United States Department of the Interior

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Memorandum

To: Regional Director, Bureau of Reclamation
Sacramento, California

From: Regional Director, Fish and Wildlife Service
Region 1, Portland, Oregon

Subject: Formal Consultation on the 1994 Operation of the Central Valley Project and State Water Project: Effects on Delta Smelt.

This responds to your request of October 5, 1993, for formal consultation pursuant to Section 7(a)(2) of the Endangered Species Act of 1973, as amended, on the effects of the 1994 operation of the Central Valley Project (CVP) and State Water Project (SWP) on the delta smelt (*Hypomesus transpacificus*). The delta smelt was federally listed as a threatened species on March 5, 1993, (U.S. Fish and Wildlife Service (Service) 1993a). Included with this request for formal consultation was a biological assessment entitled: "Effects of the Central Valley Project (CVP) and State Water Project (SWP) on Delta Smelt", prepared by the California Department of Water Resources (DWR) and the Bureau of Reclamation (Reclamation) (1993).

This biological opinion addresses effects of the combined operations of the CVP/SWP on the delta smelt from February 15, 1994, to February 15, 1995. The biological opinion also incorporates the conference report, pursuant to 50 CFR 402.10, addressing project effects on the October 3, 1991, proposed delta smelt critical habitat (Service 1991b). The biological opinion does not address all of the interrelated and interdependent effects of this CVP/SWP action. Effects of CVP/SWP operation on the bald eagle (*Haliaeetus leucocephalus*), California clapper rail (*Rallus longirostris obsoletus*), and salt mouse harvest mouse (*Reithrodontomy raviventris*) have been addressed in another biological opinion (Service 1993d). Effects of the CVP in the Friant Division service area were addressed in Service (1991a). In an April 8, 1993, letter, Reclamation agreed to request consultation on other federally listed endangered and threatened species in the remaining CVP service areas.

On January 6, 1994, a revised proposed rule to designate critical habitat for the delta smelt (Service 1994a) and a proposed rule to list the Sacramento splittail as a threatened species (Service 1994b) were published in the Federal Register. The Service recommends that Reclamation/DWR request a conference on the effects of the CVP/SWP on the revised proposed critical habitat and the Sacramento splittail.

The following sources of information were used to develop the biological opinion: (1) the biological assessment transmitted with the request for

formal consultation; (2) discussions with Reclamation, DWR, U.S. Environmental Protection Agency (EPA), and California Department of Fish and Game (DFG) at several informal meetings; (3) references cited throughout this biological opinion; (4) miscellaneous materials provided by Reclamation, DWR, EPA, and DFG during the consultation process; and (5) unpublished information in Service files.

BIOLOGICAL OPINION

It is our biological opinion that the proposed 1994 combined CVP/SWP operations are likely to jeopardize the continued existence of the delta smelt and adversely modify or destroy proposed critical habitat for the delta smelt.

DESCRIPTION OF THE PROPOSED ACTION

As described in DWR and Reclamation (1993), the project action is defined as those measures required by the State Water Resources Control Board (SWRCB) Water Rights Decision 1485 (D-1485) as modified by the requirements of the February 12, 1993, National Marine Fisheries Service's (NMFS) winter-run chinook salmon biological opinion (NMFS 1993). A detailed description of the Delta facilities and historic and proposed operations of CVP/SWP are described in the DWR and Reclamation (1993). Additional information on CVP/SWP facilities and operations can be found in Reclamation (1992), NMFS (1993), and Service (1993b).

The CVP is composed of some 20 reservoirs with a combined storage capacity of about 11 million acre-feet (AF), eight power plants and two pumping/power-generating plants with a maximum capacity of about two million kilowatts, and about 500 miles of major canals and aqueducts. These various facilities are generally operated in coordination as a single project. Authorized project purposes include flood control and navigation, provision of water for irrigation and domestic uses; fish and wildlife protection, restoration, and enhancement; and power generation. However, not all facilities are operated to meet each of these purposes. Flood control is not an authorized purpose of the CVP's Trinity River Division, for example.

Figure 1 shows major features of the CVP including Shasta and Keswick dams and Shasta Reservoir on the Sacramento River; Trinity and Lewiston Dams and Clair Engle Reservoir on the Trinity River; Folsom and Nimbus Dams and Folsom Reservoir on the American River; New Melones Dam and Reservoir on the Stanislaus River; Friant Dam and Millerton Reservoir on the San Joaquin River; the Tracy Pumping Plant; the Contra Costa Canal; and the Delta-Mendota, Friant-Kern, and Madera Canals in the San Joaquin Valley. Other features, including San Luis Reservoir, O'Neill Forebay, and a portion of the California Aqueduct (San Luis Canal) are joint facilities also owned by the SWP. The Delta facilities and project operations will be described in greater detail below.

The SWP stores and distributes water for agricultural, municipal, and industrial uses in northern California, the San Francisco Bay area, the San Joaquin Valley, and southern California. Other project functions include

flood control, water quality maintenance, power generation, recreation, and fish and wildlife enhancement. Figure 1 shows major features of the SWP including Oroville Dam and Reservoir, and Thermolito Dam and Afterbay on the Feather River; the North and South Bay Aqueducts; the Harvey O. Banks Delta Pumping Plant and Clifton Court Forebay near Tracy; the California Aqueduct, which runs south from the Delta through the San Joaquin Valley and into southern California; and Pyramid, Perris, and Castaic Reservoirs along the California Aqueduct.

Delta Facilities

The CVP/SWP use the Sacramento River and channels in the Delta to transport water to their export pumping plants in the southern Delta. The CVP's Tracy Pumping Plant, about five miles north of Tracy, consists of six pumps including one rated at 800 cubic feet per second (cfs), two at 850 cfs, and three at 950 cfs. Maximum sustained pumping capacity is about 4,600 cfs, the nominal capacity of the Delta-Mendota Canal at the pumping plant. The Tracy Pumping Plant is located at the end of an earth-lined intake channel about 2.5 miles long. At the head of the intake channel, louver screens that are part of the Tracy Fish Protection Facility, intercept fish which are collected and transported by tanker truck to release sites away from the pumps.

Other CVP facilities in the Delta include the Delta Cross Channel and the Contra Costa Canal. The Delta Cross Channel is a gated diversion channel in the Sacramento River near Walnut Grove and Snodgrass Slough. When the gates are open, water is diverted from the Sacramento River through natural channels of the lower Mokelumne and San Joaquin Rivers toward the pumping plants in the southern Delta. The Contra Costa Canal originates at Rock Slough, about four miles southeast of Oakley, and terminates after 47.7 miles at Martinez Reservoir. Historically, diversions at the unscreened Rock Slough facility (Contra Costa Canal Pumping Plant No. 1) have ranged from about 50 to 250 cfs. While the canal and its associated facilities are part of the CVP, they are operated and maintained by the Contra Costa Water District.

The SWP's Harvey O. Banks Delta Pumping Plant (Banks Pumping Plant), in the south Delta, about 12 miles northwest of Tracy, consists of 11 pumps, including two rated at 375 cfs capacity, five at 1,130 cfs capacity, and four at 1,067 cfs capacity. Water is pumped into the California Aqueduct, which has a nominal capacity of 10,300 cfs at Banks Pumping Plant. A one-mile, open intake channel conveys water to the Banks Pumping Plant from Clifton Court Forebay, a 31,000 AF reservoir which provides storage for off-peak pumping and moderates the effect of the pumps on the fluctuation of flow in the adjacent Delta channels. Water enters the Clifton Court Forebay and then passes through the John E. Skinner Fish Protective Facility, which intercepts fish that would otherwise be entrained into the pumps and California Aqueduct. As at the Tracy Fish Facility, fish captured at the Skinner Fish Facility are relocated elsewhere in the Delta.

Other DWR facilities in and near the Delta include the North Bay Aqueduct, the Suisun Marsh Salinity Control Structure (SMSCS), and several temporary barriers in the south Delta. The SWP pumps water from Barker Slough into the North Bay Aqueduct for use in Napa and Solano counties. The intake in Barker

Slough includes a DFG approved fish screen to reduce entrainment of fish into the pumping facility and the aqueduct. Maximum pumping capacity at Barker Slough is 175 cfs (pipeline capacity); the average annual pumping rate is 35 cfs.

The SMSCS spans Montezuma Slough near Collinsville. Operation of the structure restricts the upstream movement of salty water from Suisun Bay during flood tide while allowing the normal flow of freshwater from the Sacramento River during ebb tides. This action helps to offset the effects of upstream diversions by the CVP/SWP, and other small agricultural diversions and improves water quality in the Suisun Marsh when water from Montezuma Slough is diverted onto private lands and lands owned by DFG.

DWR's existing South Delta Temporary Barriers Project consists of seasonal installation and removal of temporary rock barriers at three locations in the southern Delta. Barrier location and operation of these barriers is described in more detail below.

Operations of Delta Facilities

This section summarizes information on CVP/SWP operations that is presented in greater detail in DWR and Reclamation (1993).

Delta Export Facilities: The Delta acts as a conduit for natural river flows and reservoir storage to the CVP/SWP facilities in the southern Delta which export uncontrolled water to the projects' service areas. The Contra Costa Canal and the North Bay Aqueduct supply water to users in the northwestern San Francisco Bay and Napa Valley areas, while the Banks and Tracy pumping plants are operated to meet demands in the San Joaquin Valley, southern California, and southwestern San Francisco Bay area. CVP/SWP Delta export operations are constrained by regulatory decisions and permits, laws, and negotiated agreements. Examples include: the SWRCB D-1485, an Army Corps of Engineers (Corps) permit for the Banks Pumping Plant, the Coordinated Operation Agreement between the CVP/SWP of 1986 (COA), and the NMFS biological opinion on the effects of the projects on the threatened winter-run chinook salmon, and last year by the Service's 1993 biological opinion on the effects of the project on delta smelt.

Operations of Banks and Tracy pumping plants are closely coordinated with each other and with operations of the joint CVP/SWP San Luis Reservoir. A typical annual cycle of Delta operations begins in August or September, when storage in San Luis Reservoir is typically at its lowest following peak spring/summer water demand in the project service areas. At this time, demand for irrigation water begins to decline, and export capacity in the Delta is increasingly devoted to refilling San Luis Reservoir. During the fall, the CVP/SWP largely transfer water stored north of the Delta (from Shasta, Clair Engle, Folsom, and Oroville Reservoirs) to San Luis Reservoir; during the winter, the Tracy and Banks Pumping Plants export a combination of uncontrolled natural river flows and upstream reservoir releases for storage in San Luis Reservoir.

In past years, export pumping has continued at or near maximum from August through April, or until San Luis Reservoir was full. The Tracy Pumping Plant is usually operated at or near its maximum of 4,600 cfs, except when restrictions are imposed by water right or endangered species requirements. Average daily diversions at Banks Pumping Plant are generally limited to 6,680 cfs, as set forth by Corps requirements (dated October 13, 1981). However, from mid-December to mid-March, diversions at Banks may be increased by one-third of the flow of the San Joaquin River (as measured at Vernalis), if discharge from the San Joaquin River exceeds 1,000 cfs. The maximum potential diversion rate at Banks Pumping Plant during this period is 10,300 cfs, the nominal capacity of the California Aqueduct.

The reasonable and prudent alternative in the long-term NMFS (1993) biological opinion for winter-run chinook salmon imposed new constraints on export pumping in the late fall, winter, and early spring. From November 1 through January 31, NMFS required that project operations allow flows in the western San Joaquin River exceed negative 2,000 cfs (based on the 14-day running average of QWEST). QWEST is a calculated discharge defined as San Joaquin River flow in the Delta near Vernalis. From February 1 through April 30, NMFS requires Delta export facilities to operate in a manner that insures a net positive flow in the lower San Joaquin River (based on the 14-day running average of QWEST).

In May, June, and July, D-1485 limits export pumping as irrigation demands begin to increase. These demands are met by a combination of export pumping and storage withdrawals from San Luis Reservoir. D-1485 also established water quality standards to protect beneficial uses in the Delta and Suisun Marsh, including agriculture, municipal, industrial, and fish and wildlife uses. While such Delta standards apply throughout the year, they are most critical for operations of the CVP/SWP when balanced water conditions exist in the Delta. These balanced conditions typically occur from April through November but vary depending on hydrologic and storage conditions. To protect striped bass spawning, D-1485 requires that the CVP and SWP each limit pumping to an average of 3,000 cfs during May and June, and 4,600 cfs in July. In August, pumping at both plants generally is increased to near-maximum rates to meet demands south of the Delta and to begin refilling San Luis Reservoir. During this period, the SWP pumps up to 195,000 AF of CVP water to replace exports lost during the May and June D-1485 restrictions.

The Service's biological opinion (Service 1993b) imposed additional constraints on operations of the projects from May 26, 1993, through February 15, 1994. The project description included mitigation for project effects on delta smelt. In addition, reasonable and prudent measures were required to minimize the potential impact of the incidental take of delta smelt associated with operations of the projects. The terms and conditions implementing these reasonable and prudent measures required (1) improved salvage operations and estimates of take of delta smelt at the Tracy and Skinner Fish Protection Facilities during the delta smelt spawning period from February 1 through July 31; (2) limited pumping at the Barker Slough intake of the North Bay Aqueduct to a 14-day average of 65 cfs through July 31, 1993; (3) limited combined pumping at Banks and Tracy pumping plants to a 14-day combined average rate of 4,000 cfs during May 1993, 5,000 cfs during June 1993, and 9,200 cfs

(including Contra Costa pumping) during July 1993 or less if the 14-day running average of estimated combined salvage exceeded 400 delta smelt; and (4) that export facilities be operated to maintain QWEST greater than negative 2,000 cfs in August 1993, and greater than negative 1,000 cfs, from January 1 through February 15, 1994.

The COA between Reclamation and DWR became effective in November 1986. The agreement defines the rights and responsibilities of the CVP/SWP regarding Sacramento Valley and Delta water needs, including water required under D-1485. The CVP/SWP are obligated to ensure that water is available for the specific uses identified by the agreement. When water must be withdrawn from storage to meet Sacramento Valley and Delta needs, 75 percent of the responsibility is borne by the CVP and 25 percent by the SWP. The agreement also provides that, when unstored water is available for export, 55 percent of the sum of CVP/SWP stored water and the unstored export water, is allocated to the CVP and 45 percent is allocated to the SWP.

Some of the current operational restrictions imposed by NMFS and the Service biological opinions are not addressed by the COA. Specifically, the agreement does not address sharing of responsibilities for meeting either the QWEST standard or the take limitations at the export pumping facilities. As a result, in 1993, the CVP/SWP were not operated in strict accordance with the COA. Instead, Reclamation and DWR by mutual agreement apportioned the available water supply and responsibility for meeting Delta standards between the two projects.

Delta Cross Channel: Reclamation operates the Delta Cross Channel to augment the transfer of water from the Sacramento River to the southern Delta and the export facilities at Banks and Tracy pumping plants. Flows into the Delta Cross Channel from the Sacramento River are controlled by two 60-foot by 30-foot radial gates. In accordance with D-1485, the gates are closed to avoid diverting salmon whenever the daily Delta Outflow Index exceeds 12,000 cfs between January 1 and April 15. Delta Outflow Index is defined as flow of water from the Delta past Chipps Island to the San Francisco Bay. From April 16 through May 31, at the request of DFG the gates may be closed to avoid diverting striped bass when the Delta Outflow Index exceeds 12,000 cfs. According to D-1485, Reclamation is not required to close the gates for more than two out of four consecutive days or for more than twenty total days. However, during several years, with concurrence of DFG, Reclamation kept the Gates closed for most of the April 16 to May 31 period.

To reduce scour in the channels on the downstream side of the gate, and to reduce potential flood flows that might occur from diverting water from the Sacramento River through the Mokelumne River system, the gates are also closed when flows in the Sacramento River, at Sacramento, exceed 25,000 cfs. The gates also are operated occasionally to regulate flow in the Sacramento River to help meet the D-1485 salinity standard at Emmaton. Closing the gates increases flow downstream in the Sacramento River, helps meet the D-1485 standard, and reduces flows in the lower San Joaquin River. When the gates are closed and there is no additional inflow, the net flow of the western San Joaquin River can reverse direction and salinity in the central and southern

Delta can increase. To avoid this effect, the DCC gates are closed for only a day or two at a time to help meet the Emmaton standard.

The reasonable and prudent alternatives in the February 12, 1993, NMFS's biological opinion for winter-run chinook salmon require closure of the Delta Cross Channel gates from February 1 through April 30 to avoid diversions of downstream-migrating juveniles. Also, from October 1 through January 31, the gates must be operated to minimize diversion of juvenile winter-run chinook salmon when monitoring indicates their presence in the lower Sacramento River.

Suisun Marsh Salinity Control Structure: The SMSCS spans Montezuma Slough, a width of 465 feet. In addition to permanent barriers adjacent to each levee, the structure consists of the following components (from east to west): (1) a flashboard module, which provides a 66-foot-wide maintenance channel through the structure (the flashboards can be removed if emergency work is required downstream of the gates, but removal requires a large, barge-mounted crane); (2) the radial gate module, 159 feet across, containing three radial gates, each 36 feet wide; and (3) a boat-lock module, 20 feet across, which is operated when the flashboards are in place.

Operation of the SMSCS restricts the upstream flow of salty water from Suisun Bay during flood tides while allowing the normal flow of freshwater from the Sacramento River during ebb tides. This action helps to meet D-1485 water quality standards in Marsh channels during below-normal, dry, and critical water years and during drier periods of other water-year types.

During full operation, the gates open and close twice each tidal day. Flows past the gates vary from no flow when the gates are closed to several thousand cfs with all three gates open; the net flow through the gates is about 1,800 cfs when averaged over one tidal day. Typically in summer when the gates are not operating and the flashboards are removed, the natural net flow in Montezuma Slough is low, and often in the upstream direction from Grizzly Bay toward Collinsville.

In the spring of 1992, the NMFS's biological opinion for winter-run chinook salmon significantly changed operation of the SMSCS from what previously occurred in critically dry years. The gates were closed from March 1 through March 27, with full gate operations beginning March 27. Individual landowners along Montezuma Slough agreed not to divert water through their unscreened diversions until May 1 so that full gate operations might occur.

South Delta Temporary Barriers: The existing South Delta Temporary Barriers Project consists of installation and removal of temporary rock barriers at the following locations: (1) Middle River near Victoria Canal, about 0.5 mile south of the confluence of Middle River, Trapper Slough, and North Canal; (2) Old River near Tracy, about 0.5 mile east of the Delta-Mendota Canal intake; and (3) Head of Old River near San Joaquin River, within 0.1 miles west of the confluence of the two rivers. The barriers on Middle River and Old River near Tracy are tidal control facilities designed to improve water quality and increase water levels in southern Delta channels during irrigation season. The barrier at the head of Old River is designed to improve conditions in the

San Joaquin River during the migration of fall-run chinook salmon. If the temporary barriers accomplish their purpose and have minimal negative environmental impacts, DWR plans to replace them with permanent structures (e.g., radial gates), that would be operated seasonally. Installation of the head of Old River barrier during the fall is permitted by the Corps from 1968 until 1997. It is also permitted in 1995 to reduce the number of outmigrant smolts entering Old River and subsequently exposed to the CVP and SWP intakes. In 1993, the Middle River and the Old River barriers near Tracy were permitted to be in place between Junel and September 30 on an annual basis until 1995. DWR will submit a request to the Corps to permit installation of the barriers according to the original schedule presented in Figure 23 of DWR and Reclamation (1993).

SPECIES ACCOUNT/ENVIRONMENTAL BASELINE

Species Account

Delta smelt: Please refer to Service (1993b, 1993c) and DWR and Reclamation (1993) for additional information on the biology and ecology of the delta smelt. Historically, the delta smelt is thought to have occurred from Suisun Bay upstream to at least the city of Sacramento on the Sacramento River and Mossdale on the San Joaquin River (Moyle et al. 1992, Sweetnam and Stevens 1993). The delta smelt is an euryhaline species (tolerant of a wide salinity range) that spawns in fresh water and has been collected from estuarine waters up to 14 parts per thousand (ppt) salinity (Moyle et al. 1992). For a large part of its annual life span, this species is associated with the freshwater edge of the entrapment zone (mixing zone at the saltwater-freshwater interface), where the salinity is approximately 2 ppt (Ganssle 1966, Moyle et al. 1992, Sweetnam and Stevens 1993).

The delta smelt is adapted to living in the highly productive Sacramento-San Joaquin River Estuary (Estuary) where salinity varies spatially and temporally according to tidal cycles and the amount of freshwater inflow. Despite this tremendously variable environment, the historical Estuary probably offered relatively constant suitable habitat conditions to delta smelt, because they could move upstream or downstream with the entrapment zone (Moyle, pers. comm., 1993). The final rule (Service 1993c) to list the delta smelt as threatened, describes in detail the factors that have contributed to this species' decline.

Shortly before spawning, adult delta smelt migrate upstream from the brackish-water habitat associated with the entrapment zone to disperse widely into river channels and tidally-influenced backwater sloughs (Moyle 1976, Radtke 1966, Wang 1991). Migrating adults with nearly mature eggs were taken at the CVP's Tracy Pumping Plant from late December 1990 to April 1991 (Wang 1991).

Delta smelt spawn in shallow, fresh, or slightly brackish water upstream of the entrapment zone (Wang 1991). Most spawning occurs in tidally-influenced backwater sloughs and channel edgewaters (Moyle 1976; Moyle et al. 1992; Wang 1986, 1991). Although delta smelt spawning behavior has not been observed

(Moyle et al. 1992), the adhesive, demersal eggs are thought to attach to substrates such as cattails and tules, tree roots, and submerged branches (Moyle 1976, Wang 1991).

Spawning location appears to vary widely from year to year (DWR and Reclamation 1993). Sampling of larval smelt in the Delta suggests spawning has occurred in the Sacramento River, Barker Slough, Lindsey Slough, Cache Slough, Georgiana Slough, Prospect Slough, Beaver Slough, Hog Slough, Sycamore Slough, in the San Joaquin River off Bradford Island including Fisherman's Cut, False River along the shore zone of Frank's Tract and Webb's Tract, and possibly other areas (Dale Sweetnam, DFG, pers. comm.; Wang 1991). Delta smelt also may spawn north of Suisun Bay in Montezuma and Suisun sloughs and their tributaries (Lesa Meng, Service, pers. comm.; Sweetnam, DFG, pers. comm.).

The spawning season varies from year to year and may occur from late winter (December) to early summer (July). Moyle (1976) collected gravid adults from December to April, although ripe delta smelt were most common in February and March. In 1989 and 1990, Wang (1991) estimated that spawning had taken place from mid-February to late June or early July, with peak spawning occurring in late April and early May.

Delta smelt eggs hatched in 9-14 days at temperatures from 13-16° C during laboratory observations in 1992 (Mager as cited in Sweetnam and Stevens 1993). After hatching, larvae and juveniles move downstream toward the entrapment zone where they are retained by the vertical circulation of fresh and salt waters (Stevens et al. 1990). The pelagic larvae and juveniles feed on zooplankton. When the entrapment zone is located in Suisun Bay where there is extensive shallow-water habitat within the euphotic zone (depths less than four meters), high densities of phytoplankton and zooplankton may accumulate (Arthur and Ball 1978, 1979, 1980). However, since an invasion of the Asian clam (*Potamocorbula amurensis*) in 1986, phytoplankton abundance has dropped dramatically (DWR and USBR 1993). In general, estuaries are among the most productive ecosystems in the world (Goldman and Horne 1993). Estuarine environments produce an abundance of fish as a result of plentiful food and shallow, productive habitat.

When the 2 ppt isohaline is contained within Suisun Bay, young delta smelt are dispersed more widely throughout a large expanse of shallow-water and marsh habitat than when the 2 ppt isohaline is upstream in the deeper Delta channels. Dispersion in areas downstream from Collinsville reduces their susceptibility to entrainment in Delta water diversions and distributes juvenile delta smelt among the extensive, protective, and highly productive shoal regions of Suisun Bay. In contrast, when located upstream, the entrapment zone becomes confined in the deeper river channels, that are smaller in total surface area, contain fewer shoal areas, and are less productive.

Environmental Baseline

The existing environmental baseline includes CVP/SWP operations as modified by the requirements of D-1485, the February 12, 1993, winter-run chinook salmon

biological opinion, and the Service's May 26, 1993, delta smelt biological opinion. The Service's 1993 opinion addressed effects of CVP/SWP project operations from May 26, 1993, to February 15, 1994. Included in the 1993 CVP/SWP project operations were several mitigation measures to benefit the delta smelt. Reclamation/DWR have not included these delta smelt mitigation measures in the proposed CVP/SWP 1994 project operations. Therefore, after February 15, 1994, the environmental baseline for the delta smelt will consist of D-1485 conditions as modified only by requirements of NMFS's 1993 winter-run chinook salmon biological opinion. For the reasons described below, baseline conditions likely will perpetuate the long-term population decline of the delta smelt.

The delta smelt is adapted to living in the highly productive Sacramento-San Joaquin River Estuary where salinity varies spatially and temporally according to tidal cycles and the amount of freshwater inflow. Despite this tremendously variable environment, the historical Estuary probably offered relatively consistent spring transport flows that moved delta smelt juveniles and larvae downstream to the entrapment zone (Peter Moyle, University of California, pers. comm., 1993). Since the 1850's, however, the amount and extent of suitable habitat for the delta smelt has declined dramatically. The advent in 1853, of hydraulic mining in the Sacramento and San Joaquin Rivers, led to increased siltation and alteration of the circulation patterns of the estuary (Nichols et al. 1986, Monroe and Kelly 1992). The reclamation of Merritt Island for agricultural purposes, in the same year, marked the beginning of the present-day cumulative loss of 94 percent of the Estuary's tidal marshes (Nichols et al. 1986, Monroe and Kelly 1992).

In addition to this degradation and loss of estuarine habitat, the delta smelt has been increasingly subject to entrainment, upstream or reverse flows of waters in the Delta and San Joaquin River, and constriction of low salinity habitat to deep-water river channels of the interior Delta (Moyle et al. 1992). These adverse conditions are primarily a result of drought and of the steadily increasing proportion of river inflow being diverted from the Delta by the Federal and State water projects (Monroe and Kelly 1992). Operations of the Federal Central Valley Project began in 1940. The State Water Project began delivering water in 1968. However, the proportion of freshwater being diverted has increased since 1983, and has remained at extremely high levels ever since (Moyle et al. 1992). The high proportion of fresh water exported has exacerbated the already harsh environmental conditions experienced by the delta smelt during the last six drought years. Fortunately, low salinity habitat was pushed downstream of Roe Island at the beginning of 1993 due to above normal precipitation and outflows and implementation of the delta smelt biological opinion mitigation requirements. By late 1993, however, low salinity habitat moved back upstream as inflow decreased and water exports increased. The fall midwater trawl index showed an increase in delta smelt abundance concurrent with the more favorable placement of low salinity habitat in early 1993.

Seven abundance indices used to record trends in the status of the delta smelt showed that this species suffered consistently low population levels in the last ten years (Stevens et al. 1990). These same indices also show a pronounced decline from historical levels of abundance (Stevens et al. 1990).

The summer townet abundance index is thought to be one of the more representative indices because data has been collected over a wide geographic area (from San Pablo Bay upstream through most of the Delta) for the longest period of time (since 1959). Figure 3 shows the distribution of summer townet sampling sites. The summer townet abundance index measures the abundance and distribution of juvenile delta smelt and provides data on the recruitment potential of the species. Except for two years since 1983 (1986 and 1993), this index has remained at consistently lower levels than experienced previously (Figure 4).

The second longest running survey (since 1967), the fall midwater trawl survey, measures the abundance and distribution of late juveniles and adult delta smelt in a large geographic area (San Pablo Bay upstream to Rio Vista on the Sacramento River and Stockton on the San Joaquin River, Figure 5)(Stevens et al. 1990). The fall midwater trawl provides an indication of the abundance of adult population. Figure 6 shows that until recently, except for 1991, this index has declined irregularly over the past 20 years. Since 1983, the delta smelt population has exhibited more low fall midwater trawl abundance indices for more consecutive years, than previously.

The results of seven surveys (Figure 7) currently done by the Interagency Ecological Study Program corroborate the dramatic declines in delta smelt attributable to baseline conditions. Existing baseline conditions do not provide sufficient Delta outflows from February 1 through June 30 to transport larval and juvenile delta out of the "zone of influence" of the pumps, nor provide them low salinity and productive rearing habitat (Herbold, EPA, pers. comm.).

Export Pumping, Reverse Flows, and Entrainment: Existing baseline conditions do not provide the necessary positive riverine flows and estuarine outflows to transport delta smelt larvae downstream to suitable rearing habitat outside the influence of the Federal and State pumping plants. When the total Delta diversion rates are high relative to Delta inflow, the lower San Joaquin, Old, and Middle Rivers, and other Delta channels, have a net upstream (i.e., reverse or negative) flow. Out-migrating larval and juvenile fish of many species, including delta smelt, become entrained in these flows and are displaced upstream into the south Delta. The Federal Tracy pumping plant can export water at rates up to 4,600 cfs. Figure 8 shows the average monthly pumping at Tracy for water years 1978 to 1991. The State operated Banks pumping plant generally exports water at rates up to 6,400 cfs. At times, an additional 3,900 cfs of San Joaquin River flow can be pumped through use of four newly installed pumps. Figure 9 shows average monthly pumping at Banks pumping plant for water years 1978 to 1991. Pumping from Barker Slough, a delta smelt spawning area, through the North Bay Aqueduct has averaged at least 36,000 AF in 1990 and 1991 (about 50 cfs). Pumping from Rock Slough into the Contra Costa Canal adds another 250 cfs diversion. In addition, local private water right holders divert 3,000-4,000 cfs during peak irrigation season from about 1,800 diversions located throughout the Delta. Fish are entrained and lost to these diversions and, at the water project diversions, and also as a result of predation by striped bass and other predators.

In recent years, the number of days of reverse San Joaquin River flow which enhance transport of fish to the pumps have increased, particularly during the January-July spawning months for delta smelt (Moyle et al. 1992). All size classes of delta smelt are lost from the Estuary when they are entrained at the water project intakes in the southern Delta (Sweetnam and Stevens 1993). Average numbers of delta smelt salvaged at the State fish screen from 1980 to 1992, are as follows:

April	May	June	July	August
676	1,413	7,884	4,309	1,041

Salvaged delta smelt probably do not survive well because of stress due to handling and trucking (Sweetnam and Stevens 1993). To estimate losses due to predation, screen efficiency, and handling, salvage numbers would have to be multiplied by a factor that varies with length of the smelt (as the delta smelt increases in length the screen efficiency also probably varies). Currently, there is no morphometric or respirometry information available to determine the screening variables of mesh size or approach velocity. There are also no data on predation rates on delta smelt or any closely related species. These data do not reflect losses of larvae, which are too small to be screened or salvaged.

Table 1 gives information on salvage for delta smelt and splittail for 1993:

Table 1. Preliminary January through August 27, 1993, salvage estimates for delta smelt.

	SALVAGE	
MONTH	CVP	SWP
January	0	3,086
February	36	1,154
March	60	85
April	0	0
May	768	15,901
June	2,400	6,187
July	40	827
August	0	24

Figure 10 shows the high correlation of the 14-day running average of combined CVP/SWP salvage of delta smelt and export pumping rates from January through August 1993.

Fish Screens: There are over 1,800 screened and unscreened diversions within the delta most of which probably adversely affect delta smelt. Diversions in the northern and central Delta, where delta smelt abundance is highest, are likely the greatest source of entrainment (DWR and Reclamation 1993). No fish screens can protect all delta smelt from being entrained or impinged. Larval delta smelt are particularly susceptible to entrainment even with the best screening. The current DFG criteria for screening of 0.33 feet per second approach velocity and 3/32-inch opening for a profile bar screen or 5/32-inch opening for a perforated plate was based primarily on the needs of salmon. Ongoing studies may result in a new recommended approach velocity specifically for delta smelt. Until then, the Service recommends a 0.2 feet per second approach velocity with a 3/32-inch opening at this time for delta smelt. This estimate is based on swimming tests done with shad (Service 1993b), not a closely related species but one which has among the lowest velocity requirements measured.

Delta Outflow: During the delta smelt critical spawning and rearing interval from February 1 to June 30, adequate outflows of sufficient magnitude and duration are beneficial to maintain the placement of the entrapment zone. For delta smelt these flows provide transport away from the influence of the CVP/SWP pumps, but also provide the necessary habitat rearing areas within Suisun Bay and Marsh. To be free of the influence of the pumping plants, the entrapment zone needs to be at or downstream of the confluence of the Sacramento-San Joaquin Rivers. Figure 11 shows correlations for several positions in the Estuary between the number of days the 2 ppt isohaline was at a certain river reach and the subsequent Fall Midwater Trawl Index. This information likely indicates the locations where delta smelt are benefitted by higher habitat quality and avoidance of entrainment at the pumps. Figure 45 in DWR and Reclamation (1993) demonstrates a similar correlation between Delta outflow and juvenile delta smelt salvaged at the Skinner Fish facility for 1979-1991 (except 1983). At an average Delta outflow of 9,000 cfs or more, the expanded delta smelt salvage per year is 10,000 or fewer juvenile fish. Figure 45 shows that at an outflow of 4,500 cfs, expanded delta smelt salvaged per year is over 20,000 juvenile fish (DWR and Reclamation 1993). In recent drought years, inflows, exports, diversions, and other hydrologic conditions have limited net mean daily delta outflow to about 4,500 cfs often resulting in placement of the entrapment zone within the "zone of influence" of the pumps and agricultural diversions which may have led to the declines in 1983-1992. "Zone of influence" is defined through use of the Particle Tracking Model, in the DWR and Reclamation (1993), as the area in the Delta where particles are entrained by the CVP/SWP pumps and agricultural diversions. Table 2 shows the relationship of Delta outflow to the position of the entrapment zone in kilometers (km) from the Golden Gate Bridge. This information can be used to estimate outflows needed to maintain the placement of the entrapment zone in suitable rearing habitat.

Table 2. Relationship of Delta Outflow to Entrapment Zone Position from the Golden Gate Bridge (km) [Kimmerer as cited in DWR and Reclamation (1993)]:

Delta Outflow (cfs)	Entrapment Zone Position (km)
3,500	92-106
4,500	88-100
9,000	73-85
12,000	70-82
15,000	67-78
20,000	65-73
30,000	60-68

Using Table 2, Delta outflow of 20,000 cfs to 30,000 cfs likely moves delta smelt larvae and juveniles to an area that provides higher quality habitat and lower entrainment risks as indicated in Figure 11. Lesser flows of 6,800 cfs to 12,000 cfs are likely the minimum flows that move larvae and juveniles downstream of the confluence to suitable rearing habitat and out of the "zone of influence" of the pumps (Figure 45, DWR and Reclamation 1993). Figure 12 shows the hypothetical distances in kilometers on a map of the 2 ppt isohaline upstream of the Golden Gate Bridge in the Sacramento-San Joaquin Delta. This figure shows the location of delta smelt transported by a 12,000 cfs flow to kilometers 70-82 (Table 2) at being between Honker Bay and the downstream end of Sherman Island. The recent average outflow of 4,500 cfs places the eastern edge of the 2 ppt isohaline near Isleton on the Sacramento River and Santa Clara Shoal on the San Joaquin River within the "zone of influence" of the CVP/SWP pumps. If such low flows continue, larval and postlarval delta smelt mortality rates will likely increase due to increased salinity levels and relocation of the entrapment zone upstream into the river channels. Indeed, in recent drought years, as the delta smelt has declined, the 2 ppt isohaline frequently has been in the central and southern Delta where entrainment risks to delta smelt are higher and rearing conditions are not as suitable as downstream of Collinsville.

1993 Formal Consultation: CVP/SWP Operations to Benefit Delta Smelt

The 1993 formal consultation on effects of CVP/SWP operations on the delta smelt established part of baseline conditions from May 26, 1993, to February 15, 1994. The CVP/SWP operated during this period to provide conditions that were beneficial to delta smelt. Indeed, delta smelt abundance indices increased in 1993 (see Figures 4,5).

Stipulations of the Service's biological opinion (Service 1993b) that were implemented to benefit delta smelt, included: (1) no reverse flow in the western Delta, based on the 14-day running average of the QWEST index, from May 1 through June 30; (2) the flow in the western Delta shall exceed negative 1,000 cfs from July 1 through July 31; and negative 2,000 from December 1 through January 31; (3) springtime pulse flows were required from both the Sacramento and San Joaquin Rivers to help transport larval delta smelt through the Delta and into Suisun Bay; (4) for Sacramento River at Freeport, Rio

Vista, and Chipps Island, the minimum daily flows were set for March through August and December through February 15; (5) CVP/SWP reduced combined Delta exports at Tracy and Banks to a daily average of not more than 1,500 cfs during the period April 26 through May 16, or coincident with the arrival of the San Joaquin pulse flows in the Delta; (6) for combined Delta pumping at Tracy, Banks and Contra Costa, the 14-day running average export rate was set from April through July; and (7) the CVP/SWP was operated to maintain the salinity regime in eastern Suisun Bay to provide a 14-day running average electro-conductivity of 3 mmhos per centimeter at Mallard Slough from May 1 to June 30.

In 1993, Reclamation and DWR had agreed to study and monitor effects of operations and facilities on delta smelt. The Interagency Ecological Study Program was also conducting monitoring and studies in the Delta that addressed most of the effects of the 1993 proposed CVP/SWP operations which included the winter-run biological opinion modifications. The following studies and monitoring were done by Reclamation/DWR as part of 1993 CVP/SWP proposed operations: (1) information obtained concerned the average daily position of the 2 ppt isohaline (as measured one meter off the bottom), the average net daily Delta outflow of the Sacramento River at Chipps Island, the average daily QWEST value for the San Joaquin River, and delta smelt adult and larval surveys in the vicinity of the 2 ppt isohaline, provided during the time adults and larvae were present; (2) studies were done to determine more effective fish salvage procedures at the CVP/SWP fish protection facilities; (3) the past operation of SMSCS was analyzed; (4) studies continued to better quantify the population of delta smelt including spawning areas; (5) studies addressed ways of minimizing diversion of adult and larval fish within the Delta, including screening requirements.

The incidental take statement in the May 26, 1993, biological opinion provided (1) improved salvage operations at Tracy and Skinner Fish Protection Facilities, (2) decreased pumping at the Barker Slough intake, (3) decreased pumping at the Federal Tracy and State Banks Pumping Plants and use of a 400 fish take limit that was modified June 30, 1993, to a 14-day running average of 400 delta smelt, and (4) QWEST requirements that reduced delta smelt juvenile and adult losses.

Proposed Critical Habitat

The Service (Service 1991b) proposed designation of critical habitat for the delta smelt as follows: areas of all water and all submerged lands below ordinary high water and the entire water column bounded by and contained within Suisun Bay (including the contiguous Grizzly and Honker Bays), the length of Montezuma Slough, portions of the Sacramento River, portions of the Sacramento-San Joaquin Delta, portions of the San Joaquin River, and the contiguous water bodies in between (a complex of bays, dead-end sloughs, channels typically less than 4 meters deep, marshlands, etc.).

Conclusion

As stated previously, operations agreed to in Service (1993b) were effective for only one year and Reclamation/DWR have not included similar delta smelt

mitigation measures in the proposed CVP/SWP 1994 project operations. Therefore, after February 15, 1994, the environmental baseline for the delta smelt will revert to D-1485 conditions as modified by requirements of NMFS's 1993 winter-run chinook salmon biological opinion and the population decline of the delta smelt is likely to continue.

EFFECTS OF THE PROPOSED ACTION

Please refer to Service (1993b) and Reclamation and DWR (1993) for more information on the effects of the CVP/SWP on delta smelt. The Service's 1993 biological opinion addressed CVP/SWP effects from May 26, 1993, to February 15, 1994. Post-May 26, 1993, conditions contributed to a marked increase in abundance of delta smelt as evidenced by the 1993 fall midwater trawl survey (Figure 9). This proposed action will maintain pre-May 26, 1993, operation of the CVP/SWP that have resulted in the long-term decline of delta smelt.

Transport and Habitat Flows

Proposed operations of the CVP/SWP do not provide adequate flows to transport delta smelt away from the influence of the pumps and provide productive, low-salinity rearing habitat in Suisun Bay. Flows for these purposes are needed from February to the end of June during most years. Because delta smelt are weak swimmers as larvae and juveniles, they are passively transported with the flows. Therefore, during the larval and juvenile phases, flows of sufficient magnitude and duration are needed to transport and disperse delta smelt from the Delta to the Estuary. Bruce Herbold (EPA, pers. comm.) has found a positive correlation between Delta outflow and abundance as measured by the fall midwater trawl index when the 2 ppt isohaline is between Middle Ground Shoals and Roe Island (Figure 12). These data indicate that placement of the 2 ppt isohaline downstream of Chipps Island may be beneficial to recruitment.

To ensure adult recruitment, delta smelt larvae must be transported during the months of February to the end of August from the area where they are hatched to shallow, productive rearing or nursery habitat. Adequate river flow is necessary to provide this transport to Suisun Bay. Proposed operations would result in reverse flows interfering with these transport requirements, maintaining larvae upstream in deep-channel regions of low productivity, and exposing them to entrainment. The specific geographic area important for larval transport is confined to waters contained within the Delta, Suisun Bay, and Montezuma Slough and its tributaries. The specific season when habitat conditions identified above are important for successful larval transport varies from year to year depending upon when peak spawning occurs.

Maintenance of the 2 ppt isohaline between Collinsville and Chipps within the Estuary is necessary to provide delta smelt larvae and juveniles a shallow, protective, food-rich environment in which to mature to adulthood. After hatching, larvae are transported downstream toward the entrapment zone where they are retained by the vertical circulation of fresh and salt water (Stevens

et al. 1990). The pelagic larvae and juveniles feed on zooplankton. When the entrapment zone is located in a broad geographic area with extensive shallow-water habitat within the euphotic zone (depths less than 4 meters), high densities of phytoplankton and zooplankton are produced (Arthur and Ball 1978, 1979, 1980), and larval and juvenile fish, including delta smelt grow rapidly (Moyle et al. 1992, Sweetnam and Stevens 1993). When the entrapment zone is contained within Suisun Bay, young delta smelt are dispersed widely throughout a large expanse of shallow-water and marsh habitat. Dispersion in shallow regions protects delta smelt from large predators and increases the likelihood of their survival to adulthood. In contrast, when located upstream the entrapment zone becomes confined to the deep river channels which are smaller in total surface area, contain fewer shoal areas, have swifter, more turbulent water currents and lack high zooplankton productivity (Moyle et al. 1992).

Placement of the 2 ppt isohaline also serves to protect larval, juvenile, and adult delta smelt from entrainment in the State and Federal water projects as well as from agricultural diversions. The confluence of the Sacramento-San Joaquin Rivers, marked by Collinsville, defines the western limits of the "zone of influence" of the pumps (Service 1993b; DWR and Reclamation 1993). However, tidal influence in this area moves delta smelt larvae and juveniles into the "zone of influence", upstream of Collinsville. Flows that move the 2 ppt isohaline downstream of Collinsville are needed to move delta smelt away from this zone of influence. When delta smelt are moved into this zone, they are subjected to increased entrainment from both State and Federal pumps as well as agricultural diversions. Indeed, salvage of juvenile delta smelt is inversely related to Delta outflow (DWR and Reclamation 1993, Figure 45). Continuing the CVP/SWP operations, as proposed, would perpetuate these adverse affects and contribute to the continued decline of the species.

San Joaquin River Transport Flows

Proposed operations of the CVP/SWP do not provide for an outflow component from the San Joaquin River when San Joaquin flow is less than the following: about 11,000 cfs from August to April, 6,000 cfs in May and June, and 9,200 cfs in July (Burke, Reclamation, pers comm.). Prior to agricultural diversions and the construction of the CVP/SWP, fresh water flowed down the San Joaquin River, and attracted spawning delta smelt to its fresh water channel edges and tributary sloughs. Over time, the delta smelt established a distinct spawning population in the San Joaquin River, and now requires an outflow component to move juveniles and larvae toward eastern Suisun Bay and to possibly stimulate future adult up-stream migration (Moyle, UCD, pers. comm.). However, San Joaquin River water, downstream of Sack Dam, now contains contaminants that enter the system from agricultural drains. This contaminated water likely adversely affects delta smelt and its food organisms as has been observed for juvenile chinook salmon and striped bass (Saiki et al. 1992). The proposed operations do not provide high quality water down the San Joaquin River to maintain transport and attractant flows and dilute and minimize the adverse effects associated with contaminants. Additional sources of water potentially available to provide San Joaquin River outflow include "temporary water supplies" and Friant Class 2 water. Temporary water supplies are those made possible as a result of an unusually large water supply not

otherwise storable for project purposes, or infrequent and otherwise unmanaged flood flows of short duration. Under temporary contracts that do not exceed one year, these flows can be made available for agricultural purposes to lands without regard to the acreage limitation and full-cost provisions of Federal Reclamation law. Friant Class 2 water is that supply of water which becomes available in addition to the supply of Class 1 water and which, because of its uncertainty as to availability and time of occurrence, will be undependable in character and will be furnished for agricultural purposes only if and when Reclamation determines such water is available. By not proposing to use these two types of water for instream purposes, and instead reserving this water for agricultural/municipal purposes, the proposed project would perpetuate the continued unavailability of San Joaquin River flows.

Presence of Delta Smelt Upstream of the Confluence in July-August

In years when peak spawning occurs late in the year, the proposed operations do not provide flows to move delta smelt larvae and juveniles in July and August to suitable rearing habitat in Suisun Bay. Operation of the CVP/SWP pumping plants in the summer months are particularly harmful to delta smelt. This is especially true when smelt spawn late and are not well distributed. An area extending eastward from Carquinez Straits, including Suisun Bay, Grizzly Bay, Honker Bay, Montezuma Slough and its tributary sloughs, up the Sacramento River to its confluence with Three Mile Slough, and south along the San Joaquin River, including Big Break, defines the specific geographic area critical to the maintenance of suitable rearing habitat.

The proposed operations would not provide additional "pulse" flows when delta smelt spawn late in the season or when the summer townet survey indicates that delta smelt are not distributed widely throughout the Delta. Therefore, in years when the delta smelt numbers are low and distribution poor, larvae and juveniles would be especially vulnerable to entrainment.

Suisun Marsh Salinity Control Structure

When the SMSCS is in operation, the flashboards and radial gates impair free movement of delta smelt into or out of Montezuma Slough. The twice daily closure of radial gates may slow the movement of the delta smelt out of Montezuma Slough, and may increase the likelihood of entrainment due to private and State owned diversions. When the radial gates are opened, higher velocities and turbulence may occur causing increased stress, disorientation, and greater risk of predation. Suisun Marsh is an important area that allows wide geographic distribution of delta smelt. SMSCS operation interferes with the distribution of delta smelt within the Marsh, increases predation and diversion.

Entrainment and Predation at the Pumps, Barker Slough and Roaring River Diversion

The proposed action does not include curtailments in pumping to mitigate for entrainment at the pumping plants other than those required by D-1485 and the winter-run chinook salmon biological opinion. The DWR Particle Tracking Model indicate that the export pumps have a "zone of influence" in the interior

Delta from which a large percentage of modeled particles were entrained (DWR and Reclamation 1993). When delta smelt are in or near the interior Delta, losses from entrainment will increase. Furthermore, reverse flows, which are a consequence of pumping, move delta smelt into the "zone of influence", thus decreasing smelt distribution and increasing the likelihood of entrainment. During December through March, delta smelt adults migrate upstream from Suisun Bay and into the lower Sacramento-San Joaquin Rivers to spawn. This is the most important life-stage in determining the abundance of the following years recruitment (Herbold, EPA, pers. comm.). Losses of these adults occur when CVP/SWP pumping entrains these fish as they migrate upstream into the "zone of influence" of the pumps. In all water-year types, these adult spawners must have protection from entrainment. Larval and juvenile delta smelt migrate downstream from the Delta to Suisun Bay from February through June. These life-stages float passively downstream with flows and are easily entrained when in the influence of the pumping plants. In wet, above normal, and below normal water-years, abundance of these life-stages is relatively high compared to dry and critically dry years when more protection is necessary. Delta smelt spawn in July and August in some years. Larvae and juveniles produced by this late spawning are susceptible to entrainment at a time when diversions are high in the Delta. In most years, spawning is earlier and juveniles that have survived to July and August have become biologically more important to recruitment in the next year-class with August being more important than July. The summer townet survey indicates the abundance of this life-stage during these months (Figure 3). If flows have moved and maintained larvae and juveniles to Suisun Bay, entrainment is least likely in September through November.

Predation occurs concurrent with entrainment because striped bass and other predator fish accumulate at the pumping plants and other diversions where delta smelt are drawn due to the "zone of influence." The high flows and turbulence associated with these diversions disorient fish making them highly susceptible to predation (Coulston, DFG, pers. comm.).

CVP/SWP has not proposed to change operations at the salvage facilities to increase survival of salvaged delta smelt. Practices at the salvage facilities result in substantial losses of delta smelt. Currently, salvaged delta smelt adults are released at the same site where juveniles are released, in the western/downstream reaches of the Sacramento and San Joaquin Rivers. Adult delta smelt migrate upstream to spawn and when salvaged are released in a downstream location. Release of adults in an upstream location would reduce losses due to unnecessary retracing of migration routes. Salt is added to tank trucks to give a solution of 5 ppt. The purpose of this relatively high salt concentration administered over the short time before release is to help restore the fishes' slime layer, to reduce bacterial, fungal, and parasite infection, and to lower stress by lowering energy requirements by placing fish in isotonic balance with their environment. However, current information indicates that a solution of 8 ppt would better produce an isotonic balance for the delta smelt (R. Mager, UCD, pers. comm.).

CVP/SWP has not proposed reducing diversions from Barker Slough during the delta smelt spawning interval. Adult delta smelt can spawn in Barker Slough from February through August. This spawning area is thought to be one of the

most important in the Delta (Sweetnam, DFG, pers. comm.). DWR has proposed additional diversions from Barker Slough through the North Bay Aqueduct during the spawning period. CVP/SWP has not proposed changing approach velocities at the Roaring River Diversion screen in Montezuma Slough. Roaring River Diversion in Montezuma Slough is screened using DFG requirements for salmon. This requirement may not fully address delta smelt needs. Both of these diversions attract predators that add to the losses of delta smelt.

CVP/SWP has not proposed reducing diversions from Rock Slough during the delta smelt spawning interval. Contra Costa Canal carries 50 to 250 cfs taken from an unscreened intake at Rock Slough in Old River. Since delta smelt adults are in this area, the lack of screening has created the potential for entrainment. Large spawning areas for delta smelt lie just north of the intake at Twitchell Island. The unscreened intake at Rock Slough is responsible for annual losses that can exceed 6,000 adult equivalents (Jones and Stokes 1992). This may be as much as 1.5 percent of the entire current population of delta smelt. These fish would be lost forever from the estuary. Predatory fish reside near the Rock Slough intake and add to the delta smelt losses here. Continued operations are likely to perpetuate the long-term decline in smelt populations.

Because one of the most important primary constituent elements identified in Service (1991b) was the maintenance of the 2 ppt isohaline in Suisun Bay to provide rearing habitat for juvenile delta smelt, effects of CVP/SWP operations on proposed critical habitat are similar to those that affect the continued existence of the species. As described above, high diversion and export rates of surface water inflows, in combination with upstream water storage management practices and operations, that would move the 2 ppt isohaline upstream of Suisun Bay during late winter through early summer months, would adversely modify or destroy proposed critical habitat for the delta smelt.

Conclusion

The proposed continuation of project operations as they occurred prior to 1993 would perpetuate the decline in the delta smelt population experienced during the 20 years before 1993. Survival of the species cannot be insured by the continuation of this population decline. Accordingly, effects of the proposed project on larval and juvenile transport, rearing habitat, and vulnerability to entrainment, predation, and contaminants, would decrease the likelihood of survival and recovery of the species in the wild and adversely modify or destroy proposed critical habitat.

CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, local, or private actions affecting listed species that are reasonably certain to occur in the area considered in this biological opinion. Future Federal actions not related to this proposed action are not considered in determining the cumulative effects, but are subject to separate consultation requirements pursuant to section 7 of the Act.

Cumulative effects on the delta smelt or its proposed critical habitat include any continuing or future diversions of water that may entrain adult or larval fish or that may decrease outflows incrementally, thus shifting upstream the position of the delta smelt's preferred habitat. Water diversions through intakes serving numerous small, private agricultural and duck clubs in the Delta, upstream of the Delta, and in Suisun Bay contribute to these cumulative effects. These diversions also include municipal and industrial uses, as well as providing water for power plants. State or local levee maintenance and channel dredging activities also destroy or adversely modify critical habitat by disturbing spawning or rearing habitat. Delta smelt adults seek shallow, tidally-influenced, freshwater (i.e., less than 2 ppt salinity) backwater sloughs and edgewaters for spawning. To assure egg hatching and larval viability, spawning areas also must provide suitable water quality (i.e., low concentrations of pollutants) and substrates for egg attachment (e.g., submerged tree roots and branches and emergent vegetation). Suitable water quality must be provided by addressing point sources of contaminants so that maturation is not impaired by pollutant concentrations. Levee maintenance and channel dredging disturbs spawning and rearing habitat, and resuspends contaminants into these waters.

The following listing represents non-Federal entities which have water storage capabilities greater than 100,000 AF:

Entity w/ Storage (Delta water)	Actual Storage
Reclamation	8,824,655
DWR	3,786,183
TID/MID	2,103,000
PG&E	1,486,842
Merced ID	1,024,000
Yuba Co. WA	961,300
San Francisco	654,500
EBMUD	640,734
SCE	572,500
City of Sacramento	418,060
Placer Co. WA	343,995
Nevada ID	266,085
Oakdale/SSJID	231,600
Calaveras Co. WA	184,300
Oroville/Wyandotte	158,000
S. Sutter WD	103,000
Total:	21,758,754

Entity w/ Storage (Sacramento R.)	Actual Storage
Reclamation	5,587,100
DWR	3,786,183
PG&E	1,423,142
Yuba Co. WA	961,300
City of Sacramento	418,060
Placer Co. WA	343,995
Nevada ID	266,085
Oroville/Wyandotte	158,000
S. Sutter WA	103,000
Total:	13,046,865

Entity w/ Storage (San Joaquin)	Actual Storage
Reclamation	2,920,500
TID/MID	2,103,000
Merced ID	1,024,000
San Francisco	654,500
SCE	572,500
Oakdale/SSJID	231,600
Calaveras Co. WA	184,300
PG&E	63,700
Total:	7,754,100

Based on these figures, Reclamation represents 40.6 percent of Delta water, 42.8 percent of Sacramento River water, and 37.7 percent of San Joaquin River water, respectively, of the entities with storage greater than 100,000 AF. Therefore, the non-Federal entities represent 59.4 percent of Delta water, 57.2 percent of Sacramento River water, and 62.3 percent of San Joaquin River water, respectively, of those with storage greater than 100,000 AF. The non-Federal actions likely do not jeopardize the continued existence or adversely modify when assessed individually. Collectively, however, they contribute to the existing deleterious effects of the baseline and proposed action.

Cumulative effects also include point and non-point source chemical contaminant discharges. These contaminants include selenium and numerous pesticides and herbicides associated with discharges related to agricultural and urban activities. Implicated as potential sources of mortality in delta smelt, these contaminants may adversely affect smelt reproductive success and survival rates.

Conclusion

The cumulative effects described above operate in combination with the proposed action to contribute to jeopardy to the delta smelt and destruction or modification of its critical habitat.

REASONABLE AND PRUDENT ALTERNATIVE

The section 7 regulations define reasonable and prudent alternatives as alternative actions identified during formal consultation that can be implemented in a manner consistent with the intended purpose of the action, and within the scope of the Federal agency's legal authority and jurisdiction, are economically and technologically feasible, and that the Service believes would avoid the likelihood of jeopardizing the continued existence of listed species or resulting in the destruction or adverse modification of proposed critical habitat.

Based on the analysis of impacts described above in the EFFECTS OF THE PROPOSED ACTION, several operational and project modifications are needed to avoid jeopardy and destruction or adverse modification of proposed critical habitat. Therefore, the Service provides the following reasonable and prudent alternative to assist in operation of the CVP/SWP in 1994.

Development of the Reasonable and Prudent Alternative

Subsequent to the issuance of the May 26, 1993, biological opinion, the Service, Reclamation, DWR, DFG, and EPA formed a Working Group that met on numerous occasions to discuss the preparation of the 1994 biological assessment and biological opinion on the effects on the delta smelt of CVP/SWP operations. Subsequent to receipt of the biological assessment on October 5, 1993, the Service distributed working drafts of the reasonable and prudent alternatives to the Working Group for review by the participating agencies. On November 19, 1993, the Service presented the information on the proposed incidental take limits and proposed requirements to agency representatives and CVP/SWP water contractors. In addition, numerous other briefings were held with agency representatives and CVP/SWP water contractors.

Prior to and concurrent with this process, the EPA through their Estuary Program, formed a Flow Group that analyzed flows and location of the 2 ppt isohaline within the Sacramento-San Joaquin Estuary for benefits to fish. Flow Group participants included the Service, EPA, DFG, and other interested agencies and individuals. To reverse the decline of estuarine fish, the Flow Group recommended that the 2 ppt isohaline be placed as far west as Roe Island for some minimum period each year. EPA (1993) determined an historic average number of days that the 2 ppt isohaline was located at three locations (1) Collinsville at the confluence of the Sacramento-San Joaquin Rivers, (2) Chipps Island in Suisun Bay, and (3) Roe Island in Suisun Bay. Location of the 2 ppt isohaline can be converted to amount of Delta outflow (cfs) using Kimmerer's work (1992; as cited in DWR and Reclamation 1993).

CVP/SWP shall implement and comply with the following operational criteria during Water Year 1994 starting on February 15, 1994, and ending February 15, 1995, in a manner that does not conflict with the flow and temperature requirements of NMFS' 1993 winter-run chinook salmon biological opinion and is based on a 90 percent exceedance forecast:

(1) Transport and Habitat Flows

Reclamation/DWR shall ensure that the following conditions concerning transport and habitat flows are implemented:

a. Reclamation/DWR shall ensure that the 2 ppt isohaline is placed downstream of Collinsville for at least one day between February 1 and June 30 in all but critical dry years. In critical dry years, the 2 ppt isohaline shall be placed downstream of Collinsville for at least one day between April 1 and April 15. Table 3 lists the required number of days that Reclamation/DWR shall provide a minimum of 6,800 cfs and/or 12,000 cfs outflow for the period beginning February 1 through June 30. The number of days required at each flow need not be consecutive within the period specified. In all water-year types, except for critical dry years, counting of days shall commence with placement of the 2 ppt isohaline at Collinsville. In critical dry years, counting of the required 18 days at 12,000 cfs may precede placement of the 2 ppt isohaline at Collinsville. In critical dry years, the requirement for outflows of 6,800 cfs shall be provided for a minimum period of 40 days starting between April 1 and April 15, and extending through June 30, once the 2 ppt isohaline has reached Collinsville. In all water-year types, the minimum number of days of 6,800 cfs and 12,000 cfs flows may be concurrent.

b. The computation of the salinity at Collinsville shall be based on a mean daily average electroconductivity at the Collinsville gage. The 2 ppt isohaline is defined to be met with a mean daily surface electroconductivity of 3.0 milli-siemens/cm.

c. Delta outflows shall be computed from the daily Delta Outflow Index as reported each day by the operations offices of the CVP/SWP. A minimum net Delta outflow of 3,500 cfs shall be maintained from February 1 to June 30.

d. Water-year classifications shall be based on the forecasted (90 percent probability of exceedance) Sacramento River Index (SRI) as defined in SWRCB D-1485. D-1485 defines a split classification for water-year type based on agricultural, municipal and industrial uses, and fish and wildlife uses, in years following a critical year. Since 1993 was not a critical dry year, this split classification will not affect the designation of water-year type in this biological opinion. DWR's Bulletin-120 published forecasts will be used to initially classify the water year in February, and update the classification in March, April, and May. The May Bulletin-120 forecast will finalize the classification of the water year. Until publication of DWR's February Bulletin-120 forecast (about February 10), a preliminary forecast of the SRI will be used. If deemed acceptable by the Working Group (defined in the Reporting Requirements section), a sliding scale (to allow a smooth transition between water-year types) will be developed and incorporated into the long-term biological opinion. In the event that the water-year classification changes to a wetter year, which requires more days of compliance than remain in the period, then the flow need only be maintained to June 30.

e. In the period beginning February 1 through June 30, a minimum average San Joaquin River flow component as calculated at Vernalis and shown in Table 3b below shall be provided in every water-year type for the number of days indicated in Table 3a.

f. The Service recognizes that strict adherence to the required transport and habitat flows may not be reasonable and prudent under certain adverse hydrologic conditions, such as those experienced in the 1976 and 1977 critical dry years. If under adverse operational or hydrologic conditions, it is determined by Reclamation and DWR that meeting these criteria would result in a conflict with protection of other threatened and endangered species, a conflict with the project's capability to meet requirements, or otherwise require actions that would not be reasonable or prudent, then Reclamation and DWR may immediately reinitiate consultation to determine appropriate modifications.

g. If monitoring indicates that the flows specified below are not sufficient to transport delta smelt away from the southern and central delta and into adequate rearing habitat, then the Working Group will convene and recommend to project operators any actions that may be appropriate to protect delta smelt. Based on these recommendations, Reclamation and DWR will reinitiate section 7 consultation, if it is deemed necessary.

Table 3a. Minimum number of days that net Delta outflows of 6,800 cfs and 12,000 cfs must be provided in wet, above normal, below normal, dry, and critical water- years (based on Delta outflow from DWR's DAYFLOW for 1955-1991).

OUTFLOW/ WATER-YEAR TYPE	WET	ABOVE NORMAL	BELOW NORMAL	DRY	CRITICAL DRY
6,800 cfs	150 days	150 days	114 days	109 days	40 days
12,000 cfs	150 days	150 days	85 days	64 days	18 days

Table 3b. Minimum average San Joaquin River flow (calculated at Vernalis) component of 6,800 cfs and 12,000 cfs required flows listed in Table 3a, above.

WATER-YEAR TYPE	Wet	Above Normal	Below Normal	Dry	Critical Dry
SAN JOAQUIN RIVER COMPONENT	2000 cfs	2000 cfs	1500 cfs	1200 cfs	800 cfs

Biological Justification: As proposed, the 1994 operation of the CVP/SWP does not include adequate flows of sufficient duration from February to June to transport juvenile delta smelt from areas of entrainment in the central and southern Delta to suitable rearing habitat in Suisun Bay. The confluence of the Sacramento-San Joaquin Rivers, marked by Collinsville, defines the western limits of the "zone of influence" of the pumps (Service 1993b; DWR and Reclamation 1993). Delta outflows of 6,800 cfs are sufficient to transport delta smelt larvae and juveniles to Collinsville. Delta outflows of about 12,000 cfs, are necessary to transport larvae to the shallow, productive rearing habitat in the Suisun Bay region. Smaller or reverse Delta outflows maintain larvae and juveniles upstream in the deep-water channel regions of the Sacramento and San Joaquin rivers where delta smelt are entrained and where safe, productive rearing habitat is unavailable. This effect is demonstrated by the finding of Bruce Herbold (EPA, pers. comm.) who has recently found a positive correlation between the number of days when the 2 ppt isohaline is between Chipps Island and Grizzly Bay in Suisun Bay and abundance of delta smelt, measured by the fall midwater trawl index (Figure 11). Therefore, placement of the 2 ppt isohaline between Collinsville (by providing Delta outflows of 6,800 cfs) and Chipps Island (by providing outflows of 12,000 cfs) would be the minimum outflows that could be required to keep young delta smelt from being entrained in in-Delta diversions and export pumps and allow some periods of dispersal (through tidal flux and transport flows) into the safe, productive rearing habitat of Suisun Bay. According to the Flow Group's calculation, the above combined Sacramento and San Joaquin River flows are sufficient to move delta smelt larvae and juveniles to Suisun Bay. Without these minimal transport and habitat flows, recruitment into adult life stages will be adversely affected by the proposed 1994 CVP/SWP operations. Figure 13 shows that in critical dry years, juvenile delta smelt are located in the "zone of influence" of the pumps in April and into May. Therefore, transport flows to move these fish to Suisun Bay are essential during this time period.

Without some contribution of discharge from the San Joaquin River, larval and juvenile delta smelt will not be transported from spawning habitat in the river and its tributary sloughs. Table 3b lists the San Joaquin River components required. These flows are low, compared with Sacramento River flows, reflecting the scarcity of water available from the San Joaquin River drainage.

(2) San Joaquin River Transport Flows

If monitoring indicates that adult delta smelt are present (an average of one or more adult delta smelt over all San Joaquin River sample stations 802-912 and captured in any one month's sampling period) in the San Joaquin River or its tributary sloughs from January through March, Reclamation shall provide the following additional 30-day average flows at Vernalis for a 30-day period from April 1 through May 15: 2,400 cfs in critical years; 2,600 cfs in dry years; 3,200 cfs in below normal years; 3,600 cfs in above normal years; and 5,200 cfs in wet years. An amount of water sufficient to provide these flows through May 15 shall be held in storage until monitoring shows that adult delta smelt were not present in the San Joaquin River or its tributary sloughs from

January through March.

Biological Justification: 1994 CVP/SWP operations do not propose minimum flows down the San Joaquin River, other than those required from New Melones Reservoir to meet D-1485 salinity standards in the south Delta. The San Joaquin River and tributary sloughs are delta smelt spawning habitat that require flows from April 1 to May 15 to move larvae and juveniles toward Suisun Bay. Therefore, this requirement provides a pulse flow that is triggered by the presence of adult delta smelt on the San Joaquin side to supplement flows provided above. Because of the relative scarcity of water available from the San Joaquin River drainage, flows provided in the first requirement of the reasonable and prudent alternative may not be adequate in some years to transport larvae and juveniles out of the south and central Delta toward Suisun Bay.

(3) Presence of Delta Smelt Upstream of the Confluence in July-August as a Result of a Late Spawning Period

If the summer townet survey shows that delta smelt are not found distributed in 3 out of 7 Suisun Bay stations 405-515, 3 out of 6 Montezuma Slough/Sacramento River stations 604-709 and 3 out 5 north central delta stations 802-904, then the following measure shall be implemented: The Working Group and Management Group will convene, recommend and decide, respectively, what actions are appropriate to protect delta smelt larvae and juveniles in the San Joaquin River and Reclamation/DWR will reinitiate section 7 consultation, if it is deemed necessary.

Biological Justification: This situation is more likely to occur when smelt spawn late. When outflow has been inadequate to transport larvae and juveniles downstream, delta smelt distribution may be limited to a small area upstream of the Sacramento-San Joaquin River confluence. The proposed project does not include transport flows of sufficient magnitude and duration to maintain low salinity habitat at or downstream of the confluence of the Sacramento-San Joaquin Rivers and to transport larval and juvenile delta smelt away from the influence of the CVP/SWP pumps and toward suitable rearing habitat in the eastern Suisun Bay. Without these provisions, it is possible that an entire year class of young delta smelt could be lost as a result of one catastrophic event (e.g., reverse flows causing extremely high entrainment in the southern and central Delta or a contaminant pulse). In annual species like the delta smelt, such a catastrophic event could result in extinction.

(4) Suisun Marsh Salinity Control Structure

DWR, in coordination with Reclamation, shall develop and implement a program of investigations designed to evaluate the effects of the operation of the SMSCS on delta smelt. The investigations will seek to address the diversion rate of adult delta smelt into Montezuma Slough and predation at the control structure. The proposed evaluation program will be submitted to the Service and the Working Group for review and approval by October 1, 1994. Investigations will be initiated during the spring of 1995. During the interim, DWR will operate the gates only as required to meet existing Suisun

Marsh salinity standards. When not operating, the gates shall remain in the raised position.

Biological Justification: Suisun Marsh is an important area that allows wide geographic distribution of delta smelt. SMSCS operation may interfere with the distribution of delta smelt to spawning and rearing habitat within the Marsh.

INCIDENTAL TAKE

Sections 4(d) and 9 of the Act, as amended, prohibit taking (harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in any such conduct) of listed species of fish or wildlife without a special exemption. Harm is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. Harass is defined as actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. Under the terms of §7(b)(4) and §7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered a prohibited taking provided that such taking is in compliance with the terms and conditions of this incidental take statement. The measures described below are nondiscretionary and must be implemented by the agency so that they become binding conditions of any grant or permit issued to the applicant, as appropriate, for the exemption in §7(o)(2) to apply. The Federal agency has a continuing duty to regulate the activity that is covered by this incidental take statement. If the agency fails to require the applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of §7(o)(2) may lapse.

The Service distributed to the Working Group drafts of various proposed methods to determine incidental take limits at the CVP/SWP salvage facilities. After elimination and refinement of the original eight proposals, term and condition number 2, below, was formulated.

In operating the CVP/SWP, the Service anticipates the take and loss of delta smelt. This take includes that incurred by salvage activities and studies undertaken by Reclamation, DWR, and CCWD through the Interagency Ecological Study Program addressing delta smelt in particular, and other fishery studies in the Delta that also may provide information on delta smelt. Adults, juveniles, and larvae are present in the southern Delta from January through July. Larvae and juvenile delta smelt are flushed to the eastern Suisun Bay by outflows during this interval and removed from the influence of most direct project effects through June 30. On implementation of the reasonable and prudent measures below, the CVP/SWP are authorized to incidentally take all delta smelt entrained as a result of exports allowed by the long-term operations described above. In operating the Tracy and Skinner fish facilities, the Service anticipates the take and loss of delta smelt.

Additionally, take is expected at the Barker Slough intake on the North Bay Aqueduct and the Rock Slough intake with the Contra Costa Canal. To allow implementation of studies in this opinion, all take resulting from ongoing fishery studies done by Reclamation, DWR and the Interagency Ecological Study Group is authorized for Water Year 1994. The Service establishes the following reasonable and prudent measures to minimize the impact of incidental take. The measures below are nondiscretionary, and must be undertaken by Reclamation/DWR.

(1) Improve salvage operations at Tracy and Skinner Fish Protection Facilities during the spawning interval.

(2) Minimize take at the Tracy and Skinner Fish Protection Facilities.

(3) Minimize take at the North Bay Aqueduct intake on Barker Slough during the spawning interval.

(4) Minimize take at the Roaring River Diversion in Montezuma Slough.

(5) Minimize take at Contra Costa Water District diversions.

To be exempt from the prohibitions of section 9 of the Act, the following terms and conditions, which implement the reasonable and prudent measures described above, must be complied with in entirety. All notices, plans and other documents required below shall be prepared and implemented with the approval of the Service.

(1) The CVP shall add a new, fully functional release site (similar to the SWP release site at Horseshoe Bend) near the Rio Vista Bridge. Between December 1 and March 30, "loads" of salvaged fish from the CVP/SWP salvage facilities shall be transported to the new release site whenever the number of adult delta smelt observed in any salvage count preceding a "load" exceeds 0.5 adult delta smelt per count minute. The triggering abundance (0.5 adult delta smelt) may be adjusted by the Working Group if it is apparent that too few or too many loads are being transported to the new release site. Salt shall be added to maintain an 8 ppt salinity in transport water for trucking delta smelt during this interval. At the Tracy and Skinner Fish Protection Facilities, between the issuance of this opinion and July 31, fish shall not be held more than 8 hours before beginning transport to a release site.

(2) CVP/SWP shall use the following table to calculate a take limit at the CVP/SWP fish salvage facilities. If the 14-day running average of estimated combined delta smelt salvage exceeds the values tabulated below, operations shall be modified to restore the 14-day running average. When a 14-day (or other) averaging period begins, or a change in water year classification causes a requirement to change, the 14-day averaging begins accumulating values on day 1, and on the 14th day will comply with the requirement. For example, if Reclamation and DWR were to meet a 14-day average take criterion for a period that begins April 10, then the 14-day average salinity should achieve compliance by April 23. This averaging method is consistent with the requirements of both

SWRCB D-1485 and the NMFS winter-run biological opinion. If reasonable operation of the CVP/SWP cannot correct numbers of fish taken, the Working Group (defined in the Reporting Requirements section, below) shall meet to develop alternative actions.

Table 4. Incidental take calculation at the Federal and State fish facilities.

MONTH	WET, ABOVE NORMAL, BELOW NORMAL	DRY, CRITICAL
DECEMBER JANUARY	100, IF FALL MIDWATER TRAWL INDEX IS BETWEEN 0 AND 250; 200, IF PRECEDING FALL MIDWATER TRAWL INDEX IS BETWEEN 250 AND 500; 300, IF PRECEDING FALL MIDWATER TRAWL INDEX IS BETWEEN 500 AND 1,000; 400, IF PRECEDING FALL MIDWATER TRAWL INDEX IS BETWEEN 1,000 AND 1,500; 500, IF PRECEDING FALL MIDWATER TRAWL INDEX IS GREATER THAN 1,500	100, IF FALL MIDWATER TRAWL INDEX IS BETWEEN 0 AND 250; 200, IF PRECEDING FALL MIDWATER TRAWL INDEX IS BETWEEN 250 AND 500; 300, IF PRECEDING FALL MIDWATER TRAWL INDEX IS BETWEEN 500 AND 1,000; 400, IF PRECEDING FALL MIDWATER TRAWL INDEX IS BETWEEN 1,000 AND 1,500; 500, IF PRECEDING FALL MIDWATER TRAWL INDEX IS GREATER THAN 1,500
FEBRUARY MARCH	FALL MIDWATER TRAWL INDEX (LATEST AVAILABLE) X 0.7	FALL MIDWATER TRAWL INDEX (LATEST AVAILABLE) X 0.7
APRIL MAY JUNE	PREVIOUS YEAR'S FALL MIDWATER TRAWL INDEX X 0.7 (THE NUMBER MAY NOT BE GREATER THAN 755) OR 600 WHICHEVER IS GREATER	PREVIOUS YEAR'S FALL MIDWATER TRAWL INDEX X 0.7 (THE NUMBER MAY NOT BE GREATER THAN 755) OR 400 WHICHEVER IS GREATER
JULY	PREVIOUS YEAR'S FALL MIDWATER TRAWL INDEX OR 600 (USE GREATER VALUE UNLESS THIS YEAR'S SUMMER TOWNET SURVEY IS LESS THAN MEAN OF WET, ABOVE NORMAL, AND BELOW NORMAL YEARS FROM 1959-1993, THEN USE LESSER VALUE	PREVIOUS YEAR'S FALL MIDWATER TRAWL INDEX OR 300 (USE LESSER VALUE UNLESS THIS YEAR'S SUMMER TOWNET SURVEY IS GREATER THAN MEAN DRY AND CRITICAL DRY YEARS, THEN USE GREATER VALUE)
AUGUST	PREVIOUS YEAR'S FALL MIDWATER TRAWL INDEX OR 300 (USE GREATER VALUE UNLESS THIS YEAR'S SUMMER TOWNET SURVEY IS LESS THAN MEAN FOR WET, ABOVE NORMAL, AND BELOW NORMAL YEARS FROM 1959-1993, THEN USE LESSER VALUE)	PREVIOUS YEAR'S FALL MIDWATER TRAWL INDEX OR 200 (USE LESSER VALUE UNLESS THIS YEAR'S SUMMER TOWNET SURVEY IS GREATER THAN MEAN FOR DRY AND CRITICAL DRY YEARS FROM 1959 TO 1993, THEN USE GREATER VALUE)
SEPTEMBER OCTOBER NOVEMBER	THE LESSER VALUE OF: 1. PREVIOUS YEAR'S FALL MIDWATER TRAWL INDEX, OR 2. THE LATEST VALUE FOR THIS YEAR'S FALL MIDWATER TRAWL INDEX, BUT 3. THE VALUE CANNOT BE LESS THAN 100	THE GREATER VALUE OF: 1. 100, OR 2. THE LATEST VALUE FOR THIS YEAR'S FALL MIDWATER TRAWL INDEX

"Latest available", as used in the above table, means the current years or months index value, to be updated with the next years or months value. An example would be the fall midwater trawl index, sampled in September, October, November, and December where the "latest available" value on December 1 would be the additive value of September, October, and November.

(3) When monitoring at Barker Slough (stations 720 and 721) indicates the presence (as defined in reasonable and prudent alternative 2) of delta smelt under 20 mm, diversions from Barker Slough shall be reduced to a 3-day running average rate of 65 cfs for a minimum of two weeks, at which time presence of delta smelt will be reassessed. The averaging period for the 65 cfs shall begin 48-hours after the presence of delta smelt is detected. The Service shall be notified within 48-hours when diversions are reduced due to presence of delta smelt juveniles and larvae and when diversions are subsequently increased due to absence of delta smelt juveniles and larvae.

(4) Reclamation shall change approach velocities at the Roaring River Diversion to 0.2 feet per second by December 31, unless and until new information on a more appropriate approach velocity becomes available, as a result studies conducted in the Reporting Requirements described below. Any changes to these approach velocities shall be approved by the Service, before they are implemented.

(5) To minimize take of delta smelt in the unscreened Rock Slough intake, monitoring information described in Reporting Requirements below shall be used by CVP to determine reduction in diversion of water at the Rock Slough and Mallard Slough intakes. The intent is to minimize take of delta smelt adults, juveniles, or larvae during the spawning and rearing interval of January 1 through August 31 that are exposed to pumping/diversion related losses. Notification of proposed reduction of diversion to reduce take of delta smelt shall be submitted to the Service for approval and submitted in the twice monthly report mentioned above.

Reporting Requirements

Reclamation/DWR shall require all contractors, constituent farmers and salvage operation personnel at the State and Federal fish screens to report immediately any information about take or suspected take of delta smelt. Reclamation/DWR shall immediately notify the Service within 1 working day of any such information. Notification must include the date, time, and precise location of the incident/specimen, and any other pertinent information. The Service contact persons are Robert Pine and Matt Vandenberg at 916-978-4613 and 916-978-4866, respectively. Any killed specimens that have been taken shall be properly preserved in accordance with Natural History Museum of Los Angeles County policy of accessioning (10 percent formalin in quart jar or freezing). Information concerning how the fish was taken, length of the interval between death and preservation, the water temperature and outflow/tide conditions, and any other relevant information shall be written on 100 percent rag content paper and included in the container with the specimen. This preserved specimen shall be delivered to the Service's Division of Law Enforcement at 2800 Cottage Way, Sacramento, California 95825-1846 (916-978-4861).

All studies and monitoring that were initiated by the May 26, 1993, opinion, shall be continued and results reported to the Service unless specifically modified by this opinion.

Salvage information from the State and Federal fish protection facilities shall be faxed (916-978-4619) to the Service on Monday of each week.

Surveys for adult delta smelt in the San Joaquin River and tributary sloughs shall be conducted in December through March. Results shall be reported to the Service within 90 days of completion of each survey.

The Service shall be notified within 48-hours when diversions are reduced at Barker Slough due to presence of delta smelt juveniles and larvae and when diversions are subsequently increased due to absence of delta smelt juveniles and larvae. Flow reports from the Barker Slough intake in North Bay Aqueduct shall be submitted weekly to the Service by fax: 916-978-4619. A report relating flow to abundance of delta smelt and Sacramento splittail in Barker Slough, and estimated number of these species entrained by the intake shall be submitted to the Service each month.

By August 1, 1994, DWR shall submit a report to the Service addressing means of reducing entrainment losses of juvenile and adult delta smelt at the Roaring River Diversion. The report shall include an evaluation of the current screening requirements of 0.33 fps and 0.2 fps on delta smelt. This report shall be completed by December 1, 1994, and a schedule for the implementation of the findings for screening shall be submitted to the Service by January 1, 1995.

A study plan shall be submitted to the Service for approval within 30 days of the issuance of this opinion to determine the presence of delta smelt adults, juveniles, and larvae at the Rock Slough. Funding for the ongoing Interagency Ecological Studies Program shall be provided to develop techniques for monitoring and instantaneous abundance index calculation for these two intake sites. During the interval January 1 through August 31, monitoring to calculate an index of abundance for delta smelt adults, juveniles, and larvae shall be conducted at the Rock Slough intake of the Contra Costa Canal and the Mallard Slough intake. Sampling shall be done in close proximity to the intake and in the channel nearby. This monitoring also shall include water quality monitoring at the Rock Slough intake, including monthly measured total dissolved solids, and daily measured electrical conductivity, temperature, and flow. A summary of the calculated indices form the real time monitoring for adults, juveniles, and larvae present near the Rock Slough and Mallard Slough intakes, and water quality data from the Rock Slough intake, shall be transmitted at the beginning and middle of each month to the Sacramento Field Office of the Fish and Wildlife Service at 916-978-4619. This study shall begin within four months after approval of the plan by the Service. A summary of the results of this study shall be transmitted to the Service at the end of each calendar year. The study plan shall include a methodology for determining estimates of entrainment losses. Fish sampling techniques and handling procedures shall be done so that fish mortality is minimized.

Monitor location of 2 ppt in relationship to Roe Island, Chipps Island, and Collinsville and relate to Delta 14-day running mean outflow, and DFG surveys that determine delta smelt abundance. Fax (916-978-4619) maps to the Service showing X2 location, Delta 14-day running mean outflow, 14-day running average salvage at CVP/SWP pumps, and latest DFG survey information immediately when

survey information is available in the following months: June, July, September, October, November, and December or once a month in other months.

A study plan shall be submitted to the Service and implemented upon approval of the Service concerning the relationship of salvage at the CVP/SWP pumps and with the onset of storm events. This study shall be completed and the results summarized and provided to the Service by November 30, 1994.

A study plan shall be submitted to the Service and implemented upon approval of the Service concerning losses due to operation of Clifton Court Forebay and possible methods for decreasing these losses including non-operation of the radial gates. This study shall be completed and the results summarized and provided to the Service by November 30, 1994.

The list of studies and the requested information shall be submitted to the Service by February 16, 1994. A Working Group (see next requirement) will review the list and recommend which studies should be conducted and the timing of implementation.

Establishment of a Working Group and Management Group

The Service, NMFS, Reclamation, EPA, DWR, SWRCB, and DFG shall identify participants from each agency that will form two separate committees, a Management Group and a Working Group. The purpose of the Management Group shall be to oversee implementation of the actions described in this biological opinion, assist in coordinating agency actions and resolving management conflicts, and to protect the delta smelt and other federally and State listed endangered and threatened species. The purpose of the Working Group is to resolve biological and technical issues raised by this biological opinion and develop recommendations for consideration of the Management Group. The Service shall convene the Working Group on a regular basis and will consider requests from agency participants at other times. The Management Group shall meet as necessary as recommended by the Service, Reclamation, and DWR.

CONSERVATION RECOMMENDATIONS

Sections 2(c) and 7(a)(1) of the Act direct Federal agencies to use their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species and the ecosystems upon which they depend. Conservation recommendations are Service suggestions regarding discretionary agency activities to promote the recovery of listed species. Therefore, the Service recommends the following additional actions to promote the recovery of federally listed species and their habitats:

(1) Reclamation/DWR, in cooperation with the Interagency Ecological Study Program and other interested parties, develop a program for threatened and endangered species that allows acquisition and management of areas used as spawning habitat, such as backwater sloughs and shallow channel edges, to prevent destruction and adverse effects caused by in-Delta project activities.

(2) Reclamation/DWR, in cooperation with the Interagency Ecological Study Program and other interested parties, develop baseline information (i.e., proposed operations plus February 12, 1993, winter-run chinook salmon biological opinion): on project effects on currently unlisted species including longfin smelt, Sacramento splittail, and green sturgeon to prepare for compliance with the Act as new species become listed.

(3) Reclamation/DWR, in cooperation with the Interagency Ecological Study Program and other interested parties, develop an ecosystem-centered analysis of the Bay-Delta to promote understanding of the interrelated effects of operating the Federal and State water projects.

Because this biological opinion has found jeopardy, Reclamation is required to notify the Service of its final decision on the implementation of the reasonable and prudent alternative.

CONCLUSION

This concludes formal consultation on proposed operations of the CVP and the SWP described in the before-mentioned documents and meetings. Reinitiation of formal consultation is required if (1) the amount or extent of incidental take is exceeded, as previously described, (2) the provisions and requirements under the INCIDENTAL TAKE section are not implemented, (3) new information reveals effects of the operations that may affect listed species or critical habitat in a manner that was not considered in this opinion, (4) commitments and time lines described in the PROJECT DESCRIPTION to offset and avoid project related impacts are not met or adhered to, and/or (5) a new species is listed or critical habitat is designated that may be affected by the action.

If you have any questions regarding this opinion, please contact Vicki Finn, Chief, Division of Recovery at 503-231-6241 or Dale Pierce, Acting Field Supervisor, Sacramento Field Office at 916-978-4613.

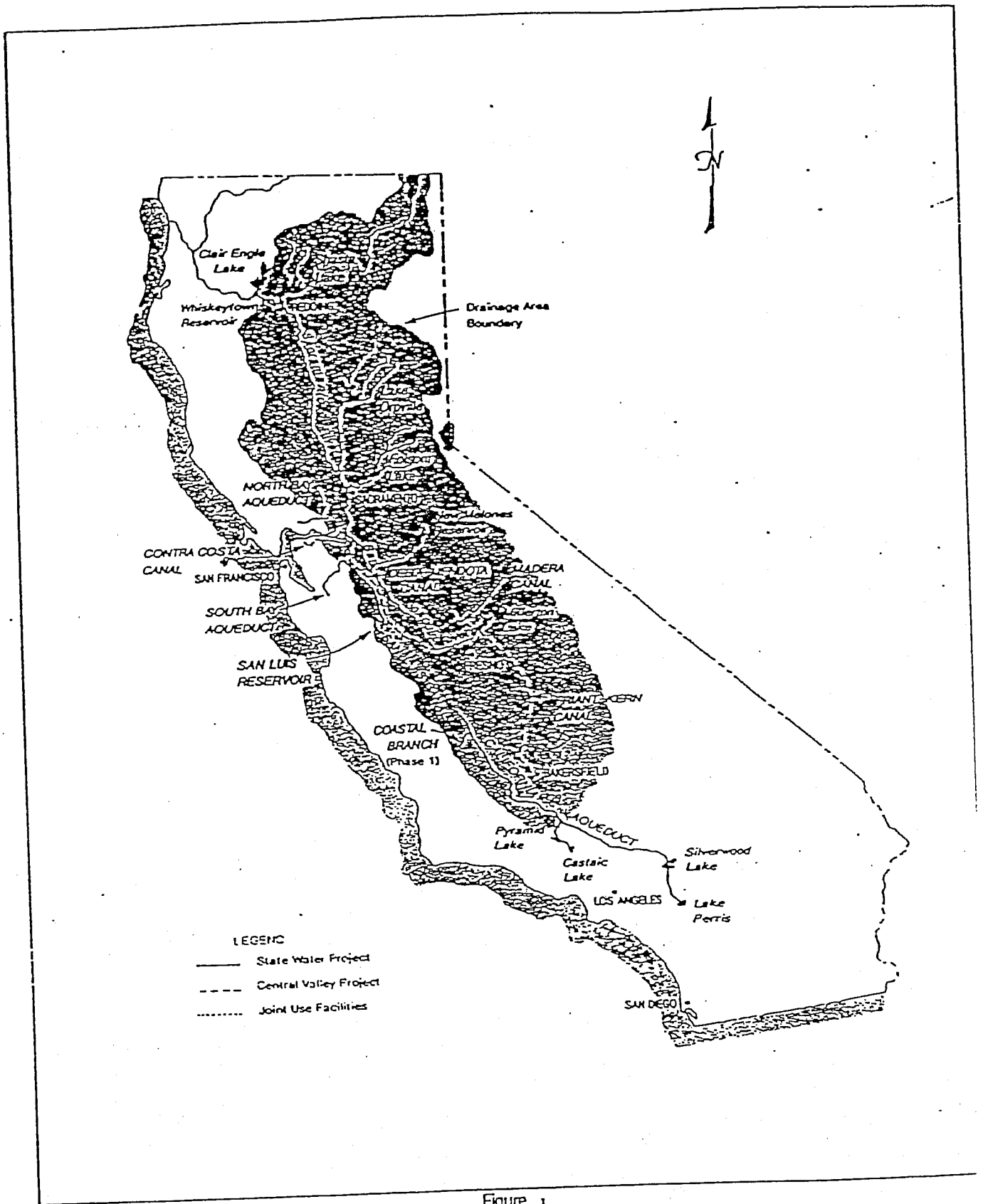


Figure 1.
MAJOR FEATURES OF THE CENTRAL VALLEY PROJECT AND STATE WATER PROJECT

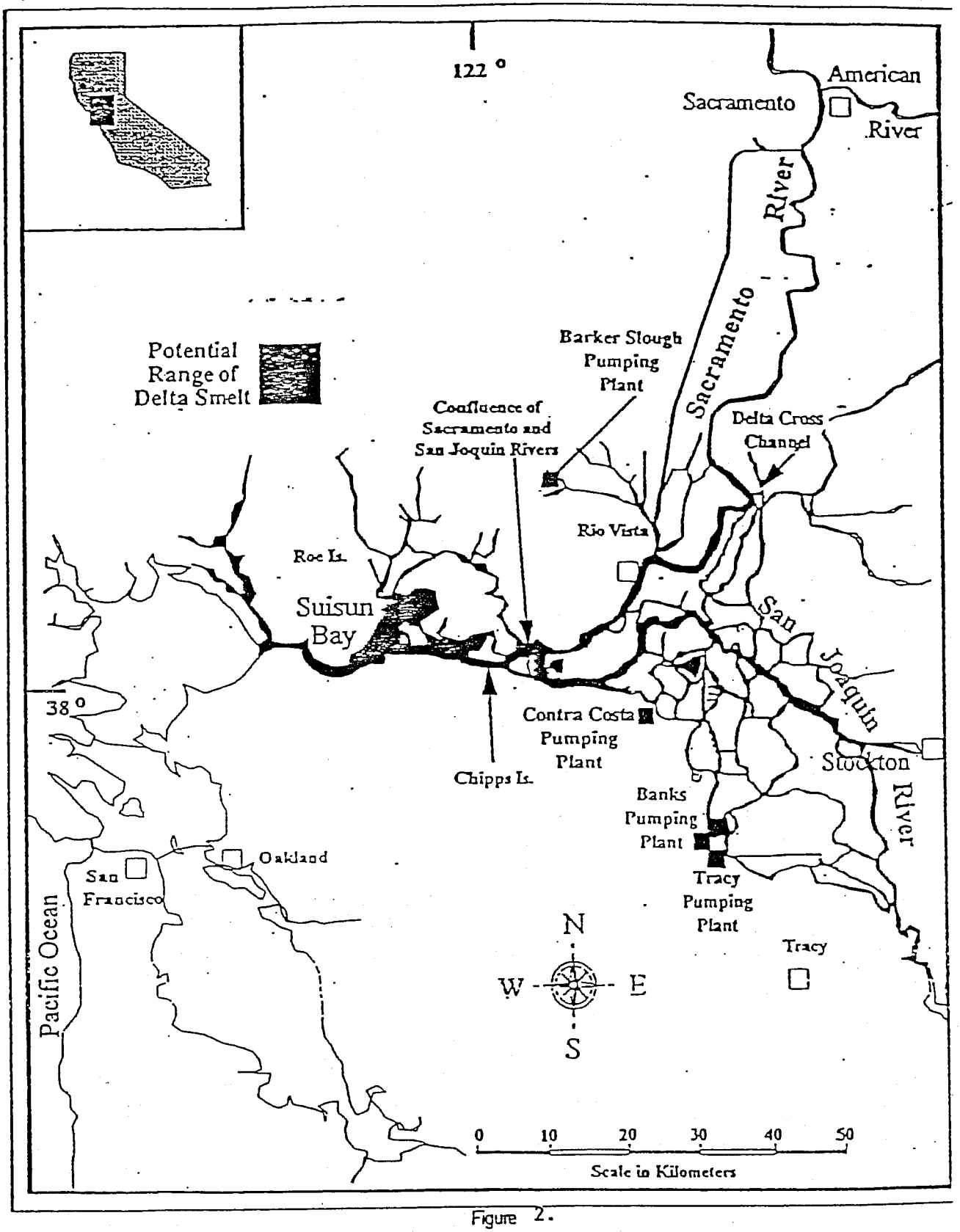


Figure 2.

SACRAMENTO-SAN JOAQUIN ESTUARY

Adapted from Sweetnam and Stevens 1993.

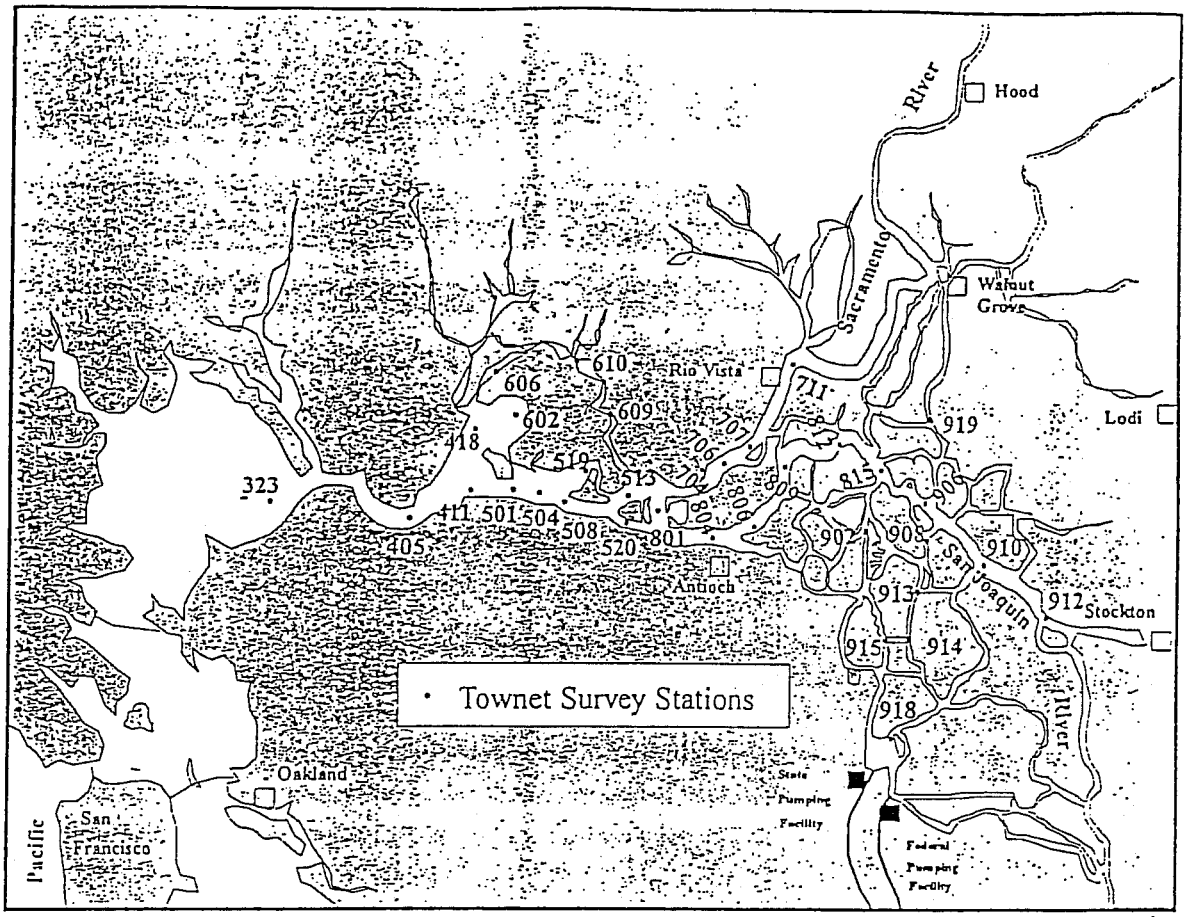
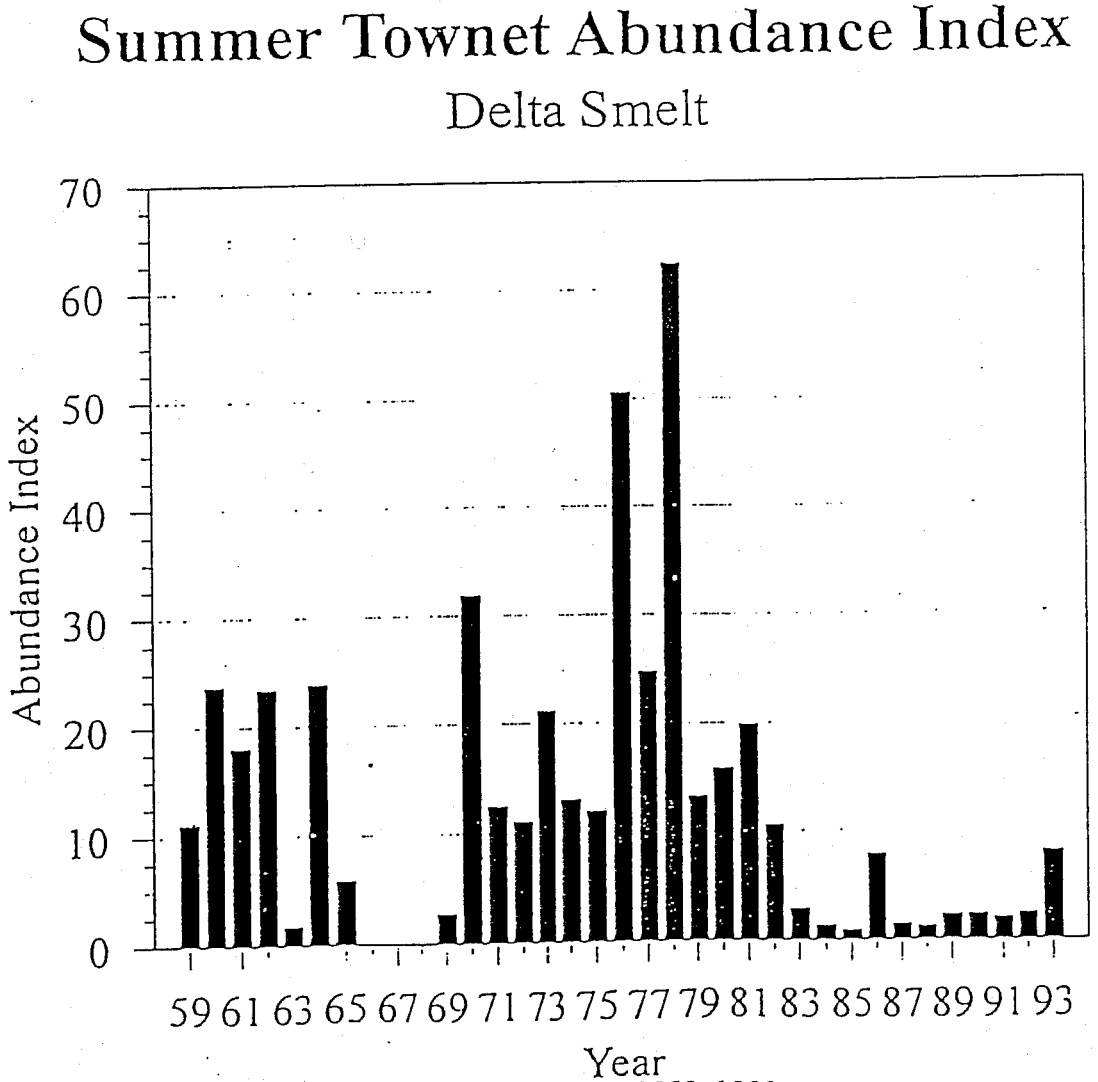


Figure 3. Summer tow-net survey sampling sites in the Sacramento-San Joaquin Estuary.



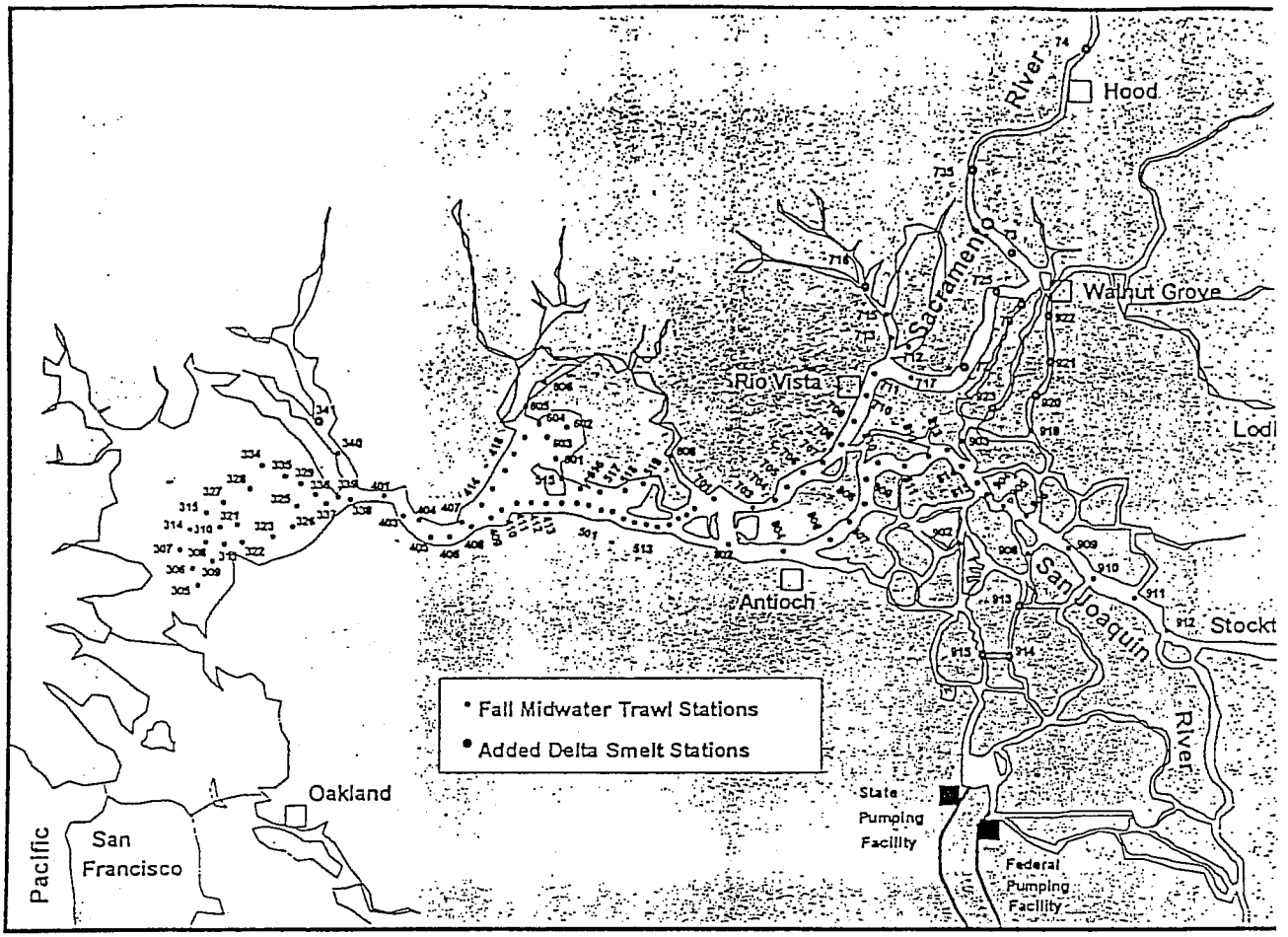
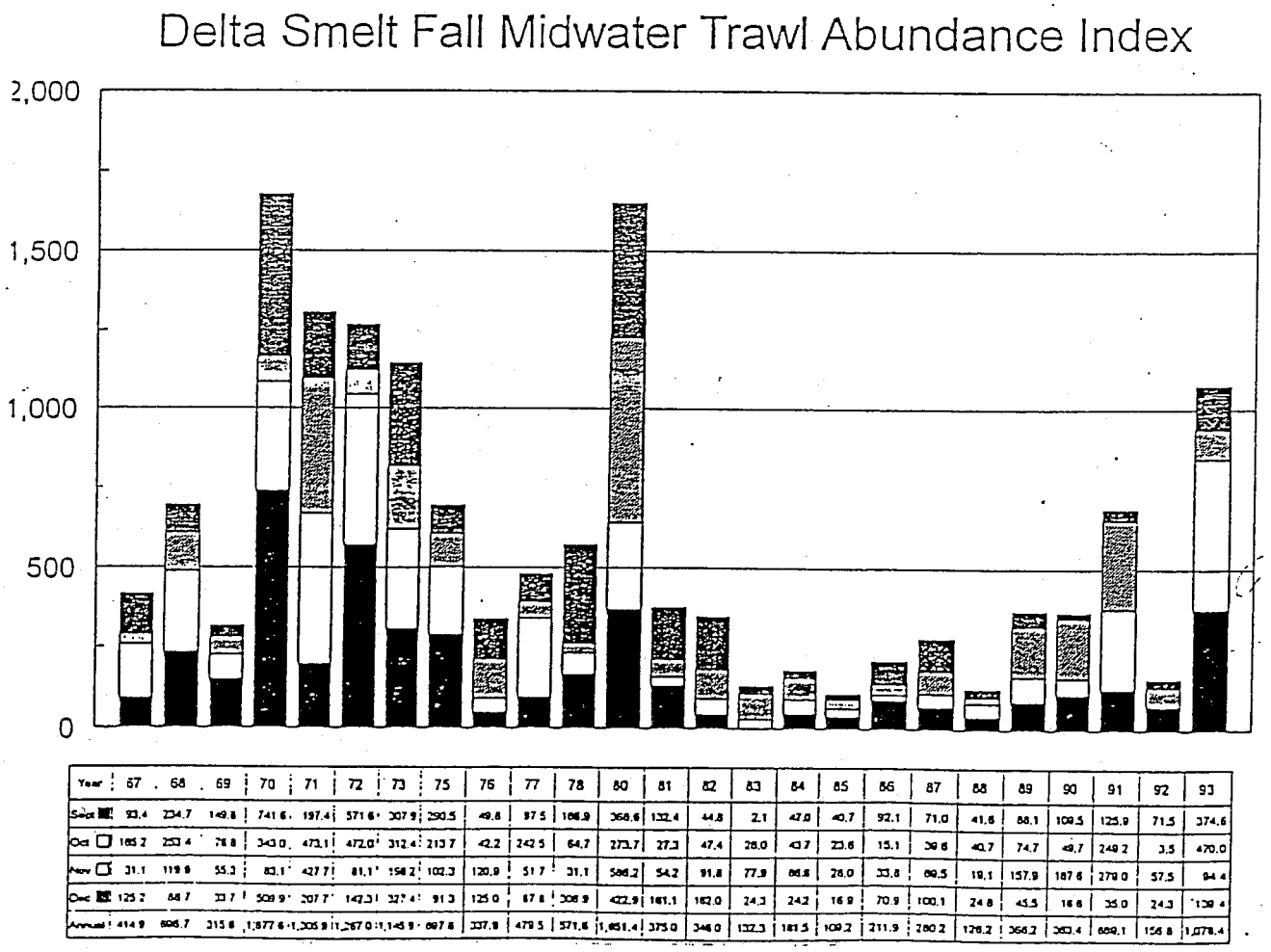


Figure 5. Fall midwater trawl sampling sites in the Sacramento-San Joaquin Estuary.



Year	67	68	69	70	71	72	73	75	76	77	78	80	81	82	83	84	85	86	87	88	89	90	91	92	93
Sept	93.4	234.7	149.8	741.6	197.4	571.6	307.9	290.5	49.8	97.5	186.9	368.6	132.4	44.8	2.1	47.0	40.7	92.1	71.0	41.6	88.1	109.5	125.9	71.5	374.6
Oct	165.2	253.4	76.8	343.0	473.1	472.0	312.4	213.7	42.2	242.5	64.7	273.7	27.3	47.4	28.0	43.7	23.6	15.1	39.6	40.7	74.7	49.7	249.2	3.5	470.0
Nov	31.1	119.8	55.3	83.1	427.7	81.1	158.2	102.3	120.9	51.7	31.1	586.2	54.2	91.8	77.9	86.8	26.0	33.8	89.5	19.1	157.9	187.6	279.0	57.5	94.4
Dec	125.2	84.7	33.7	509.9	207.7	142.3	327.4	91.3	125.0	87.6	308.9	422.9	161.1	182.0	24.3	24.2	16.9	70.9	100.1	24.8	45.5	16.6	35.0	24.3	139.4
Annual	414.9	696.7	315.6	1,877.6	1,305.9	1,267.0	1,145.9	697.8	337.9	479.5	571.6	1,651.4	375.0	346.0	132.3	181.5	109.2	211.9	280.2	126.2	366.2	363.4	689.1	156.8	1,078.4

Figure 6. Fall midwater trawl index showing decline from 1981 to 1992. Note increas in 1991 and 1993.

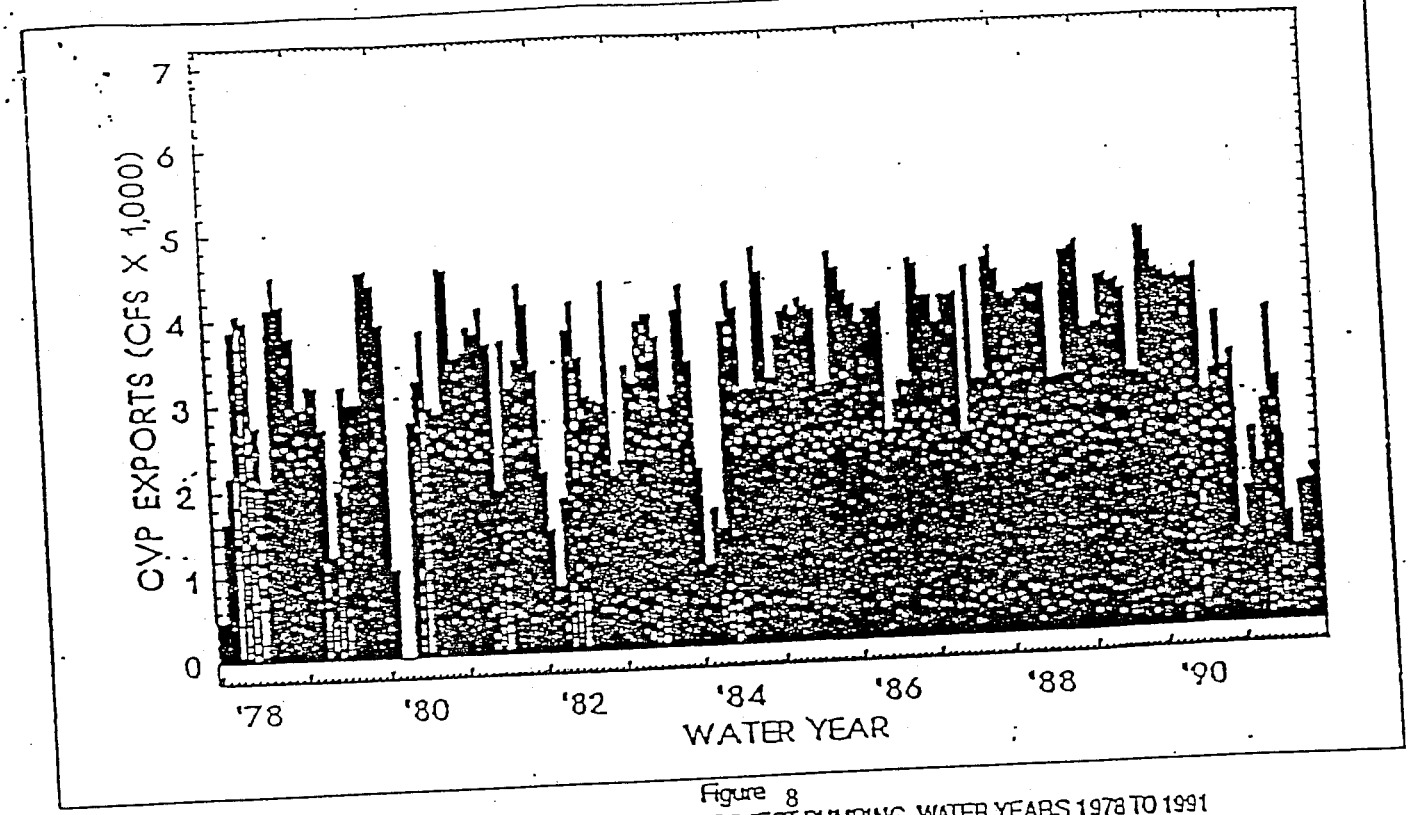


Figure 8
AVERAGE MONTHLY CENTRAL VALLEY PROJECT PUMPING, WATER YEARS 1978 TO 1991
From the DAYFLOW Database

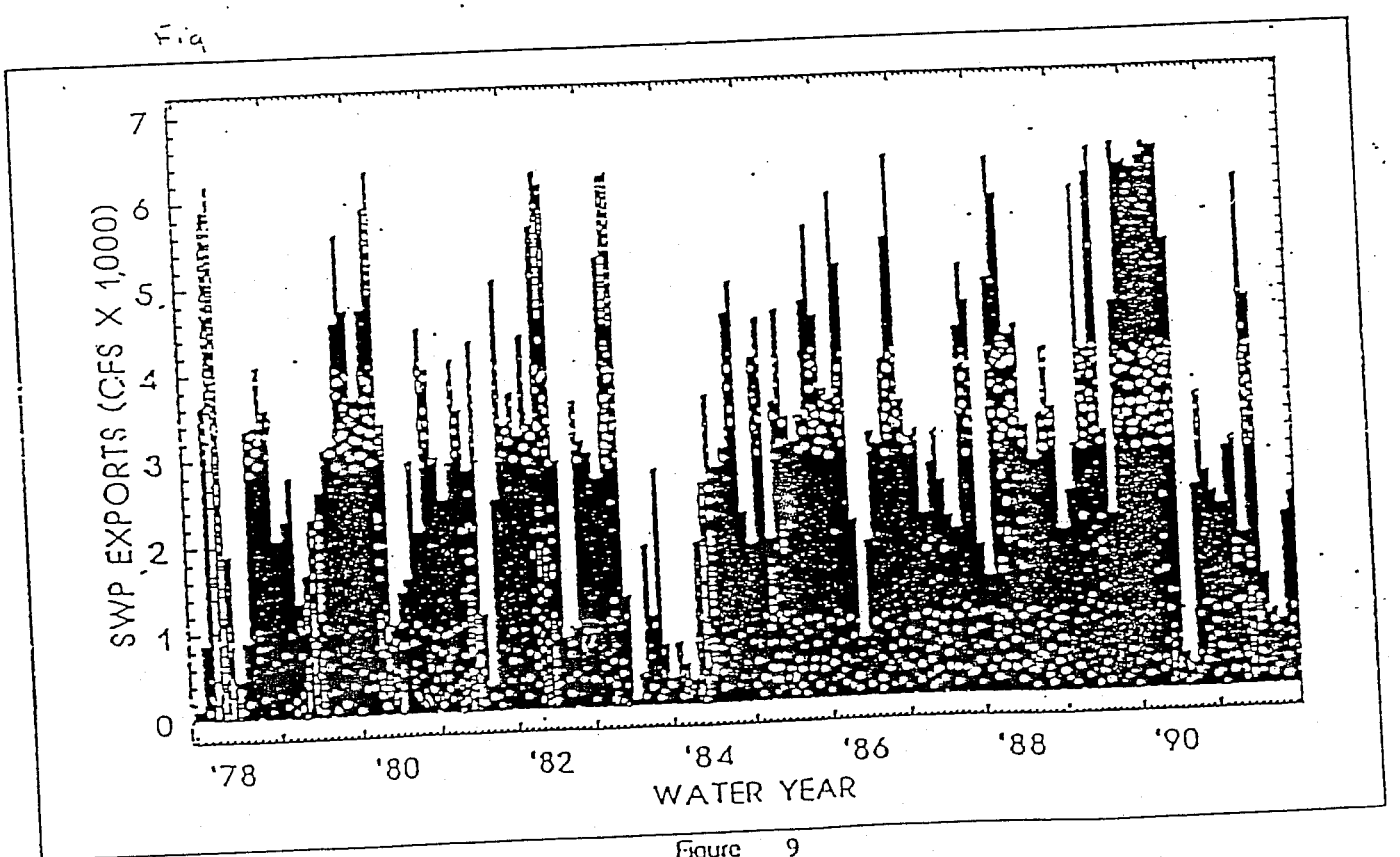
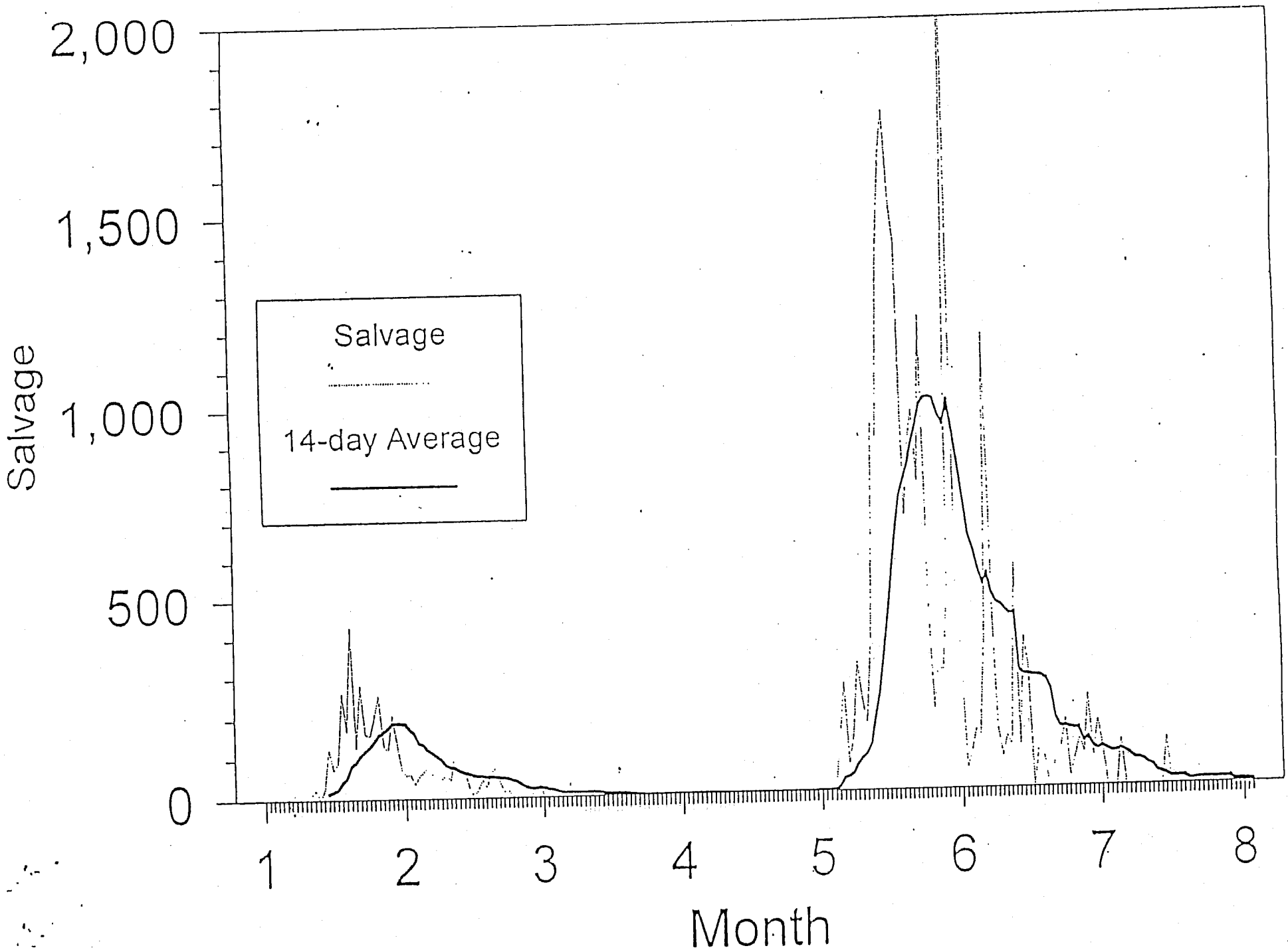


Figure 9
AVERAGE MONTHLY STATE WATER PROJECT PUMPING, WATER YEARS 1978 TO 1991
From the DAYFLOW Database

14-Day Running Average of Total



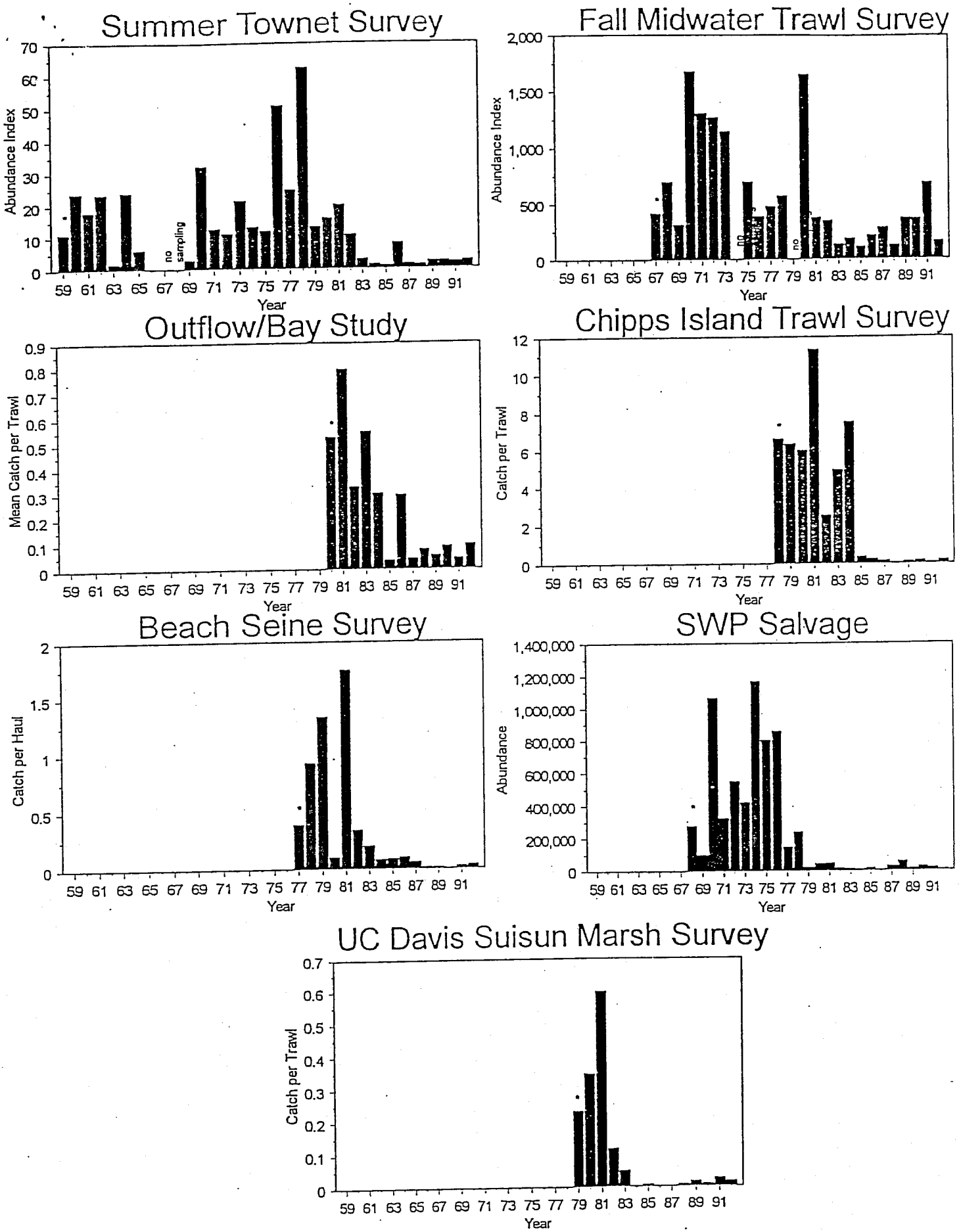


Figure 7. Seven independent surveys showing delta smelt decline.

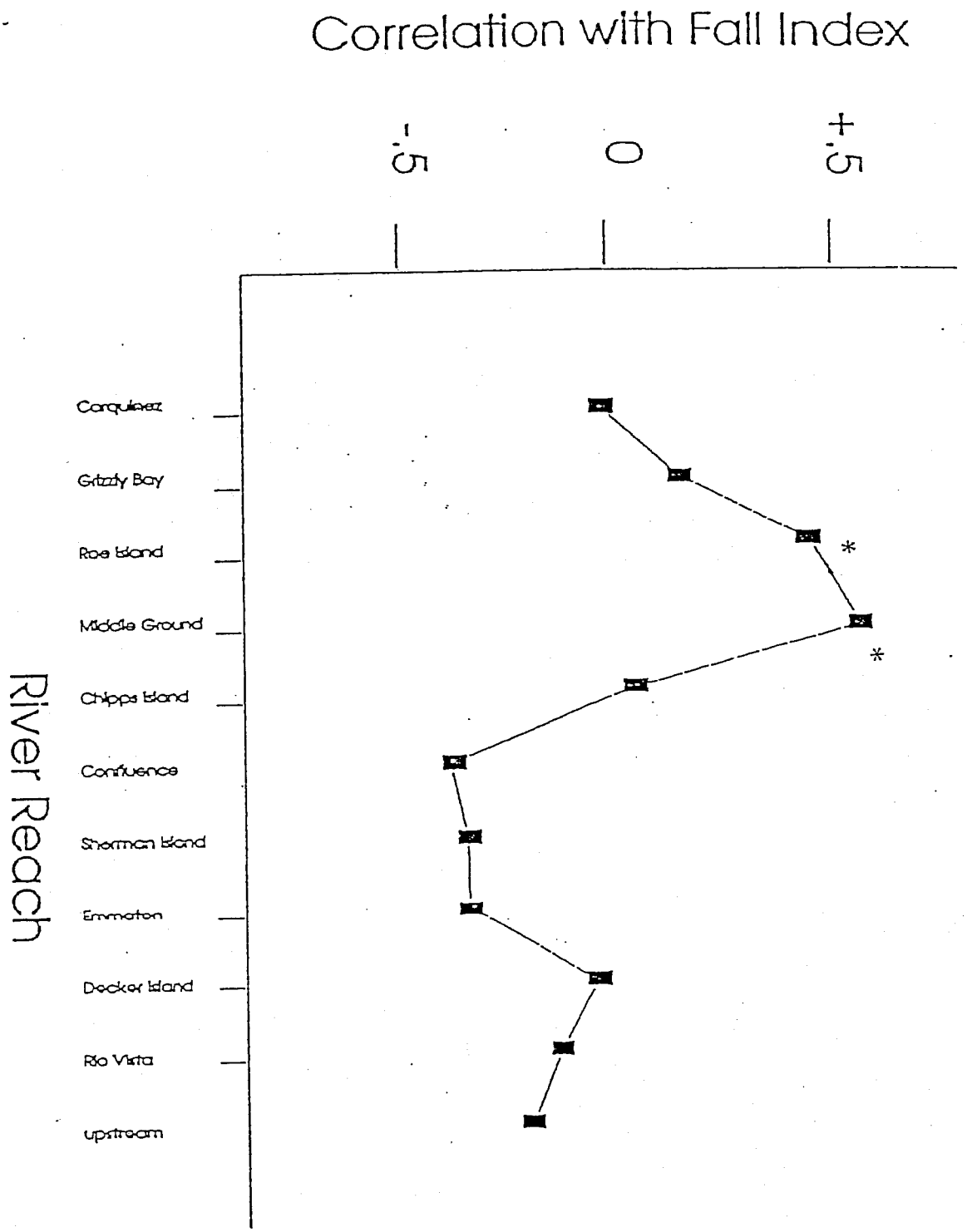
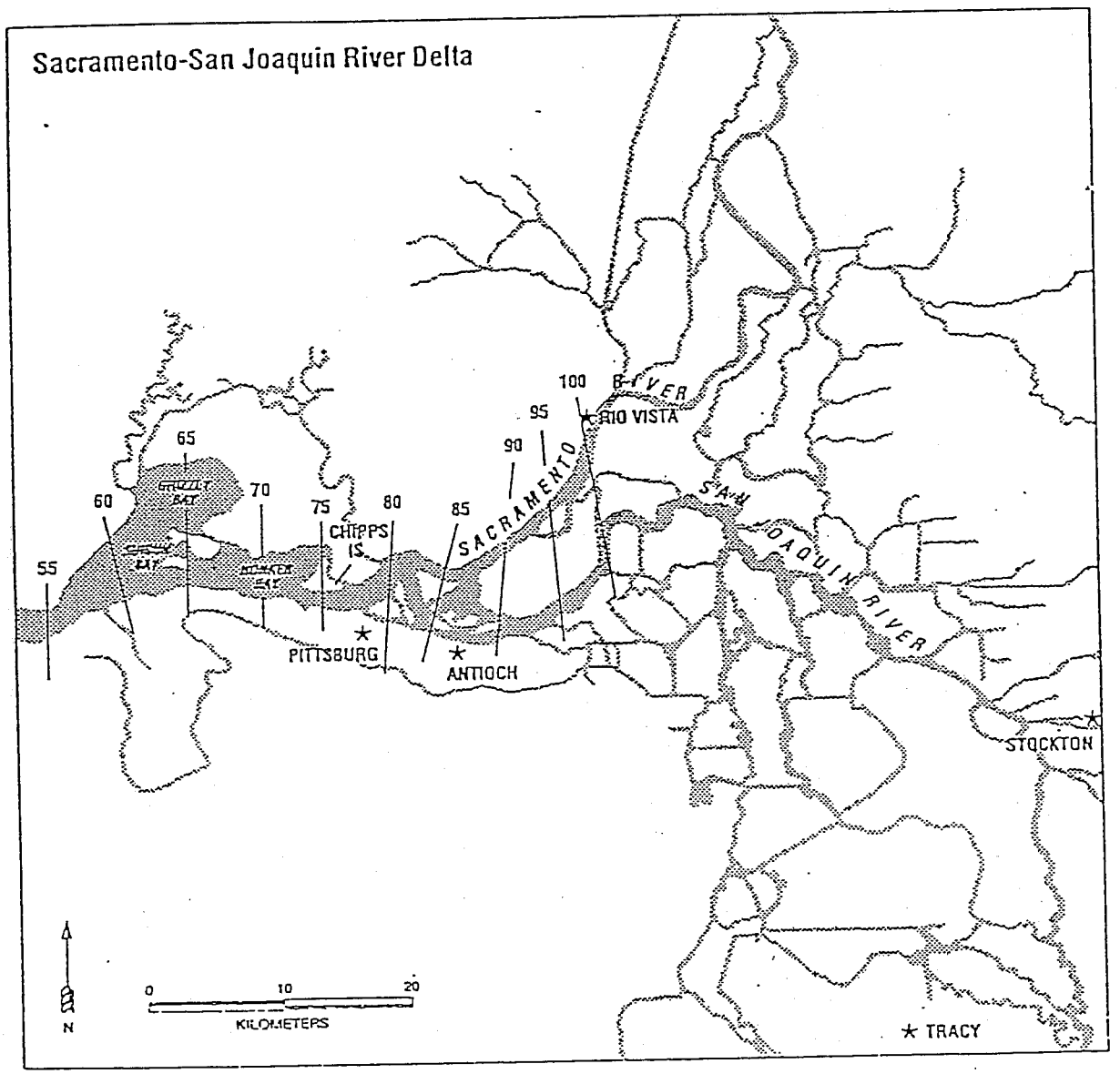
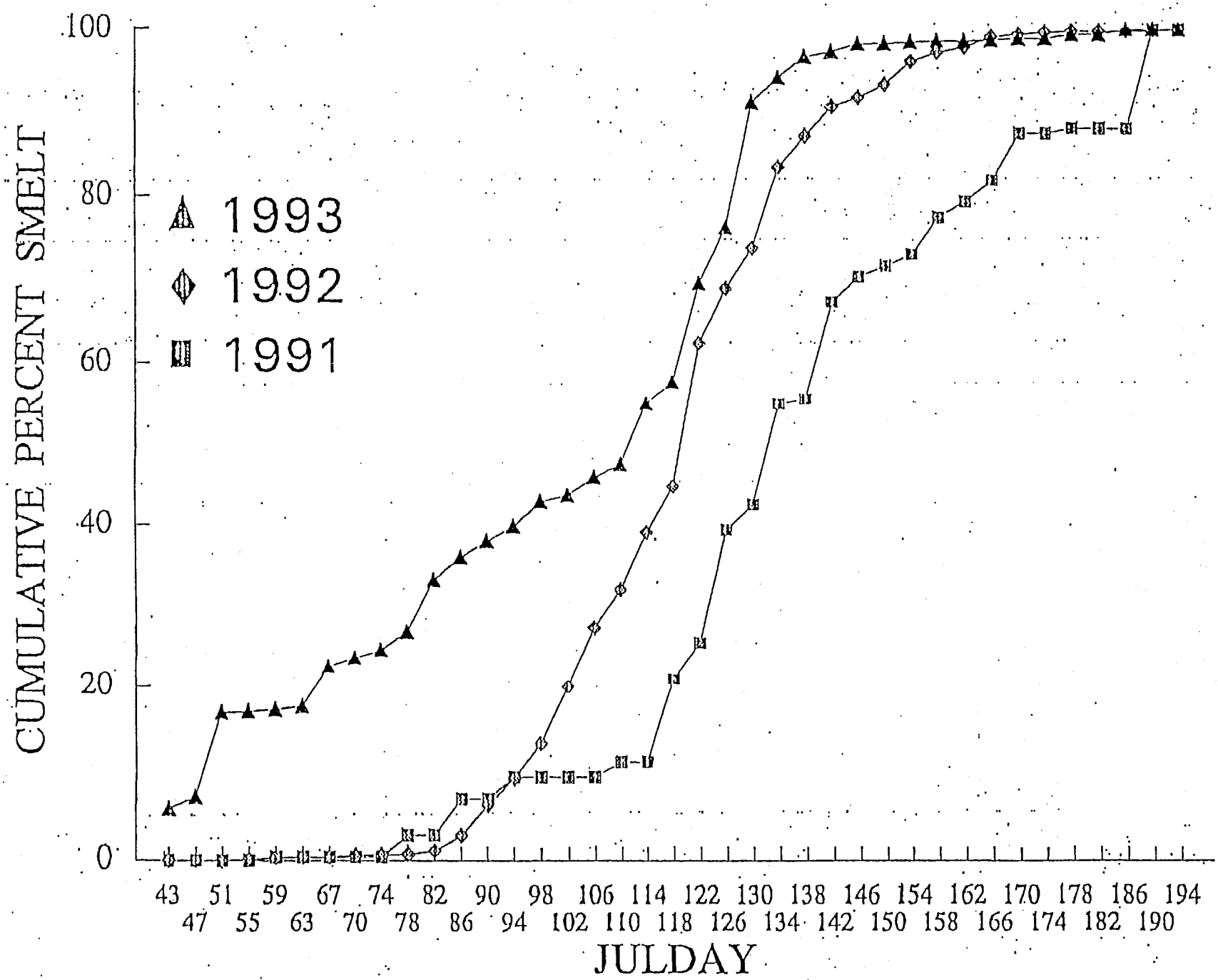


Figure 11. Correlations for several reaches between number of days when 2 ppt isohaline is in a reach and the subsequent Fall Midwater Trawl Index. (*-for significant correlations ($P \leq 0.05$), correlation coefficient given on Y axis).

FIGURE LEGEND

Figure 12 This map of the upper estuary displays sites of the continuous monitoring stations (triangles) within the study area, and indicates hypothetical positions of a 2ppt isohaline measured at 5 kilometer increments upstream from the Golden Gate Bridge.





1991-93 Delta smelt larva, prejuvenile, and juvenile temporal distribution expressed as cumulative percent

Figure 13. Increase in delta smelt distribution in the Delta from April 1 to July 13 (Julian days 91 to 194)

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