout California could be affected by the proposed regulations. Table 4-6 shows the existing and projected water demands for major regions throughout California.

Table 4-7 shows current (1991) retail water costs by region and type of user. Water costs depend on the source of the water, the distance it must be transported to its ultimate place of use, and the level of treatment required. Pricing and rate structure policies adopted by individual water agencies also affect retail water costs. Because of these factors, urban retail water prices vary substantially throughout the state.

Methodology

This section describes the methods used to estimate the reductions in water to urban users and the costs of the reductions. The methodology relies on simplifying assumptions regarding the supply and demand for water by urban users. These assumptions are necessary because of data constraints for the analysis. Improved information may become available in late 1993 under the process used to generate the California Water Plan Update (California Department of Water Resources 1993b). This planning document is being developed under an advisory committee composed of a variety of experts on California water issues. The methodology used in this analysis, however, provides a range of the costs of supply reductions.

As previously described, the analysis used three scenarios to illustrate the range of economic impacts. These scenarios differ mainly with respect to assumptions about urban water districts' ability to adjust to the reductions and the availability of water transfers.

Scenario 1 assumes that urban water districts have little flexibility to adjust to reduced supplies and that water transfers would not be available. It is assumed that drought water pricing, which reduces water demand, is the method used by urban water agencies to adjust to water supply reductions in critically dry years. Under Scenario 1, it is further assumed that water from reclamation projects is used to meet the shortfall to urban water districts during other types of water years.

Table 4-6. Urban Water Use by Hydrologic Regions in California (Acre-Feet per Year)

Region	1990		2000		2010		2020	
	Total	Residential	Total	Residential	Total	Residential	Total	Residential
North coast	180,119	49,062	192,105	51,751	207,899	56,455	224,813	60,488
San Francisco	1,306,088	677,687	1,428,071	744,784	1,521,715	793,622	1,592,172	827,002
Central coast	272,307	116,495	333,355	143,378	375,024	161,301	416,694	179,223
South coast	3,834,252	2,264,035	4,544,648	2,678,488	5,076,492	2,981,823	5,442,219	3,185,689
Sacramento River	675,223	276,003	837,420	341,868	997,824	407,508	1,085,867	443,465
San Joaquin River	473,597	194,457	623,584	255,393	768,867	314,536	855,902	350,829
Tulare Lake	593,228	218,652	737,055	273,315	839,884	311,736	940,697	349,485
North Lahontan	43,350	19,042	39,429	17,362	38,309	16,802	37,525	16,466
South Lahontan	187,512	102,829	291,237	160,181	403,028	221,116	448,058	250,912
Colorado River	239,711	141,138	276,227	162,645	364,719	215,068	403,252	237,919
Total state	7,805,387	4,059,400	9,301,129	4,829,045	10,593,761	5,479,967	11,447,197	5,901,483

Note: Demand in years 2000, 2010, and 2020 incorporate use reductions resulting from implementation of best management practices.

Source: Derived from information in California Department of Water Resources 1993b.

Table 4-7. 1991 Residential, Commercial, and Industrial Retail Water Costs per Acre-Foot for Selected Cities

Region/City	Single-Family Residential ($)	Commercial ($)	Industrial ($)
North coast/Crescent City	369	379	282
San Francisco Bay/San Francisco	484	471	358
Central coast/Santa Barbara	838	2,317	2,782
South coast/Los Angeles	455	457	433
Sacramento River/Chico	518	324	244
San Joaquin River/Stockton[a]	311	316	198
Tulare Lake/Fresno	193	183	136
North Lahontan/Susanville	434	576	447
South Lahontan/Barstow	379	672	258
Colorado River/Hemet	515	758	742

[a] 1990 costs per acre-foot.

Source: California Department of Water Resources 1993b.

Under Scenario 2, it is assumed that urban water districts have more flexibility in adjusting to the reductions and that the reductions in supply are met in most years through new reclamation projects. Under Scenario 2, a combination of drought water pricing and a drought water bank would be used in critically dry years.

Under Scenario 3, it is assumed that water is available through transfers and/or a drought water bank in all year types.

Two steps were used to generate the estimates: estimating the water supply reductions to urban users and estimating the cost or value of the water supply reductions, based on costs to replace these supplies or on the implied cost from reducing demands through water pricing. The costs of increased conservation efforts by urban water agencies were not used for two reasons. First, the availability and costs of various conservation techniques vary widely by geographic location. Second, conservation best management practices are considered key to reducing the growth in demand resulting from population growth.

Estimating Water Supply Reductions

The estimates of total water supply reductions were obtained from DWRSIM modeling, as previously noted; urban reductions were assumed to be 20% of total reductions. This calculation could overestimate the impacts on urban users because both SWP and CVP policies shield urban users from reductions until agricultural supply is reduced. However, under SWP provisions, although agricultural supply would be reduced first, the reduction would be only for a specified time period, then there would be equal reductions in the agriculture and urban sectors.

Costs of Water Supply or Demand Options

All scenarios assume that water supply reduction will be borne by nonindustrial users. Nonindustrial users have the lowest value for water and were the urban users most affected during the drought. Although industrial use accounts for only 2% of statewide water consumption, water is a critically important input to many industrial processes.

The costs to urban water agencies are based on three possible demand reduction or supply options: water pricing to reduce demand, reclamation projects, and water transfers or purchases from a state water bank. These options are described below.

Water Pricing to Reduce Demand. Pricing reduces demand by providing an incentive for customers to change behavior or invest in new technologies such as ultralow-flush toilets. For customers who do not conserve, a premium is paid for the use of water above a set amount. A value of $1,612 per af was derived by Dr. Michael Hanemann of the University of California as the price needed to reduce demand to balance supply reductions.

The drought water pricing costs used in the RIA analysis were estimated from a study on the cost of water shortages to the city of Los Angeles during the 1991 drought (Griffith and Associates 1992). During that period, the Los Angeles Department of Water and Power increased water prices in an effort to decrease water use. The relationship between the marginal cost of water, the price of water, and water use inferred from higher prices was used to establish pricing necessary to reduce demand during periods of urban water shortages (City of Los Angeles Office of the Mayor 1992). The marginal (retail) costs range from $1,200 per af to $2,400 per af, depending on the percent reduction required. These costs are higher than those estimated in previous studies because they rely on short-run demand elasticities, whereas the current empirical literature on demand elasticities deals almost entirely with long-run rather than short-run demand (Hanemann pers. comm.). In situations such as droughts, the relevant concept for both predicting demand and measuring the welfare loss is the short-run demand function.

The value per af ($1,600) of welfare loss for the urban sector is a measure of consumers' surplus losses, not a measure of water bill increases at the consumer level resulting from drought water pricing. Drought water pricing works efficiently because many consumers are not willing to pay higher prices and find other options that fit their needs. Consumers' surplus reflects three consumer responses in this situation: some consumers will pay more rather than conserve; some consumers will conserve by purchasing technology improvements; and some consumers will change behavior, which may result in few out-of-pocket expenditures but results in a welfare loss. Consumer surplus is a measure economists use to estimate the value that consumers place on goods and services over and above their actual expenditures on them.

An alternative approach to estimating welfare losses of increased water pricing is based on a study by Carson and Mitchell (1987) for the San Francisco Bay Area and south coast regions. Cost estimates from this study represent residents' willingness to pay to avoid water shortages similar to those that occurred during the 1977 drought and are considerably higher than those reported above for the city of Los Angeles. These cost estimates have been used in several studies in California to determine residents' willingness to pay for investments in new water supply facilities, such as reservoirs. However, the Hanemann methodology, which is based on actual consumer behavior during the 1991 drought, was considered more appropriate for the RIA analysis.

Reclamation Projects. Water reclamation is considered a key long-term supply option. Because the potential for water reclamation has increased dramatically in recent years, it is considered the most likely source for balancing future supply with demand. A recent study conducted by the WateReuse Association of California indicates that public and private water and sewerage agencies in California involved in water recycling are planning reclamation projects that would provide capacity that substantially exceeds estimates prepared by the Metropolitan Water District of Southern California (MWD) as recently as 1992 for the Bay/Delta hearings.

The cost of reclamation projects was developed from a study conducted by DWR (1990) on the proposed Los Banos Grandes reservoir. In the study, costs were estimated for long-term options for the south coast region to meet the demand for water; the costs range from $167 to $785 per af of water that was treated and distributed to users. For this analysis, costs corresponding to the higher end of the range are used based on the conservative assumption that the less expensive reclamation may not be available. An average cost of $705 per af is used; this corresponds to the average cost of the two sets of reclamation projects at the upper end of the cost range. This average cost is generally consistent with the cost per af ($620) for more expensive reclamation projects being considered by the city of Los Angeles (Jones & Stokes Associates 1993). After a deduction of the avoided cost of MWD supplies at the current rate of $322 per af, the net cost to urban water agencies for augmenting supplies is estimated at $383 per af, which is used to project costs for Scenarios 1 and 2.

Water Transfers. The estimates of water transfer costs were based on prices charged for water from the state water bank during the 1991 drought to help meet the needs of urban users. Water was purchased from DWR by urban users at an average cost of $175 per af (California Department of Water Resources 1992). This cost represents the net incremental cost of obtaining additional supplies. The costs used for this analysis range from $175 to $250 per af, depending on the type of water year. As previously indicated, marginal costs are assumed to increase as demand increases.

Results

Determining the total amount (in acre-feet) of the different options (drought water pricing, reclamation, and water transfers/water bank) is difficult because water districts often have to react quickly to changes in water supply and many lower cost options (especially changes in residential water use technologies) have a longer implementation timeframe. The estimates for Scenario 1 were based on the assumption that no transfers or drought water bank supplies would be available and that the additional water supply reductions in critically dry years are derived using the value per af from drought water pricing. Scenarios 1 and 2 assume that approximately 200,000 af of reclamation projects will be available.

Scenarios 2 and 3 assume that a drought water bank will be available. However, because of uncertainties regarding the potential size of the drought water bank, Scenario 2 combines both drought water pricing and a drought water bank. Currently, DWR estimates that 600,000 af of water are available from the drought water bank to meet water needs and that 200,000 af are available to the south coast area from the Colorado Region (California Department of Water Resources 1993b). Uncertainties about the limits on transfers to urban areas include questions regarding how great a portion of the drought water bank will be purchased by non-Delta water users and agricultural areas, and the physical limits on transfers resulting from physical and regulatory constraints. Therefore, a range of estimates was developed for these scenarios. Thus, Scenario 2 assumes that from 60% to 70% of the 280,000 af reduction to urban areas could be replaced by a drought water bank and that the remainder would be offset through drought water pricing. Under Scenario 3, all reductions could be accommodated through some form of water transfers or drought water bank purchases.

Table 4-8 shows estimated costs to urban users of reducing water supplies under the three scenarios. Under Scenario 1, in which no water transfers occur and no drought water bank exists, the consumer surplus losses are estimated to average $79 million for the proposed new requirements. The weighted average is weighted by water-year type according to the historical percentage of water-year types.

Scenario 2, which assumes additional flexibility to adjust to the reductions through a smaller drought water bank, has an average annual cost of $50-54 million.

Under Scenario 3, which assumes that the reductions can be replaced through water transfers and a drought water bank, the average annual cost is estimated to be $25 million.

COSTS OF DESIGNATING CRITICAL HABITAT FOR THE DELTA SMELT

As previously described, USFWS listed the Delta smelt as an endangered species on March 5, 1993, as provided for by the federal ESA. This section outlines the economic costs resulting from designating critical habitat for the Delta smelt. These costs reflect restrictions beyond the water supply impacts that may occur as a result of the proposed federal requirements.

Description of Critical Habitat for Delta Smelt

USFWS has determined the geographic area of critical habitat for Delta smelt to be the water bodies within the legal boundary of the Delta, Suisun Bay, and Montezuma Slough and its tributaries as far west as the Carquinez Straits. Following are the requirements for maintaining habitat conditions for different Delta smelt life stages:

- Spawning habitat: provide shallow, tidally influenced fresh water (i.e., less than 2-ppt salinity); backwater sloughs; and edge waters with suitable water quality and substrates for egg attachment from February 1 through June 30.
- Larval transport: protect the Sacramento and San Joaquin Rivers and tributary channels from physical disturbances and flow disruption, and provide adequate

Table 4-8. Estimated Urban Water Supply Impacts and Associated Costs Resulting from Implementation of Proposed Federal Actions

	Type of Water Year						
	Critically Dry	Dry	Below Normal	Above Normal	Wet	Weighted Average[a]	EPA and USFWS Actions Only
Water supply reduction to urban users (af)	280,000	200,000	100,000	80,000	80,000	NA	NA
Economic impact of federal proposal (1990 dollars)							
Scenario 1: no drought water bank, drought management techniques, water reclamation, no trading							
- value per af	1,612	383	383	383	383	NA	NA
- consumer surplus losses (annual $1,000)	451,360	76,600	38,300	30,640	30,640	98,650	78,920
Scenario 2: smaller drought water bank, some drought management techniques, water reclamation							
- value per af ($)	NA	383	383	383	383	NA	NA
- consumer surplus losses ($1,000)	184,000-223,000	76,600	38,300	30,640	30,640	62,400-67,700	49,920-54,160
Scenario 3: drought water bank, water transfers in nondrought years							
- value per af ($)	250	200	200-175	175-200	175-200		
- consumer surplus losses ($1,000)[b]	70,000	40,000	20,000	14,000-16,000	14,000-16,000	31,000	24,800

Note: Drought water pricing estimates consumer surplus losses, which exceed out-of-pocket expenses, based on drought studies.

[a] Weighted average of varying water-year types by historical occurrence.

[b] Does not subtract the monetary benefits to agriculture of income transfer from urban users.

river flow and water quality for suitable transport of larvae from spawning to rearing habitat from February 1 through August 1.

- Rearing habitat: maintain the 2-ppt salinity gradient within the Bay/Delta estuary (specifically the Delta and Suisun Bay) to reflect historical patterns, and maintain adequate flows and water quality to sustain shallow, productive nursery habitat.

- Adult migration: same as spawning habitat, with season of December 1 through April 31.

Assessment of Costs

According to the USFWS, the designation of critical habitat will result in the restriction of certain economic activities. The restrictions are in addition to those resulting in a determination of jeopardy for a species. (Under the ESA, the restrictions imposed by the listing of the Delta smelt that result in a jeopardy determination [e.g., actions that would appreciably reduce the likelihood of both the survival and recovery of the species] are not subject to economic considerations; therefore, only the critical habitat designation is considered in this economic analysis.

The specific activities that could be restricted or modified as a result of critical habitat being designated are:

- sand and gravel extraction in river channels or marshes,
- diking and dredging for agricultural operations,
- levee maintenance,
- Montezuma Slough control structure operations, and
- marina construction.

Sand and Gravel Operations

Delta smelt spawning habitat can be destroyed when sand and gravel mining occurs in shallow areas such a dead-end sloughs with emergent vegetation (e.g., tules). Restrictions placed on mining operations to protect the habitat may include limiting the timing of operations (the Delta smelt occupies these areas between December and August), requiring the use of best management practices, and replacing destroyed habitat using a 3:1 ratio. Federal regulation of such activities will usually be in the form of issuance of a Section 404 permit by the U.S. Army Corps of Engineers (Corps).

Only two sand and gravel mining operations are located in lowland areas of the Delta that could be affected by restrictions. Both of these are in San Joaquin County, which has a total of 11 aggregate sites (California Department of Mines and Geology 1990). The estimated value of aggregate production in San Joaquin County for 1986 was $13 million (Taylor pers. comm.). The two aggregate operations in the Delta that could be affected by the regulations produced less than 1% of California's aggregate in 1992, valued at $473 million.

Future economic impacts on the aggregate production industry resulting from designation of critical habitat in the Delta would likely be minor, given the relatively small amount of sand and gravel production occurring in the Delta. Mitigation required of aggregate operations for destruction of habitat would consist of habitat replacement. The cost is estimated to range from $10,000 to $50,000 per acre for wetlands restoration. Costs could be reduced if low-cost lands were acquired and levees were breached to flood areas.

Diking and Dredging for Agricultural Operations

Shallow aquatic areas and wetlands in the Delta have been converted to agricultural areas through past diking and dredging activities, which have created an extensive system of dikes and levees. Some tracts of Delta land, such as Little Holland Tract and possibly Franks and Mildred Tracts, have been allowed to revert to their natural condition in recent years. Converting these areas to agricultural uses by replacing levees and draining the land has been proposed. The Delta smelt critical habitat designation could require implementation of best management practices and a 3:1 replacement ratio of permanently destroyed habitat in these areas.

The regulatory cost associated with converting the Little Holland Tract to agricultural uses under critical habitat designation would be the cost to replace 440 acres of critical habitat at a 3:1 ratio (Monroe pers. comm.). The expense of habitat replacement would likely exceed the economic returns from agricultural production on this tract, which was historically planted for corn. Forgone income from future agricultural production on the tract's 1,300 arable acres amounts to $65,000 per year.

No permits for similar conversion activities are currently being processed and the regulatory costs and lack of available water will probably preclude conversions in the future (Elder pers. comm.).

Levee Maintenance

Over the 10-year period from 1981 to 1991, local agencies provided maintenance on 536.6 miles of levees in the Delta, spending an average of $1.24 million per mile. Approximately 41% of this cost was paid using state subventions (California Department of Water Resources 1993a).

The Corps now requires ESA Section 7 consultations with both NMFS and USFWS before authorizing activities under the nationwide levee maintenance and bank protection permit. Restrictions can be imposed on activities that endanger critical habitat for special-status species.

Current levee maintenance practices include moving materials from adjacent shallow aquatic areas onto levees to repair cracks and breaks, a practice that mobilizes sediment and destroys shallow vegetated aquatic areas. To protect designated critical habitat, the Corps could restrict these activities from December through August and require that clean fill be imported and maintenance activities be conducted from the landward side. Recent permit actions by the Corps and USFWS indicate that under certain circumstances emergency levee repair can avoid adverse effects on the Delta smelt.

DFG also controls dredging activity through streambed alteration permits and restricts maintenance operations that could destroy critical habitat. Additionally, DFG controls state subventions, a major source of funding for levee maintenance. Recent agreements between DFG and reclamation districts for routine maintenance include restrictions on dredging in critical habitat areas. These restrictions cover both the time of year dredging is allowed and areas that can be dredged. Dredging activity is restricted in aquatic areas shallower than 6.5 feet.

Because of protections currently being enforced by federal and state regulatory agencies, potential restrictions associated with designating critical habitat are not expected to substantially affect levee maintenance operations.

Montezuma Slough Control Structure Operations

The gates at the Montezuma Slough control structure are currently operated from November to March to maintain low salinity in the water in Suisun Marsh. Critical habitat designation could result in restrictions being placed on control structure operations, including leaving the gates open from December to August to allow spawning fish, larvae, and juvenile fish to pass through.

This area has many ecological values and some commercial values. Suisun Marsh represents about 12% of California's remaining wetland habitat and is a vital wintering and nesting ground for waterfowl of the Pacific Flyway. Some 200 species of birds, 45 species of mammals, and 36 species of reptiles and amphibians inhabit the marsh, and its waterways provide important habitat for game and nongame fish. This unique resource is the largest contiguous estuarine marsh remaining in the United States. Approximately 160 duck clubs are located in Suisun Marsh, including intensively managed commercial clubs and casually managed properties used primarily for hunting by property owners and their guests. Club-related employment is generally limited to the landowners and, in the case of large clubs, a full-time manager. Annual use of Suisun Marsh amounts to approximately 50,000-60,000 waterfowl hunter days, generating an estimated $850,000 annually in local spending (California Department of Water Resources 1984).

The 2-ppt standard is designed to decrease salinity in the Bay/Delta with specific benefits to Suisun Marsh habitat values, while changes in operation of the Montezuma Slough control structure have an associated theoretical increase in salinity. Therefore, the direction of the changes is not known. In addition, current water quality standards protect Suisun Marsh specifically. Therefore, no economic changes to Suisun Marsh are projected.

Marina Construction

Critical habitat designation for the Delta smelt could result in restrictions being placed on marina construction similar to those placed on sand and gravel extraction operations. Approximately 100 commercial marinas and docking facilities are located in the Delta. These facilities provide 12,700 berths for boats (California State Lands Commission 1991). User days in the Delta are estimated at 12,000,000 annually (California Department of Water Resources 1993a).

For new marina construction or expansion of existing facilities that could destroy critical habitat, restrictions may include limiting the timing of new construction or expansion activities, requiring the use of best management practices, and replacing destroyed habitat using a 3:1 ratio. The replacement cost of habitat is estimated at between $10,000 and $50,000 per acre. Although the demand for new marinas in the Delta is not known, increasing demand for water-related recreation suggests that future requests for new marina development in the Delta are likely.

Chapter 5. Analysis of Benefits

This chapter presents an analysis of the benefits associated with the proposed water quality regulations. It includes an explanation of economic concepts in benefits analysis; a characterization of the types of benefits that would occur; a qualitative discussion of some types of benefits; and a quantitative assessment of some benefits, monetized where possible.

ECONOMIC CONCEPTS APPLICABLE TO BENEFITS ANALYSIS

Economic Concept of Benefits

The term "economic benefits" refers to the dollar value associated with expected positive outcomes that lead to higher social welfare. Conceptually, the monetary value of benefits is embodied by the sum of predicted changes in consumers' (and producers') surplus. These surplus measures are standard and widely accepted terms of applied welfare economics and reflect the degree of well-being enjoyed by people in consuming (or producing) different goods, including environmental quality.

This conceptual economic foundation raises several relevant issues and potential limitations for the benefits analysis. First, the standard economic approach to estimating environmental benefits is anthropocentric; that is, all benefits reflect how they are perceived and valued by humans. A related issue is that the benefits of future outcomes are valued in present day values. All near-term and temporally distant outcomes must be translated into the framework of current human activities and concerns (RCG/Hagler, Bailly 1993).

Benefit Categories

The kinds of benefits resulting from the proposed water quality regulations can be categorized as use and nonuse benefits. Use benefits are those involving some form of direct use of or contact with the affected resource, which is the water resources environment. Specific kinds of use and nonuse benefits affected by the federal proposals are characterized in Figure 5-1.

Figure 5-1. Characterization of Potential Benefits

Use Benefits	
Ocean	■ commercial fishing ■ sport fishing
Inland waters (rivers, lakes)	■ sport fishing ■ wildlife viewing ■ other nonconsumptive recreation (boating, swimming)
Bay/Delta	■ sport fishing ■ wildlife viewing (improved conditions in Suisun Marsh) ■ other nonconsumptive recreation (boating, swimming)
Nonuse Benefits	
Existence values	■ biological productivity of ecosystem ■ preservation values (species protection)
Bequest values	■ intergenerational equity
Option values	■ premium to ensure future availability
Other Benefits	
Species listing	■ avoided costs of future endangered species listings ■ avoided costs of further declines in recreational and commercial fisheries

Use Benefits

Use benefits can embody both direct and indirect uses of the affected water resources. Direct uses include consumptive and nonconsumptive activities. Key benefits categories related to use of water resources are water-based recreation activities, such as fishing and boating.

The value or benefits of participating in recreation activities can be measured using nonmarket valuation techniques, such as the travel cost and contingent valuation methods. Because water-based recreation is a highly valued activity in today's society and water resource projects often affect recreation opportunities, there is a considerable body of information on the values (i.e., benefits) that people place on maintaining and enhancing recreation resources.

Nonuse Benefits

Improved environmental quality can be valued by individuals apart from current use of a resource. Protecting environmental resources is important to many people, but assigning monetary amounts to nonuse values generates considerable debate. Whereas human uses of a resource can be observed directly and valued with different economic valuation techniques, nonuse values can be determined only in surveys in which individuals are asked directly to reveal their values.

Among the more significant benefits of the federal proposals are the ecological benefits. The Bay/Delta estuary provides habitat for many individual species and also supports a diverse ecosystem. The protection of a healthy Bay/Delta estuary is an important societal value that requires economic consideration.

Individuals may have several motivations for placing a value on protecting environmental resources. The Bay/Delta estuary provides an important ecological function in maintaining fish and wildlife resources, and individuals may place value on knowing that the ecological system remains healthy. This type of motivation is often referred to as existence value. A second type of motivation is related to an individual's desire to ensure that fish and wildlife resources that depend on the Bay/Delta ecosystem are available for future generations to enjoy. This type of motivation is referred to as bequest value. Another type of motivation relates to an individual's desire to protect the resource for his/her own future use, either for recreation or for other activities. This type of motivation is referred to as option value.

The important ecological functions that the Bay/Delta performs in the preservation of fish and wildlife species generate nonuse values that require consideration in the benefits analysis. For a more in-depth discussion of the methodological issues concerning the measurement of these values, see RCG/Hagler, Bailly (1993) and Boyce et al. (1992).

Other Benefits

Other benefits include the avoided costs of further declines in fisheries and species in the estuary. An additional benefit associated with the federal proposals is related to the potential savings associated with avoiding the future listing of species under the federal or state ESAs. Listing species restricts production activities that rely on the Bay/Delta water resources and incurs costs to producers. For example, the listing of fish or wildlife species currently in decline could result in further restrictions on water exports from the Delta or on production activities in the Delta. Acting now to prevent the further deterioration of species in the Bay/Delta estuary could avoid future costs associated with listing. Other avoided costs include further losses to the commercial and recreational fisheries sectors and communities.

Benefits to water users include increased certainty related to water management. Reliability and certainty are important considerations for both agricultural and urban water users.

CHARACTERIZATION OF BENEFITS

As previously described, the Bay/Delta estuary constitutes one of the largest habitats for fish and wildlife in the United States. The estuary supports more than 120 fish species and provides a stopover or home for more than half of the waterfowl and shorebirds migrating on the Pacific Flyway. Suisun Marsh, which is within the Bay/Delta estuary, supports many rare plant and animal species.

An important beneficial use designated for the Bay/Delta estuary is enhancement of fish and wildlife. Maintenance of freshwater, estuarine, and wildlife habitat would preserve rare and endangered species; permit fish migration; and provide opportunities for commercial ocean fishing and sport fishing.

There are many expected benefits of combined proposed federal actions. Some are addressed qualitatively only; some (primarily fish population increases) have been modeled quantitatively; and, where possible, a portion of those assessed quantitatively were monetized.

Benefits Qualitatively Assessed

Both the USEPA and USFWS proposed actions will increase the protection of the estuarine habitat in the Delta that will benefit the ecosystem overall and provide specifically for improved conditions for salmon, striped bass, and Delta smelt. As discussed previously, current conditions are associated with the continued decline of the estuary, where, DFG reports, virtually all the major fish populations are declining. Reversing this decline is a major goal and, thus, a benefit of the proposed rule. Expected benefits are as follows:

- increased biological productivity (e.g., populations) of important species, such as salmon, striped bass, and waterfowl;
- protection of a diversity of species unique to the Bay/Delta, such as the Delta smelt, longfin smelt, and Sacramento splittail;
- inhibiting of establishment of new introduced species and curbing of the current population explosion of already established exotic species;
- increased recreational fishing and hunting opportunities in the Bay/Delta estuary and elsewhere;
- increased opportunities for wildlife observation resulting from restoration of riparian and tidal marsh habitat and ecosystem health;
- improved commercial fishery harvest as a result of increased populations of fish; and
- improved ecosystem health, which could reduce the future need for listing of Bay/Delta fish and wildlife species currently in decline.

The existing wetlands and seasonally flooded fields in the Bay/Delta represent more than 25% of the statewide total of such habitat and provides a stopover or home for more than half of the waterfowl and shorebirds migrating on the Pacific Flyway, a bird migration corridor stretching from the southern tip of South America to Alaska. The waterfowl and other birds, fish, animals, and plant populations that rely on the Bay/Delta, however, are rapidly declining. There is compelling evidence that the historical values and living resources of the Bay/Delta are in peril. Protecting the fish, wildlife, and other resources of the Bay/Delta is necessary to avoid the potential collapse of the ecosystem and to maintain the public trust values that the Bay/Delta supports.

Benefits Quantitatively Assessed

Well-established relationships between estuarine conditions and populations exist for many estuarine species. The extent of low-salinity habitat in the estuary is closely associated with the abundance and distribution of estuarine species at all trophic levels. Research has shown that a well-established relationship exists for the following species; Dumas et al.

(1993) used various biological models to estimate the increases in populations of these species that would result from implementation of the proposed federal actions:

- Salmon populations are estimated to increase by approximately 90,000-130,000 salmon.

- Starry flounder populations are expected to increase; these increases are translated into an increase in catch.

- Striped bass populations are estimated to increase by approximately 10%.

- Green and white sturgeon, bay shrimp, American shad, and white catfish populations are expected to increase. Population estimates were not calculated for these species because of data limitations; however, each of these species has an associated commercial or recreational fishery.

Overall, the level of recreational fishing is expected to increase, given the expected increase in most sport species. The monetary value of this overall increase was not estimated but is the topic of ongoing research (Dumas and Thompson pers. comms.).

MONETIZED BENEFITS

Commercial Fishing

More than 200 species of fish, shrimp, and crabs are known to inhabit the Bay/Delta estuary (California Department of Fish and Game 1992a). These species are classified variously as marine, anadromous, estuarine, or freshwater. Marine species use the higher salinity areas of the Bay as a nursery area. Anadromous species migrate through the estuary on their way to and from their spawning grounds in the inland rivers and streams. Estuarine species use the brackish water portions of the estuary as a nursery. Freshwater species are found mainly upstream of the estuary but enter it during at least one stage of their life cycles or during certain types of water year.

Several commercial fisheries are dependent on the Bay/Delta estuary. This analysis focuses on the chinook salmon, starry flounder, bay shrimp, and Pacific herring fisheries; these appear to be the most important commercial fisheries associated with the Bay/Delta estuary (Dumas et al. 1993).

Baseline Conditions

The value of the statewide commercial fishery catch totaled approximately $134.8 million in 1991, which was below historical levels. Between 1986 and 1991, the value of the commercial catch peaked at $198.8 million in 1988 but dropped to $179.5 million in 1989 and to $158.4 million in 1990. (California Department of Finance 1987-1992.)

The decline in commercial fishery values is related to harvests being smaller rather than decreasing fish prices. For example, since 1986, the average commercial fish price has increased from $2.00 to $2.73 per pound; however, the dressed weight of the commercial fish harvest has fallen from 7,430 pounds to 1,605 pounds (Zilberman et al. 1993). The decline in commercial fish harvest is reflected in harvest closures in 1992 and 1993. This generally follows the timing of the drought, during which agricultural water deliveries were not reduced until 1991 and net Delta outflow declined with the fishery.

The value of the statewide commercial salmon catch totaled approximately $9 million in 1991. As with the statewide commercial fishery catch, the commercial salmon catch in 1991 was below historical levels. Between 1986 and 1991, the nominal value of the commercial salmon catch peaked at $41.9 million in 1988 but dropped to $13.5 million in 1989 and $12 million in 1990 (California Department of Finance 1987-1992). The value in real terms in the mid-1970s was approximately $45 million.

Salmon

This section describes the methods and results of estimating the benefits of the proposed federal actions to the commercial salmon fishery.

Methods. In principle, the benefits associated with fisheries result from two types of complex interactions: hydrological/biological processes and biological/economic processes. Hydrological/biological processes determine the biological responses, such as the survival of juvenile salmon, to changes in controllable hydrological variables, such as streamflows, water diversions, water diversion screening, and water export pumping. Biological/economic processes determine the interactions between biological measures, such as the number of adult salmon recruited to the fishery, and a number of economic variables, such as domestic consumer demand for salmon; the existence of substitute products; import/export markets; the economic structures of the harvesting, processing, and wholesale/retail industries; and existing regulations.

The benefits associated with potential increases in the commercial harvest of salmon include increases in the profits of businesses and the wages of employees. Changes can occur in several industrial sectors, including the fish harvesting, processing, retail, and other sectors. These effects could be felt by employees and business owners living in or outside California.

Effects within the harvesting sector are considered direct impacts. Indirect impacts include effects resulting from increased purchases by other economic sectors (the salmon processing, salmon retail, and other sectors) in response to increased catches by the fish harvesting sector. Induced impacts are the increased purchases by households resulting from direct and indirect changes in household income.

The harvesting and processing of commercially caught Sacramento River salmon are expected to affect business profits and employee wages mainly in California. Effects in the retail sector would be expected to spill over to non-California residents.

Population Model. The stages of the fall-run chinook salmon life cycle were captured in a population model developed by Dumas and Hanemann (1992). The model discriminates spatially between specific portions or reaches of the Sacramento River system, the Bay/Delta, and the ocean. Temporal effects are captured by using a weekly time step. The model is a "compartment-type" model consisting of stock variables, flow variables, and linear and nonlinear differential equations defining the relationships between the variables over time. Additional details of the model can be found in Dumas and Hanemann (1992).

Benefit Estimates. As previously indicated, changes in income (business profits and employment wages) can occur at the direct, indirect, and induced levels. This section describes the effects at each level.

Direct Impacts on the Harvesting Sector. Changes in income in the harvesting sector are estimated using information on the ex-vessel value of fish landed and operating costs. Key assumptions for estimating the benefits of changes to the harvesting sector are as follows:

- the average fish size is 10 pounds,
- the ex-vessel price for salmon is $2.68/pound (the 1988-1992 average real price),
- the marginal increase in harvest will not affect the ex-vessel price,
- non-California employees or owners of California fish harvesting firms will not be affected,
- nonwage marginal costs equal 10% of revenue, and
- the California salmon troller fleet does not respond to increases in the availability of Central Valley chinook salmon by catching less chinook salmon from other stocks.

As explained in Dumas et al. (1993), the increase in revenues of firms, net of non-wage costs, is used to estimate changes in economic welfare resulting from increases in the salmon harvest. As shown in Tables 5-1 and 5-2, increases in income (profits and wages)

Table 5-1. Increase in Income Resulting from an Increase in Salmon Caught and Marketed Directly through Farmers' Markets

	Within California ($)	Outside California ($)	Total ($)
Direct impact			
Harvesting sector	57.32	0	57.32
Indirect impact			
Processing sector	0	0	0
Retail sector	0	0	0
Other sectors	4.36	0.44	4.80
Induced impact			
Households	24.25	2.43	26.68
Total	85.93	2.87	88.80

Notes: Estimates of income changes are based on an increase of one fish over the existing rate of catch.

All prices are in 1990 dollars.

Source: Dumas et al. 1993.

Table 5-2. Increase in Income Resulting from an Increase in Salmon Caught and Marketed through Processors

	Within California ($)	Outside California ($)	Total ($)
Direct impact			
Harvesting sector	24.12	0	24.12
Indirect impact			
Processing sector	12.52	0	12.52
Retail sector	11.29	0	11.29
Other sectors	4.36	0.44	4.80
Induced impact			
Households	20.56	2.06	22.62
Total	72.85	2.50	75.35

Notes: Estimates of income changes are based on an increase of one fish over the existing rate of catch.

All prices are in 1990 dollars

Source: Dumas et al. 1993.

to the fish harvesting sector resulting from an increase of one commercially caught salmon are estimated to be $57.32 if the catch is directly marketed through farmers' markets and $24.12 if marketed through processors.

Indirect Impacts. Indirect changes in income are analyzed as a function of the ex-vessel price of salmon and operating costs. Key assumptions for estimating the benefits to indirectly affected sectors are as follows:

- shrinkage of the ex-vessel raw product is negligible,
- the processing sector applies a 90% markup to the ex-vessel price to determine the wholesale price it will charge retailers,
- nonwage marginal costs for processors are equal to 75.4% of wholesale price,
- little substitution takes place in the processing sector and production would expand with increased harvest,
- the average retail markup is 106% of the wholesale price,
- the marginal profit rate is equal to the average profit rate,
- no change in the economic welfare of employees in the retail sector results from changes in harvest either because no unemployment occurs or because unemployed retail workers find employment elsewhere in the California economy, and
- consumers will not be affected by changes in harvest because consumers have access to other seafood products that are close substitutes for California chinook salmon.

As shown in Tables 5-1 and 5-2, the change in income (profits and wages) to the fish processing, retail, and other sectors resulting from an increase in commercial catch of one salmon is estimated to be $4.36 if the catch is directly marketed through farmers' markets and $28.17 if marketed through processors.

Induced Impacts. At the induced level, changes in income are analyzed as a function of direct and indirect impacts. Induced impacts on income are estimated to be $0.393 per dollar of direct and indirect income. Out-of-state impacts associated with directly marketed salmon are assumed to equal one-tenth of the sum of the indirect impacts in sectors other than salmon processing and retailing in California and the induced impacts within California.

The change in induced income resulting from an increase in commercial catch of one salmon is estimated to be $24.25 if the catch is directly marketed through farmers' markets and $20.56 if marketed through processors.

Results. The proposed regulations are predicted to increase the commercial catch of California chinook salmon by 90,000-130,000 fish, depending on the type of water year.

Assuming that approximately half the chinook salmon harvest will be marketed directly to consumers by the harvesting sector and that the other half of the harvest is marketed through processors, benefits are estimated to be $82.07 per salmon, which is an average of the two values estimated. A large proportion of the benefits would accrue to the salmon harvesting sector. Some increases in benefits would accrue to the salmon processing and retailing sectors associated with the catch marketed through processors.

The total benefits of the increase in catch are estimated to be $9.9 million annually during above-normal water years and $8.1 million annually during critically dry years (Table 5-3).

Starry Flounder

Starry flounder occur naturally from Santa Barbara, California, northward to Alaska (California Department of Fish and Game 1992a). The Bay/Delta is thought to be the most important nursery area for starry flounder in California. Within the Bay, starry flounder concentrate near Alcatraz Island and San Pablo Bay. A sharp decline has occurred in the starry flounder catch since 1983 (Dumas et al. 1993).

Methods. This section describes the methods used to estimate population changes and benefits to the starry flounder commercial fishery that would result from the proposed water quality regulations.

Population Model. Freshwater outflow affects starry flounder abundance by influencing the amount of nursery habitat available and the distribution of juvenile starry flounder within the nursery habitat. DFG (1992a) has developed a regression model that explains an abundance index of +1 year-old starry flounder as a function of average March-June monthly net Delta outflow. DFG's model, together with flow data from DWR's DWRSIM hydrology model output supplied by USEPA, was used to describe the hydrological/biological processes affecting starry flounder in the Bay/Delta.

Benefit Estimates. Starry flounder are a moderately important part of the commercial fisheries of the Pacific Northwest (California Department of Fish and Game 1992a). Although starry flounder are a small component of the flatfish catch (2% by weight), they rate second in price per pound at the dock. Commercial landings have varied from a maximum of 486,000 to a minimum of 40,000. NMFS estimates that in 1992, when the catch and population of starry flounder were near the minimum, the total California catch of starry flounder was 77,900 pounds; of this total, 44,251 pounds, valued at $19,544, were landed in San Francisco Bay, a reduction from previous years.

Table 5-3. Estimated Increases in Commercial Catch and Benefits by Species and Type of Water Year (1990 dollars)

		Type of Water Year			
		Above Normal		Critically Dry	
Species	Value per Fish Caught ($)	Additional Number of Fish Caught	Annual Benefit ($)	Additional Number of Fish Caught	Annual Benefit ($)
Salmon	82.07	120,801	9,914,100	99,029	8,127,300
Starry flounder	0.32	471	150	49,054	15,700
Bay shrimp		+		+	

+ = not estimated, but positive.

Source: Dumas et al. 1993.

Results. The proposed regulations are predicted to increase the commercial catch of starry flounder by fewer than 500 fish during above-normal water years to about 49,000 fish during critically dry years (Table 5-3). The benefits are estimated to be less than $200 during above-normal water years to about $15,000 during critically dry years.

Bay Shrimp

Several species of shrimp are found in San Francisco Bay. Commonly called grass shrimp by anglers and bait sellers, these shrimp seldom exceed 70 millimeters (mm) in total length (Herbold et al. 1992).

Methods. DFG has found strong positive relationships between Delta outflow from March through May and both juvenile and the subsequent year's mature shrimp. DFG (1992a) has developed a regression model that explains an abundance index of mature bay shrimp as a function of average March-May monthly net Delta outflow. DFG's model, together with flow data from DWR's DWRSIM hydrology model output supplied by USEPA, was used to describe the hydrological/biological processes affecting shrimp in the Bay/Delta.

Currently, bay shrimp are not used as food because of the high labor cost of processing (Miller 1986) and because most U.S. citizens prefer eating much larger shrimp (Herbold et al. 1992). However, a bait fishery for shrimp provides bait for striped bass and sturgeon fishers. The bait fishery takes approximately 68-91 tons of shrimp each year from the Bay (Herbold et al. 1992). NMFS estimates that in 1992 the total California catch of bay shrimp was 109,806 pounds, valued at $394,124; of this total, 107,367 pounds, valued at $384,124, were landed in the San Francisco Bay area.

Results. Information on changes in the harvest of bay shrimp expected to result from implementation of the proposed water quality regulations is currently unavailable. Small additional benefits may accrue to the bay shrimp fishery with improved Bay/Delta water quality (Dumas et al. 1993).

Pacific Herring

Most Pacific herring spawning in California occurs in a very restricted area of San Francisco Bay near Tiburon Peninsula and Angel Island (Herbold et al. 1992). DFG estimates that herring spawning biomass has recently declined dramatically, from 46,000 tons during the 1991-1992 season to 21,000 tons during the 1992-1993 season. Reasons for the decline include the effects of El Niño during 1991-1992 and the 7-year California drought, which severely affected Delta outflows. Data on herring recruits in 1993 suggest that the herring stock could rebound by 1995 (Dumas et al. 1993).

San Francisco Bay supports 90% of the California fishery for Pacific herring roe (eggs) for export to Japan. Approximately 400 boats fish for herring roe under a limited-entry system established in 1977. Non-Californians hold 26% of the herring gillnet permits. California landings reached a high of 11,000 tons in 1982. The price of freely traded herring fishing permits has fallen from $50,000 to $30,000 in the past 2 years.

A relationship has not been established between Delta outflows and the survival of young herring, but research is ongoing. However, improved conditions for the Pacific herring in San Francisco Bay could result in increased catches in the commercial roe fishery. Benefits of increased catch would depend on future Japanese demand and competition from Alaskan and Canadian herring roe fisheries.

Recreation

The proposed water quality regulations would benefit recreation activities, including consumptive and nonconsumptive uses. The primary benefits would be to sport fisheries. This section discusses the benefits to sport fishing and other recreation activities of the proposed water quality regulations.

Fishing

Sport fisheries in the Bay/Delta, ocean, and inland rivers that could benefit from the proposed water quality regulations include salmon, striped bass, sturgeon, shad, white catfish, and starry flounder fisheries. Table 5-4 shows that anglers from central and northern California took almost 2.5 million saltwater fishing trips in 1985-1986. Of these trips, 919,600 (38%) were for salmon or striped bass, sometimes in combination with other species. This number of trips is estimated to generate approximately $139.5 million in angler spending in the region, based on estimated expenditures (adjusted to 1992 dollars) of $33 per shore trip, $92 per party boat trip, and $61 per private boat trip (Dumas et al. 1993). These activities also generate substantial benefits to anglers that are valued over and above the expenditures.

In general, an overall increase in recreational fishing is expected, given the overall increase in populations associated with improved estuarine conditions. It is difficult to estimate the overall increase in trips because of the lack of available information; however, research is ongoing (Dumas pers. comm.). For this study, overall increases in trips were estimated for salmon fishing, but striped bass trips were assumed to remain constant because many anglers are able to fish for a variety of species. Also, many sport species that are currently declining are expected to increase. Thus, an overall increase in recreational fishing is a reasonable expectation.

Table 5-4. Saltwater Sport Fishing by Central and Northern California Anglers, 1985-1986

Target Species	Fishing Mode: Shore	Party Boat	Private Boat	Total
Salmon	11,967	134,518	316,291	462,776
Striped bass	95,289	10,645	127,710	233,644
Striped bass/other	54,688	21,303	147,272	223,263
Rockfish	104,926	160,603	130,352	395,881
Rockfish/other	28,363	1,889	0	30,252
Other	214,827	56,718	344,308	615,853
No target	355,706	32,603	120,906	489,215
Total	865,766	418,279	1,186,839	2,450,884

Note: Reported in number of trips.

Source: Thompson and Huppert 1987.

Table 5-5. Changes in Sport-Fishing Benefits Resulting from Implementation of the Proposed Water Quality Regulations

Sport Fishing	Benefit per Trip or Fish Caught[a]	Type of Water Year: Above Normal — Change in Numbers of Trips or Fish Caught	Type of Water Year: Above Normal — Annual Benefits[a] ($)	Type of Water Year: Critically Dry — Change in Numbers of Trips or Fish Caught	Type of Water Year: Critically Dry — Annual Benefits[a] ($)
Salmon					
Inland rivers[b]	$20 per trip	0	0	0	0
Ocean	$61 per trip	14,696	896,500	13,398	817,300
Overall recreational fishing		+	+	+	+
Striped bass	$5 per fish	220	1,100	11,110	55,600
Sturgeon	N/A	+	+	+	+
American shad	N/A	+	+	+	+
White catfish	N/A	+	+	+	+
Starry flounder	N/A	+	+	+	+

N/A = no information available.
\+ = positive but not quantifiable.

[a] Prices are in 1990 dollars.

[b] Assumed that increase in salmon population would benefit only the ocean sport fishery and the commercial fishery.

The following analysis focuses on the salmon and striped bass sport fisheries because they are generally considered the most important fisheries and would benefit the most from the proposed regulations.

Salmon Fishing. The salmon recreational fishery includes an ocean fishery composed of both charter (for hire) sport-fishing boats and private sport-fishing boats, and an inland fishery composed of both pier and shore anglers and private sport-fishing boats. These fisheries are heavily influenced by existing regulations, and fishery benefits resulting from implementation of the proposed water quality regulations will be affected by any changes in existing fishery regulations. For example, if fishing regulations are relaxed, the direct benefits of increased fish populations, which are measured in terms of increased catch and consumer surplus, would increase. However, if fishing regulations are tightened, benefits could be reduced.

Methods. The benefit estimates of the salmon sport fishery are affected by the level of participation and the benefits per trip. The following section describes the methods used to estimate changes in salmon sport-fishing participation and the benefits associated with participation.

Participation. Data on ocean sport fishing are collected by DFG for party/charter boats and by NMFS for all types of fishing. NMFS collected data on west coast ocean fishing from 1979 to 1990. In 1985-1986, special surveys in northern California were conducted by NMFS to obtain additional economic information on sport-fishing activity in the San Francisco Bay region.

To estimate potential changes in ocean sport-fishing trips for salmon, Dumas et al. (1993) estimated a regression equation for analyzing the number of trips as a function of a salmon abundance index. The equation was based on data from the Pacific Fishery Management Council (PFMC) and DFG. The results are as follows:

$$\ln(\text{Trips}) = \underset{(1.34)}{1.68474} + \underset{(2.51)}{0.49363} * \ln(\text{Abundance Index})$$

N = 22 yearly observations (1970-1992)
R^2adj. = 0.20
prob F = 0.02

where:

Trips = the sum of charter boat and private boat angler trips for San Francisco and Monterey (units = thousands of trips)

Abundance Index = the sum of California Central Valley chinook salmon spawning escapement, the ocean commercial catch of chinook salmon landed at San Francisco and Monterey, and the ocean recreational catch of chinook salmon landed at San Francisco and Monterey (units = thousands of fish)

To analyze potential changes in salmon sport fishing on inland rivers that would result from implementation of the proposed water quality regulations, the number of current trips was first estimated. PFMC (1993) reports 28,200 salmon as the estimated recreational salmon catch in the Sacramento River basin for 1992. An estimated 487,500 angler-hours were expended in pursuit of these salmon. Using Loomis and Ise's (1992) estimate of 3.5 angler-hours per fishing day and assuming that all fishing trips are day trips, the number of fishing trips in 1992 is estimated at 139,286 angler trips (487,500 angler-hours/3.5 hours per day).

The estimated number of trips in 1992 was then adjusted to provide an estimated number of trips under equilibrium (baseline) conditions. Assuming a target management strategy of a fixed spawning escapement rate (the number of salmon returning to spawn) for the ocean fisheries and assuming that catch rates in each river reach remain constant, catch is estimated at 21,900 salmon, which is 22.3% less than the estimated catch in 1992, using the Dumas and Hanemann (1992) population model. Using an elasticity of 0.328 (Loomis and Ise 1992) for inland recreational fishing trips (per capita) with respect to the total catch and assuming that population remains constant at about the 1992 level, the inland recreational salmon fishing trips can be estimated at 7.33% (0.328 x 22.3%) less than the number of trips taken in 1992. Thus, inland recreational salmon fishing trips are estimated to be 129,076 (139,286 x [1 - 0.0733]) annually under equilibrium conditions.

Benefits. Benefits are estimated in terms of changes in consumer surplus. With data from the 1985-1986 NMFS survey analyzed by Huppert (1989), consumer surplus per boat fishing trip for salmon was estimated at $61 per trip. This estimate is consistent with other estimates of consumer surplus for ocean fishing in California, which generally range from $60 to $90 per trip (Dumas et al. 1993).

Results. As shown in Table 5-5, no benefits are estimated for the salmon sport fishery in inland waters. The number of sport-fishing trips for salmon in inland waters is not expected to change because the goals for salmon spawning escapement established by the PFMC presumably would not change in response to the proposed water quality regulations (Dumas et al. 1993). However, these policy targets are changed with varying conditions (Thompson pers. comm.).

The benefits to the ocean sport fishery for salmon are estimated at about $817,000 annually during critically dry years and $897,000 annually during above-normal water years (Table 5-5).

Striped Bass Fishing. Adult striped bass range in size up to more than 40 pounds, with the average catch around 6-10 pounds (Albert 1987). Adult bass follow an annual cycle of migration. They spend the summer feeding in San Francisco Bay and the nearby areas of the Pacific Ocean and in fall begin to migrate into fresh water, where many of the adults pass through the San Pablo Bay-Carquinez Strait areas. In winter, adult bass are present in the Delta but are relatively inactive and thus are seldom caught by anglers. In spring, as water in the inflowing Sacramento and San Joaquin Rivers warms up, the bass swim upstream to spawn. The spawning run up the San Joaquin River is blocked by salinity, so the spawning is limited to the lower reaches that receive fresh water from cross-Delta flows. After spawning, the adults return to the saltwaters of San Francisco Bay and the ocean.

Both the inland and ocean recreational fisheries for striped bass are regulated by DFG. Currently, fishing for striped bass is not restricted seasonally; however, there is a bag limit of two fish per day and a minimum size limit of 18 inches.

Methods. This section describes the methods used to estimate changes in striped bass sport fishing and the benefits associated with participation.

Participation. The baseline population of adult striped bass is estimated at 1 million. The results of sensitivity analyses performed on striped bass population models developed by DFG were used to estimate the population of striped bass adults. Estimated changes in net Delta outflow for several water-year types under the proposed standards were considered (Dumas et al. 1993).

Table 5-4 shows that anglers from northern and central California took approximately 456,900 trips for striped bass fishing in 1985-1986. This represents 17% of total shore trips, 8% of party boat trips, and 23% of private boat trips.

Benefits. In the 1985-1986 NMFS survey, anglers were asked how much they would be willing to pay to avoid a 50% *reduction* in the catch of salmon and striped bass and, conversely, how much they would be willing to pay to obtain a 100% *increase* in the catch of salmon and striped bass. The average catch was about eight fish per year, or 1.35 fish per trip; therefore, the stated changes translate into an average yearly reduction in catch of about four fish and a gain of eight fish.

Anglers indicated that they were willing to pay about $32 annually to avoid the loss and about $45 annually to secure the gain. These estimates roughly translate into a value of $8 per fish lost and $5 per fish gained. An estimate of $5 per fish is used to estimate the benefits of changes in the striped bass fishery.

Results. As shown in Table 5-5, the number of striped bass caught during an above-normal water year is projected to increase by 220 fish, resulting in a benefit of $1,100. During critically dry years, the catch is estimated to increase by about 11,100 fish, for a total benefit of $55,600.

These estimates may underestimate the actual benefits to sport anglers because the population increase could generate additional fishing trips that have not been directly valued (Thompson and Dumas pers. comms.). These effects have not been estimated for this draft but research is continuing on this issue. The following illustration presents a preliminary assessment of these effects.

In critically dry years, the striped bass population is expected to increase by approximately 10%. Assuming that striped bass anglers respond similar to salmon anglers to an increase in population, the estimate of elasticity of ocean recreational fishing trips results in an increase in trips of approximately 5%. Consumer surplus values of $61 per trip have been estimated for striped bass and salmon fishing and $20 per trip for freshwater sport fishing. Using the higher value of $61 per trip, additional consumer surplus for a critically dry year could be an estimated $1.5 million based on an increase of about 24,600 trips.

Other Sport Fisheries. Other sport fisheries that could be affected by the proposed water quality regulations include sturgeon, American shad, white catfish, and starry flounder fisheries. Potential benefits to these sport fisheries are discussed below.

Sturgeon. Two species of sturgeon are found in the Bay/Delta estuary: white sturgeon and green sturgeon. The white sturgeon, which may live more than 100 years and grow as large as 1,300 pounds, spends most of its life in the estuary. DFG (1992b) has found a strong correlation between an index of year-class strength and mean Delta outflow from April to July.

Green sturgeon are much less abundant than white sturgeon. Green sturgeon are known to spawn in the Sacramento River and juveniles rear in the Delta for 4-6 years (California Department of Fish and Game 1992b). It is believed that green sturgeon are declining in abundance (Herbold et al. 1992).

White and green sturgeon are important sport fishes. The sport-fishing harvest, especially of white sturgeon, increased rapidly in the 1980s as the populations of other sport fish declined and better techniques for taking sturgeon were developed. The sport harvest exceeded 10,000 fish annually in the mid-1980s but has declined over the past 5 years.

The proposed regulations are expected to be favorable to the sturgeon population and therefore would provide increased economic benefits. These potential benefits, however, could not be quantified with available information.

American Shad. Most American shad spawn in the mainstem channels of the Sacramento River and its tributaries in late May and June. Many of the adults die after spawning. Stevens and Miller (1983) describe the apparent increase in American shad recruitment in wetter years. Recent data confirm this study.

American shad support an important recreational fishery upstream of the Delta. Estimates of fishing effort for American shad in the early 1970s include 38,000 angler-days in the Delta, 35,000 angler-days in the Feather River, between 65,000 and 80,000 angler-days in the American River, and between 10,000 and 20,000 angler-days in the Yuba River (Miller 1986). These estimates probably represent a lower bound on fishing effort for

American shad because they do not include fishing effort on the mainstem Sacramento River.

The proposed regulations are expected to improve conditions for American shad juveniles in the Delta and would therefore provide increased benefits to anglers fishing for them. These potential benefits, however, could not be quantified with available information.

White Catfish. White catfish is an introduced species that has become one of the most commonly caught fish in the Delta (California Department of Fish and Game 1992c). According to DFG, the abundance of catfish is inversely associated with the increase in water exports. In 1980, it was estimated that anglers harvested 18% of the white catfish population larger than 7 inches, or approximately 1 million fish (Schaffter 1987).

The proposed regulations are expected to improve conditions for white catfish in the Delta and would therefore provide increased benefits to anglers fishing for them. These potential benefits, however, could not be quantified with available information.

Starry Flounder. Starry flounder are an important component of the recreational fishery in and near San Francisco Bay. Starry flounder were once the most common flatfish species in San Pablo Bay and were common as recently as the early 1970s. Beginning in 1976, starry flounder catch and catch per angler-hour dropped rapidly, while total angler-hours remained fairly constant at around 10,000 annually.

The proposed regulations are expected to improve conditions for the starry flounder and would therefore provide increased benefits to anglers fishing for them. These potential benefits, however, cannot be quantified with available information.

Other Recreation Activities

Implementation of the proposed federal actions also is expected to benefit recreation activities other than fishing. These benefits could occur in the ocean, Bay/Delta, and recreation areas beyond the Bay/Delta. This section describes these other activities and potential benefits of improving them.

Fishing, swimming, beach recreation, hunting, boating, and nature appreciation accounted for 400.6 million days of recreation, or about 18.7% of the total recreation activity statewide in 1980. In 1985, estimates of visitor days were as follows:

- CVP reservoirs in northern and central California - 11.6 million;
- SWP reservoirs, mainly in northern and central California - 6.6 million;
- federal and local government reservoirs - 9.4 million; and
- Delta - 7.7 million (3.9 million of which were for sport fishing).

In 1980, there were an estimated 1.3 million user days of freshwater recreation along the Sacramento River. In addition, there were about 1.7 million user days of recreation along the lower American River.

In addition to rivers and lakes, wetland areas in northern and central California provide significant opportunities for hunting and nonconsumptive wildlife recreation. Total public use of important wetland areas in northern California is estimated at about 421,000 days per year, of which about 177,000 days are for hunting and the rest for wildlife viewing. Nonconsumptive wildlife recreational activities also take place at a variety of other locations in the San Francisco Bay Area. More than 119,000 individuals participated in wildlife observation at wildlife refuges in the area between 1989 and 1990; nearly 10,000 individuals engaged in sightseeing and native (nature) studies at Grizzly Island Wildlife Area in 1989.

Table 5-6 shows data on consumer surplus per trip for the types of activities that could benefit from implementation of the proposed water quality regulations. Determining the effect of the proposed federal actions on these activities is complex. For example, effects on reservoir recreation would depend on operations, which is an implementation issue. Estimating the potential effects on other recreation activities is equally difficult.

Nonuse Benefits

Several studies have recently been conducted in California that provide a framework for evaluating the extent of nonuse benefits associated with the proposed regulations. Jones & Stokes Associates (1990) conducted a contingent valuation survey for the interagency San Joaquin Valley Drainage Program to estimate the benefits of maintaining and improving fish and wildlife resources in the San Joaquin Valley. A study also was recently conducted on the value of preserving Mono Lake, a naturally saline environment in the eastern Sierra Nevada (Jones & Stokes Associates 1993).

Estimates of nonuse values associated with these two studies are presented in Table 5-7. These estimates provide some evidence of values that households place on protecting the natural environment.

OTHER BENEFITS

The avoided costs of continued declines in species and the estuarine fisheries can be considered benefits of the proposed federal actions. "Delisting" benefits describe the increased management flexibility and decreased management costs associated either with removing a species from a list of officially designated threatened or endangered species or with preventing its listing. Listing of a species associated with a river, stream, or estuary may severely restrict water management and adjacent agricultural activities.

Table 5-6. Estimated Consumer Surplus per Trip for Various California Recreational Activities

Activity	Consumer Surplus per Trip ($)	Year
Beach recreation[a]	12	1992
Boating at lakes[b]	30-35	1990
Delta boating[c]	32	1987
Waterfowl hunting[d]	23	1989
Fishing on Sacramento River[e]	17	1980
Fishing on Feather River[f]	24	1982
Birdwatching[g]	37	1987
Charter boat fishing for salmon[h]	61	1987

Sources: [a] Dornbusch 1985.

[b] Spectrum Economics 1991.

[c] Mannesto 1989.

[d] Cooper 1990.

[e] Loomis and Ise 1992.

[f] Loomis and Cooper 1990.

[g] Cooper and Loomis 1991.

[h] Huppert 1989.

Table 5-7. Estimates of Nonuse Values Associated with Protecting the Natural Environment in California

Protected Resource	Average Willingness to Pay per Household (annual values in dollars)
San Joaquin Valley fish and wildlife[a]	
Maintaining wetlands in the San Joaquin Valley	174
Increasing salmon in the San Joaquin River	181
Protecting wildlife from selenium contamination	308
Mono Lake[b]	
Increasing lake levels and protecting the ecosystem	82-91

[a] Source: Jones & Stokes Associates 1990.

[b] Source: Jones & Stokes Associates 1993.

Presently, only two species that use the estuary have been formally listed as endangered: winter-run chinook salmon and Delta smelt. Other fish that are being considered for formal listing or that may soon qualify for listing are spring-run chinook salmon, longfin smelt, splittail, and green sturgeon. Species-specific management actions are necessary to avoid the extinction of unique species but may also result in the establishment of many new and complex requirements on the timing of water exports and reservoir releases, specific to each species. USEPA's proposed ecosystem approach to establishing water quality standards is expected to preclude the need for further species-specific regulatory actions.

Avoiding further declines to the recreational and commercial fisheries is considered a benefit to the industries dependent on these fisheries, which are valued at nearly $180 million (the recreational salmon and striped bass fisheries generate approximately $139.5 million in angler spending in the region and the commercial salmon industry had revenues of approximately $40 million before the current drought). Avoiding further losses to this sector is an economic benefit of the federal proposals.

An additional benefit to other water users is the value of certainty and reliability in water planning and financial planning.

Chapter 6. Comparing Costs and Benefits

This chapter discusses comparing the estimated costs and benefits of the proposed water quality regulations and designation of critical habitat for the Delta smelt. Because benefits do not vary by scenario, a cost-effectiveness framework is used. Because many benefits are not expressed in dollar terms, the assessment of cost-effectiveness is mostly qualitative. The impact of the transfer of income from urban areas to agricultural areas on welfare losses is considered. Regional economic effects are discussed, focusing on projected changes in employment.

COST-EFFECTIVENESS OF THE SCENARIOS

Summary of Benefits

As previously described, the Bay/Delta estuary constitutes one of the largest habitats for fish and wildlife in the United States. The estuary supports more than 120 fish species and provides a stopover or home for more than half the waterfowl and shorebirds migrating on the Pacific flyway. In addition to monetized benefits of at least $9-11 million annually to recreational and commercial fisheries and employment gains of an estimated 300-360 jobs annually, benefits include the following:

- Biological productivity and health for many estuarine species are expected to increase.

- The decline of species is expected to be reversed and the existence of species unique to the Bay/Delta, such as Delta smelt, winter-run salmon, longfin smelt, and Sacramento splittail, will be protected.

- Populations of a variety of estuarine species (salmon, striped bass, flounder, and sturgeon) are expected to increase. The populations of most estuarine species are currently declining and the abundance of many of these species shows a clear relationship with salinity. The extent of the population increases has not been determined for all species. However, population increases will benefit the recreational and commercial fisheries.

- Costs associated with further declines in the estuary will be avoided. The costs avoided include further declines in the recreational and commercial fisheries industry (which currently generates an estimated $200 million annually in revenues and consumers' surplus), costs associated with possible future actions needed to protect species from extinction, and the costs associated with losing important water management flexibility. In addition, benefits to water users include increased reliability for water management planning.

Cost-Effectiveness Implications

The implementation plan pursued by the state will substantially affect the magnitude of the costs of the proposed actions.

The social costs of implementing the regulations include changes in producers' and consumers' surplus resulting from changes in production levels and consumer prices that occur as firms and individuals respond to proposed water reallocations. In the agricultural sector, social costs would consist primarily of changes in producers' surplus, i.e. net operating revenues accruing to farmers. In the urban sector, the social costs of urban water reductions take the form of consumers' surplus losses to the residential sector.

The costs associated with the different scenarios, described in Chapter 4, typically would be compared with the benefits to assess cost-effectiveness. Because many benefits could not be monetized for this RIA, the analysis of cost-effectiveness focuses on implications of implementing the scenarios, including the following:

- Urban costs largely depend on the availability of water through transfers and a drought water bank; a drought water bank substantially reduces the consumer surplus losses in urban areas. These options appear likely, given the increases in water transfers allowed under the CVP Improvement Act and the state's continued interest in a drought water bank.

- Agricultural impacts greatly depend on the size of the area affected and on opportunities for water trading between agricultural districts; although the lowest impacts would result from a widespread allocation of water reductions that includes the entire Central Valley, such allocation may not be possible in the short run. However, trading between agricultural districts is currently increasing.

Although the state has the primary responsibility for developing an implementation plan, USEPA has continued interested in policies and programs that will assist in reducing costs while maintaining ecological protection. Other programs may include fee systems, flexibility in trading responsibility, and facilitated water markets.

Welfare Implications of Water Markets

For analyzing the welfare effects of scenarios involving water transfers or a drought water bank, the analysis must consider transfers of income from urban to agricultural areas. The implications are important because the analysis of impacts is incomplete without explicit consideration of these income effects.

To illustrate these effects, a sample case involving a 1 maf reduction during a dry year is presented in Table 6-1.. A dry year was selected because it provides a simpler illustration than a drought-year scenario, in which possibly large amounts of transfers from the drought water bank would be occurring.

Table 6-1. Net Social Costs of a Reduction in Water Supply of 1 maf, Assuming Water Transfers

Agriculture		
- Initial cost: profit lost from reduction in water supply of 1 maf	<$-15 M>	
- Transaction cost: income gained from water sales	$+30 M	
- Final cost		$+15 M
Urban		
- Increased water prices to purchase and distribute water		<$-40 M>
Net Social Costs		<$-25 M>

The agricultural costs in Table 6-1 represent results from the agricultural analysis for Scenario 2, which were estimated using the CARM model. Scenario 2 restricts the water supply reductions to an area south of the Delta but allows for transfers within agricultural districts. Urban costs represent Scenario 3, in which water transfers are used to replace urban water supply reductions.

The overall costs from water transfers are not the $40 million reduction in urban consumer surplus <u>plus</u> the $15 million reduction in agricultural producer surplus, but

$25 million (Table 6-1). This is because $30 million of the urban costs represents a transfer from the urban to the agricultural sector, as payment for transferred water. Note that the price paid by the urban sector is assumed to be much higher than the value of water to agricultural users because of the way the market has been functioning, particularly in the case of the drought water bank. It is assumed that $10 million is lost in transaction costs. Given the income from water sales, the agricultural sector is projected to benefit by $15 million.

Although this example is illustrative of overall welfare effects, the distributional impacts (both employment and geographic) need to be taken into account to properly characterize the overall welfare implications of water transfers. Employment or third-party impacts on agricultural producing regions are a particular concern of agricultural communities. Other issues associated with water transfers that need to be considered more fully are environmental restrictions, such as reductions in environmental benefits associated with cross-Delta transfers, and endangered species concerns. It should be noted, however, that an analysis of the economic impacts of the drought water bank conducted for DWR (Howitt et al. 1992) concluded that the drought water bank created overall economic gains for both California agriculture and the statewide economy.

Finally, according to a Bay Area Economics Forum (BAEF) report on a market-based approach to water allocation, water markets may lead to economic improvements for all water users (Bay Area Economics Forum 1991). The BAEF noted, however, that establishing water quality standards is a necessary step in shifting to a market-based system.

Analysis of Alternative Levels of Protection

USEPA's discussion of the economic costs and benefits in this draft RIA have focused on the costs and benefits of one proposed action in which a given level of protection is assumed. The costs of alternative levels of protection could be analyzed using a cost function.

The following analysis focuses on one important component of the proposed standard: changes in the number of days of protection at a given site for the 2-ppt isohaline. Ideally, both the costs and benefits would undergo a thorough analysis, consisting of modeling of the water supply impacts of different levels of protection, along with a determination of effects on ecosystem health and recovery of endangered species. In the absence of this type of information, this example uses a rough estimation technique to illustrate how changes in the standard may correspond to changes in economic impacts. An assessment of changes in benefits is not possible at this time.

A fundamental assumption in this report is that the economic costs of the proposal are tied to changes in water supply. Therefore, analyzing the changes in water supply impacts corresponding to incremental changes in the proposal can provide the basis for at least a rough approximation of incremental changes in economic costs.

As explained in more detail above, USEPA has relied on the DWRSIM model to analyze the water supply impacts of its proposed actions. USEPA has not used the DWRSIM model to assess incremental changes in its proposal. This is not just a matter of resources: there is some concern that the DWRSIM model (which was not designed for these purposes) may not be able to generate meaningful supply impact analyses when the incremental changes are small. Nevertheless, USEPA will continue discussing this issue with DWR.

In the absence of the preferred DWRSIM model results, USEPA has developed a method for roughly approximating the outside limit of water supply impacts for incremental changes in USEPA's proposal. This method relies on an estimate that it takes about 6,800 cfs to maintain the 2-ppt isohaline criterion at the confluence, about 12,000 cfs (or 5,200 cfs beyond the flow necessary for the confluence) to maintain 2 ppt at Chipps Island, and about 28,000 cfs (or about 21,200 cfs beyond that necessary for the confluence) to maintain the 2 ppt at Roe Island. The "cfs" figures can be translated into the more traditional "acre feet per year" figure by multiplying the cfs figure by 1.98. For example, the water supply impact caused by changing a day of attainment with the 2-ppt criterion at Roe Island to instead requiring compliance for that day only at the confluence would be (28,000 cfs - 6,800 cfs) * 1 day * 1.98 = 41,976 af/year. Similarly, the difference between a day of attainment at Roe Island versus a day of compliance at Chipps Island would be (28,000 cfs - 12,000 cfs) * 1 day * 1.98 = 31,680 af/year, and the difference between a day of attainment at Chipps Island and a day of attainment at the confluence would be (12,000 cfs - 6,800 cfs) * 1 day * 1.98 = 10,296 af/year. These calculations provide useful information when applied to the Chipps Island to confluence standard. This method greatly overstates water supply impacts when applied to the Roe Island standard, and in fact the water savings can easily exceed the total cost.

This draft RIA estimates how changes in water supply can be translated into economic costs. Using a weighted average of agricultural producer and urban consumer surplus losses per af of $90 and applying this value to the incremental water supply impacts provides a crude estimate of incremental costs (for example, the annual economic cost of changing a day of compliance with the 2-ppt criteria). For example, the incremental cost of changing a day of compliance at the confluence to a day of compliance at Chipps Island would be ($90) * 10,296 af/year = $926,600 annually.

An example of this incremental cost analysis is as follows: the proposed rule includes a request for comment on the proper historical reference period for approximating hydrological conditions of the late 1960s to early 1970s. USEPA is proposing using the 1940-1975 reference period to represent the conditions for the late 1960s to early 1970s because this longer period is hydrologically consistent with the late 1960s and early 1970s and provides a better sample of conditions across the different water-year types. One alternative suggested is to use the period 1955-1975 as the reference period, which would lead to a lower number of required compliance days at Chipps Island than would using the historical reference period 1940-1975. In dry water years, this shorter reference period would change 12 compliance days at Chipps Island to confluence compliance days. Using the above estimation method, the annual difference in water supply impacts may be 12 days * 10,296 af/year or 123,600 af/year. Changing the reference period would also change the number of days of compliance at Roe Island. The water supply impacts of this change have not been estimated, but the change may provide additional water cost savings in the event that the number of days of attainment at Roe Island changes.

USEPA believes these estimates are reasonably accurate during times when the projects can control all conditions in the Delta, which normally means nonstorm periods in the drier years. However, this estimation process greatly overestimates the water supply impacts in storm periods and in wetter years in which the projects cannot control outflow conditions. For example, in many wet years, the 2-ppt isohaline is at or downstream of Roe Island for all 150 days without project intervention. Further, this estimation approach doesn't account for the overlapping effects of the proposed USEPA criteria and the NMFS requirements for winter-run chinook salmon. If these NMFS requirements were considered, the overall net costs of USEPA's proposals would be significantly lower. Nevertheless, in the absence of better incremental analyses of costs and benefits, these estimates can serve as an approximation of how the incremental changes in the proposed standard can change the economic costs.

Conclusions

Monetized social costs and benefits of the proposed federal actions are not compared in this analysis because some use benefits to fisheries and nonuse benefits of ecological improvement and species diversity could not be estimated. The actual costs and benefits of the proposals will depend on both the implementation plan pursued by the state and the actual future hydrological conditions. However, several conclusions can be drawn concerning the analysis:

- Although the implementation plan has not been developed by the state, many cost-effective scenarios exist. Using Scenario 2 for agriculture as the most likely scenario, producer surplus losses are estimated to average $20 million. For the urban sector, Scenario 3 (the least cost scenario) is considered most likely; this scenario results in average consumer surplus losses of $25 million. Total welfare losses will be lower than the sum of these two estimates because a portion of the sum represents a transfer from the urban sector to agriculture for water purchases. Further refinements of total welfare losses are possible topics of future research. As discussed, other cost-effective implementation scenarios are possible, and USEPA is committed to working with the state and water users on minimizing economic impacts.

- Benefits are difficult to estimate accurately in the analysis because of the non-marginal nature of ecosystem protection. Although the costs are marginal considering the size of the agricultural and urban sectors, the benefits include the reduced probability of nonmarginal changes such as extinction of species and closures of fisheries.

- Monetary estimates of benefits and costs cannot be compared because nonuse benefits can account for the majority of the benefits but are not expressed in monetary terms.

- Economic concerns are more evident during periods of extended drought; however, biological concerns also become more heightened. As noted previously, USEPA is taking public comment on whether it is necessary to promulgate special criteria to address the issue of extended drought.

- As indicated in the request for comments in the proposed rule, USEPA is also requesting information in several areas that may affect the water supply impacts.

- Given both the monetary estimates and the information on ecological benefits that is not calculated in monetary terms, USEPA believes that the benefits are commensurate with the costs. Cost-effective implementation of the proposal will result in a healthy ecosystem and fisheries resources coexisting with a strong agricultural sector. Working together with the state, regulators can provide increased certainty regarding water supplies in the Delta, assisting in long-term planning for all water users.

REGIONAL ECONOMIC EFFECTS

This section analyzes the regional employment impacts resulting from reallocating water to meet the proposed Bay/Delta regulations. Regional effects resulting from production changes in agriculture and commercial and recreational fishing are discussed. No regional employment effects are presented for reductions in water supplies to urban areas because all reductions are assumed to occur in the residential sector. Several studies on the economic impacts of the drought have also included regional income multipliers; these could be a subject of future research. Zilberman et al. (1993) also estimated gross state product effects.

Effects of Displacing Agricultural Production

When crop production is displaced, the economic effects are not confined to farmers; the industries that supply goods and services to farmers are also affected. Such industries include farm equipment manufacturers and dealers; suppliers of fertilizers, pesticides, fuel, and seed; and service providers such as firms specializing in farm pesticide applications. Other sectors, including the retail firms that supply consumer goods to directly affected workers, also incur some level of secondary effects. Eventually, entire communities may share the secondary costs of displaced economic activity.

A study of the effects of reducing irrigation water supplies to Yolo and Solano Counties during the recent drought concluded that when the water reductions displaced 236 on-farm jobs, a total of 595 agriculture-related jobs were lost in the two counties (Coppock and Kreith 1993). This analysis indicates that for every on-farm job displaced as a result of water shortages, an additional 1.52 off-farm jobs were displaced in related sectors.

Similarly, a recent analysis of drought-related agriculture displacement in the San Joaquin Valley found that when 5,000 on-farm jobs were displaced by water supply reductions, an additional 4,050 jobs were lost in supporting industries (Northwest Economics Associates 1992). According to this study, an average of 0.81 off-farm jobs are dependent on each on-farm job.

Employment displacement resulting indirectly from implementation of the regulations is unlikely to have a large effect on average unemployment rates in a large region such as the San Joaquin Valley. Extensive economic displacement within a region's principal industry can adversely affect community well-being and ability to respond positively to future events (Forest Ecosystem Management Assessment Team 1993) and should be avoided. Apprehensiveness about the concentration of crop displacement is well noted. A survey of community leaders regarding the effects of agricultural water reductions in Yolo and Solano Counties found that nearly all respondents anticipated substantial increases in the demand for social services if the water supply reductions were permanent (Coppock and Kreith 1993).

Methodology

Secondary effects of reduced agricultural water supplies resulting from implementation of the regulations were assessed using IMPLAN. IMPLAN provides estimates of employment multipliers (i.e., numbers that indicate the total change in regional employment associated with one job change in a specified economic sector). Employment multipliers are shown in Table 6-2 for the crop types likely to be most affected by the projected reductions in water supply. The multipliers in this table are "type III" multipliers, which represent the ratio of the sum of direct, indirect, and induced employment changes to the direct employment change. Indirect employment effects refer to job changes in industries that supply the directly affected sector with goods and services. Induced employment effects refer to job changes associated with changes in purchases of consumer goods resulting from income losses in the directly affected sector. These regional employment calculations do not currently include calculating the results of water transfers from agriculture to urban users. Possible methodologies to include these types of interactions between the urban and agriculture sectors are found in Howitt et al. (1992).

Results

As shown in Table 6-2, employment multipliers are largest for vegetables and fruits, primarily because these crops require more inputs from agricultural suppliers than do field or forage crops. Note that most high water use crops have the lowest employment multipliers, so the current change in crop mix is to crops with more employment needs. Under Scenario 1, in which reductions are concentrated in a small area and no trading exists, secondary (i.e., indirect and induced) job losses resulting from the projected water supply reductions are estimated at 1,275 person-years for average water supply impacts. Under Scenario 2, in which trading exists, the secondary job losses are estimated at 154 person-years. Under Scenario 3, in which the reductions are spread over the entire Central Valley through an efficient trading scheme that results in only low-value crops being affected, secondary job losses are estimated at 232 person-years. Secondary employment impacts for critically dry years are estimated at 850 person-years under Scenario 3.

Effects of Enhancing Commercial Fisheries

As described in Chapter 5, "Analysis of Benefits", the proposed regulations would enhance certain commercial fisheries, particularly salmon fisheries. The benefits described would result in secondary impacts on other industries that do business with the commercial fishing sector.

Table 6-2. Secondary Employment Effects of Cropland Fallowing for Three Scenarios

Precipitation Year and Crop Type	Type III Employment Multiplier	Scenario 1 (small area, no trading) Direct Effect (person-years)	Scenario 1 Secondary Effect (person-years)	Scenario 2 (larger area, trading) Direct Effect (person-years)	Scenario 2 Secondary Effect (person-years)	Scenario 3 (entire Central Valley, trading) Direct Effect (person-years)	Scenario 3 Secondary Effect (person-years)
Average water supply impacts							
Pasture and hay	2.09	64	70	6	7	213	232
Wheat, cotton, and rice	2.55	644	998	78	122	0	0
Other field crops	2.05	86	90	11	11	0	0
Vegetables	4.43	34	117	4	14	0	0
Fruits	2.97	0	0	0	0	0	0
Total		828	1,275	99	154	213	232
Critically dry years							
Pasture and hay	2.09	NA	NA	NA	NA	NA	NA
Wheat, cotton, and rice	2.55	NA	NA	NA	NA	NA	NA
Other field crops	2.05	NA	NA	NA	NA	NA	NA
Vegetables	4.43	NA	NA	NA	NA	NA	NA
Fruit	2.97	NA	NA	NA	NA	NA	NA
Total		3,290	5,198*	1,927	3,045*	538	850*

* Based on an average multiplier of 1.58, as derived from preliminary analyses.

Based on the estimates of additional salmon caught, shown in Table 5-3, and assumptions concerning the average size of fish and price, the ex-vessel value of additional salmon harvested is estimated to range from approximately $2.6 million during critically dry years to $3.2 million during above normal years. Based on information from an economic study of California's commercial fishing industry (King and Shellhammer 1981), direct employment generated by the increased catch is estimated to increase by 260 to 317 full-time equivalent (FTE) jobs and total employment (direct, indirect, and induced) is estimated to increase by 298 to 364 FTE jobs.

These employment gains from enhancing the commercial salmon fishery would be most felt along the north coast (Bodega Bay to Crescent City), where 40% of the current salmon harvest occurs. An estimated 27% of the employment gain would be realized in the San Francisco Bay Area and 25% would be realized along the central coast. The employment gains in north coast communities would be important to local economies given the small, resource-based economies of these communities.

Effects of Enhancing Recreation

As described in Chapter 5, "Analysis of Benefits", the proposed regulations would enhance certain sport fisheries and other recreation activities. The benefits described would result in secondary impacts on recreation-related businesses.

Based on estimated changes in the number of sport-fishing trips under the proposed regulations (Table 5-5), changes in spending related to sport fisheries were estimated using sport-fishing spending profiles (adjusted to 1992 dollars) for shore, party boat, and private boat trips (Dumas et al. 1993). Spending was estimated to increase by approximately $1.0 million during above-normal water years and $1.5 million during critically dry water years. Based on employment coefficients and multipliers derived from the IMPLAN input-output model, direct employment was estimated to increase by 33-47 FTE jobs and total employment was estimated to increase by 60-88 jobs.

Because sport-fishing-related spending on gasoline, food, lodging, and recreation-related equipment and services can be spread over a large region, employment gains generated by increased spending would also be widely distributed. Most of the employment effects, however, would be felt near fishing areas. Based on recent distributions of salmon fishing days (Pacific Fishery Management Council 1991), approximately 40% of recreational ocean salmon fishing is estimated to occur along the north coast, including Crescent City, Eureka, and Fort Bragg. An additional 40% of statewide salmon fishing originates from the San Francisco Bay area. The remaining 20% of the fishing occurs in south coast areas, including the Monterey area. Most of the striped bass fishing occurs in the San Francisco Bay area. Increased spending and employment generated by additional fishing trips would likely be proportional to the distribution of fishing.

FUTURE RESEARCH

Several simplifying assumptions and uncertainties have been noted in the preparation of this draft RIA. Although USEPA believes that the information presented is correct and the results presented represent a reasonable assessment of the costs and benefits of its proposal, USEPA welcomes information and comments on this draft RIA.

Chapter 7. Initial Regulatory Flexibility Analysis

Under the Regulatory Flexibility Act (5 USC 601 et seq.) the administrator of the USEPA is required to conduct an initial regulatory flexibility analysis (IRFA) describing the impact of the proposed action on small entities. The major goals of the act are to:

- increase agency awareness and understanding of the impacts of regulations on small entities,
- establish a mechanism whereby policymakers are provided with information about regulatory options and their implications for small entities,
- provide the public an opportunity to comment on regulatory actions that have impacts on small entities, and
- encourage agencies to use flexibility in regulating small entities.

USEPA guidelines direct preparers of an IRFA to first provide a profile of the small entities and determine the statutory authority for considering regulatory options. If USEPA finds that alternative regulatory requirements are not possible under the operating statute, USEPA should prepare an abbreviated IRFA that characterizes small entity impacts and explains why the agency is precluded from considering regulatory options. For this regulatory action, USEPA has determined that the operating statute precludes USEPA from considering regulatory options; USEPA has therefore prepared this abbreviated IRFA.

Small entities affected by USEPA's proposed rule are small farms. Small farms are defined by the U.S. Small Business Administration as farms with annual sales of less than $500,000. Small farms account for 93% of all farms and 53% of all cropland (including unharvested pastureland) in California (U.S. Department of Commerce 1989). The remaining 7% of California farms, which have annual sales of more than $500,000, account for 74% of the value of farm products sold (Jolly 1993).

Another commonly used indicator of farm size is acreage. The U.S. Department of Interior has a 960-acre limitation on farms to which Reclamation provides subsidized water through the CVP. Recent legal settlement by the U.S. Department of Interior will increase the enforcement of this acreage limitation. It is not possible to determine how this legal settlement will affect small farms as defined by gross sales, given the wide variety of crops grown in California's Central Valley, where gross sales are not well correlated to acreage size.

USEPA cannot provide regulatory flexibility for small entities in its promulgation of the proposed rule. Although USEPA's action is the promulgation of water quality standards replacing state water quality standards that did not meet the requirements of the CWA, implementation of these standards is primarily the responsibility of the state. Furthermore, USEPA believes that there are several ways in which the state can implement water quality standards and USEPA encourages the most cost-effective way, which would result in fewer small farm impacts and impacts on financing.

The impacts on small farms will depend first on how the water supply reductions are distributed by the SWRCB geographically. Then, within regions, impacts will vary according to the distribution of water supply impacts within irrigation districts. Determining which type of farm (small or large) would have water supply impacts may also be difficult at the state level. A Stanford University study explains:

> Most farmers receive their water from a local district (generally an irrigation, water, or water storage district) or from a mutual water company . . . local districts have considerable discretion over the acquisition, allocation and pricing of water. The nature and limits of the discretion, however, vary among districts depending on the laws under which the district was formed, any special legislation unique to a district, and a district's local rules and regulations. (Center for Economic Policy Research 1992.)

These districts in turn mainly receive their water supplies under contract with the SWP or CVP. These contracts can limit the districts' discretion over the allocation of water. CVP contractors must comply with the 960-acre limitation. As discussed previously, acreage limits and gross sales are not well correlated; therefore, no estimates are possible of whether acreage limitations shield small farms (as defined by gross sales) from water supply impacts.

The RIA conducted for this rule making indicates that many different scenarios exist to implement the proposed water quality standards. These implementation scenarios vary widely in cost-effectiveness. USEPA encourages the most cost-effective implementation of its rule making. This would equitably and widely distribute any water supply reductions among water users, resulting primarily in field and forage crop displacement. In 1987, small farms produced 40% of all irrigated hay and field crops harvested and 30% of all nonfeedlot cattle sales in the state (U.S. Department of Commerce 1989). Approximately 80% of the irrigated hay and field crops and 50% of nonfeedlot cattle are raised in the Sacramento Valley and San Joaquin Valley counties (U.S. Department of Commerce 1989). Such cattle production is the principal use of irrigated pasture in California. These percentages are substantially lower than the overall percentage of cropland in small farms. In other words, large farms (i.e., farms with annual sales exceeding $500,000) account for a disproportionate share of the production of the crops and livestock that might be displaced by the projected water supply reductions.

Given the above factors, USEPA has prepared this abbreviated IRFA.

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