Appendix A
Impacts, Mitigation Measures, and Beneficial Impacts

This page is intentionally left blank

Appendix A
Impacts, Mitigation Measures, and Beneficial Impacts

Table 1. Summary Comparison of Effects of EWA Alternatives

Resources	Area of Analysis	Potential Effects	Effects Determination			Mitigation
			No Action/ No Project Alternative	Flexible Purchase Alternative	Fixed Purchase Alternative	
Water Supply and Management	Upstream from the Delta Region Rivers[1]	Change in the rate and timing of river flows affecting water supply of Project and non-Project users	No effect	No effect	No effect	None
	Project and Non-Project Reservoirs[2]	Reduction in carry-over storage.	No effect	LTS[5]	LTS	None
	Sacramento-San Joaquin Delta	Change in the rate and timing of Delta inflows and the amount and timing of diversions at the SWP and CVP pumps lowering South Delta water levels	No effect	PS[6], prior to mitigation	PS, prior to mitigation	Yes, see Table 2
		Change in available Banks pump capacity for the CVP (Joint Point of Diversion)	No effect	Lost Opportunity	No effect	None
	Export Service Area	Change in the rate and timing of Delta exports for Export Service Area water users	No effect	LTS	LTS	None
		Increase in water supply reliability to SWP and CVP contractors.	No effect	Beneficial effect	Beneficial effect	None
	Export Service Area Reservoirs[3]	Change in the pattern of reservoir level fluctuations	No effect	LTS	LTS	None
	Counties with Crop Idling[4]	Reduction in return flows from fields to agricultural and other water users not participating in EWA	No effect	PS, prior to mitigation	PS, prior to mitigation	Yes, see Table 2

Table 1. Summary Comparison of Effects of EWA Alternatives

Resources	Area of Analysis	Potential Effects	Effects Determination			Mitigation
			No Action/ No Project Alternative	Flexible Purchase Alternative	Fixed Purchase Alternative	
Water Quality	Upstream from the Delta Region Rivers	Change in the rate and timing of river flows increasing concentrations of water quality constituents	No effect	LTS	LTS	None
		Increase in river water temperature degrading water quality	No effect	LTS	LTS	None
	Project and Non-Project Reservoirs	Decrease in reservoir water surface elevation increasing concentrations of constituents and degrading water quality	No effect	LTS	LTS	None
	Sacramento-San Joaquin Delta	Increase in chloride, bromide or organic carbon concentrations in the Delta during months of increased pumping	No effect	LTS	LTS	None
		Increase in annual total salt and organic carbon load delivered to CVP and SWP water users.	No effect	LTS	LTS	None
	Export Service Area	Decrease in reservoir water surface elevation increasing concentrations of constituents and degrading water quality	No effect	LTS	LTS	None
	California Aqueduct	Exceedance of non-Project water acceptance criteria from release of extracted groundwater into California Aqueduct	No effect	LTS	LTS	None
	Counties with crop idling	Change in timing and quantity of water applied to cropland	No effect	LTS	LTS	None
		Increase in sediment transport via wind erosion and runoff	No effect	LTS	LTS	None

Table 1. Summary Comparison of Effects of EWA Alternatives

Resources	Area of Analysis	Potential Effects	Effects Determination			Mitigation
			No Action/ No Project Alternative	Flexible Purchase Alternative	Fixed Purchase Alternative	
Water Quality (continued)		Change in quality of surface water following mixing of groundwater and surface water	No effect	LTS	LTS	None
Groundwater Resources	Groundwater Basins[7]	Reductions in groundwater levels in excess of seasonal variations	No effect	PS, before mitigation	PS, before mitigation	Yes, see Table 2
		Reductions of flows neighboring surface water channels	No effect	PS, before mitigation	PS, before mitigation	Yes, see Table 2
		Increased potential for land subsidence	No effect	LTS	LTS	None
		Degradation of groundwater quality	No effect	LTS	LTS	None
Geology, Soils, and Seismicity	Butte, Colusa, Glenn, Sutter and Yolo Counties	Increase in soil erosion from idled fields	No effect	LTS	LTS	None
	Fresno, Kern, and Kings Counties	Increase in soil erosion from idled fields	No effect	PS, prior to mitigation	PS, prior to mitigation	Yes, see Table 2
Air Quality	Sacramento, Yolo, Sutter, Merced, Butte, Shasta, Colusa, Glenn, and Yuba Counties	Increase of emissions from use of groundwater pumps	No effect	PS, prior to mitigation	PS, prior to mitigation	Yes, see Table 2
	Butte, Colusa, Glenn, Sutter and Yolo Counties	Increase of fugitive dust and PM10 emissions from idled fields	No effect	LTS	LTS	None
	Fresno, Kern, and Kings Counties	Increase of fugitive dust and PM10 emissions from idled fields	No effect	PS, prior to mitigation	PS, prior to mitigation	Yes, see Table 2

Table 1. Summary Comparison of Effects of EWA Alternatives

Resources	Area of Analysis	Potential Effects	Effects Determination			Mitigation
			No Action/ No Project Alternative	Flexible Purchase Alternative	Fixed Purchase Alternative	
Fisheries and Aquatic Ecosystems	Project and Non-Project Reservoirs	Reduction in acreage of littoral habitat available for spawning and rearing	No effect	LTS	LTS	None
		Increase in the frequency of potential nest-dewatering events	No effect	LTS	LTS	None
		Reduction of coldwater habitat availability	No effect	LTS	LTS	None
	Upstream from the Delta Region Rivers	Change in the rate and timing of river flows affecting spawning, rearing, and migration of anadromous fish species	No effect	LTS	LTS	None
		Increase in river water temperature affecting spawning, rearing, and migration of anadromous fish species	No effect	LTS	LTS	None
		Change in the rate and timing of river flows affecting spawning habitat for resident fish species	No effect	LTS	LTS	None
		Increase in river water temperature affecting spawning habitat for resident fish species	No effect	LTS	LTS	None
		Increase in salmon mortality	No effect	LTS	LTS	None
	Butte Creek	Decrease in agricultural return flows to affect spawning, rearing, and migration of fish species	No effect	LTS	LTS	None
	Lake Natoma	Change in water temperature affecting long-term population of coldwater fish	No effect	LTS	LTS	None
	Nimbus Fish Hatchery	Increase in water temperature affecting hatchery production	No effect	LTS	LTS	None

Table 1. Summary Comparison of Effects of EWA Alternatives

Resources	Area of Analysis	Potential Effects	Effects Determination			Mitigation
			No Action/ No Project Alternative	Flexible Purchase Alternative	Fixed Purchase Alternative	
Fisheries and Aquatic Ecosystems (continued)	Export Service Area	Increase in reservoir drawdown to reduce the availability of habitat for warmwater and coldwater fish species	No effect	LTS	LTS	None
Vegetation and Wildlife	Upstream from the Delta Region Rivers	Changes in rate and timing of river flows affecting riparian, riverine, and associated wetland communities	No effect	LTS	LTS	None
	Project and Non-Project Reservoirs	Decrease in surface water elevation affecting lacustrine and associated upland habitats.	No effect	LTS	LTS	None
	Counties with Crop Idling	Decrease in available seasonally flooded agriculture and associated habitats affecting wildlife and special status species	No effect	LTS[8]	LTS	None
		Decrease in seasonally flooded agriculture wastegrain forage affecting wildlife and special-status species	No effect	LTS	LTS	None
		Decrease in return agricultural flows affecting wetlands	No effect	LTS	LTS	None
	Sacramento-San Joaquin Delta	Change in Delta parameters affecting riverine aquatic, riparian, and associated wetland habitats	No effect	LTS	LTS	None
	Groundwater Basins	Decrease in water table levels affecting wetlands and riparian habitats	No effect	LTS	LTS	None
	Export Service Area	Decrease in surface water elevation affecting lacustrine and associated uplands	No effect	LTS	LTS	None

Table 1. Summary Comparison of Effects of EWA Alternatives

Resources	Area of Analysis	Potential Effects	Effects Determination			Mitigation
			No Action/ No Project Alternative	Flexible Purchase Alternative	Fixed Purchase Alternative	
Regional and Agricultural Economics	Counties with Crop Idling	Increase net revenue to farmers/landowners participating in the sale of water to EWA	No effect	Economic effect	Economic effect	None
		Decrease in net revenues to tenant farmers	No effect	Economic effect	Economic effect	None
		Temporary reduction in economic activity indicated by rice and cotton acreage, county output, value added, wages and salaries, and employment	No effect	Economic effect	Economic effect	None
		Change in county revenue from sales tax, property taxes, and subvention payments	No effect	Economic effect	Economic effect	None
	Groundwater Basins	Increase in groundwater extraction costs	No effect	Economic effect	Economic effect	None
	All EWA Regions	Increase in water transfers market prices	No effect	Economic effect	Economic effect	None
Agricultural Social Issues	Counties with Crop Idling	Temporary decrease in farmworker employment	No effect	Economic effect	Economic effect	None
Agricultural Land Use	Counties with Crop Idling	Temporary decrease in the amount of land categorized as prime, statewide importance, or unique farmland	LTS	PS, prior to mitigation	PS, prior to mitigation	Yes, see Table 2
		Conversion of lands under the Williamson Act and other land resource protection programs to incompatible uses	LTS	LTS	LTS	None
Recreation Resources	Upstream from the Delta Region Rivers	Change in river flows affecting fishing, hunting, and recreation opportunities	No effect	LTS	LTS	None
	Project and Non-Project Reservoirs	Change in reservoir water surface elevation affecting fishing, hunting, and recreation opportunities	No effect	LTS	LTS	None

Table 1. Summary Comparison of Effects of EWA Alternatives

Resources	Area of Analysis	Potential Effects	Effects Determination			Mitigation
			No Action/ No Project Alternative	Flexible Purchase Alternative	Fixed Purchase Alternative	
Recreation Resources (continued)	Butte, Colusa, Glenn, Sutter, and Yolo Counties	Change in location of waterfowl hunting areas	No effect	LTS	LTS	None
	Sacramento-San Joaquin Delta	Decrease in Delta inflow affecting recreation opportunities	No effect	LTS	LTS	None
	Export Service Area	Change in reservoir water surface elevation affecting fishing and recreation opportunities	No effect	PS, prior to mitigation	PS, prior to mitigation	Yes, see Table 2
Flood Control	Upstream from the Delta Region Rivers	Increase in river flows reducing available channel carrying capacity	No effect	LTS	LTS	None
	Project and Non-Project Reservoirs	Change in water surface elevation affecting flood control space	No effect	LTS	LTS	None
		Increase in the amount of inflow that could be captured during a flood event	No effect	Beneficial effect	Beneficial effect	None
	Sacramento-San Joaquin Delta	Increase in Delta inflows during high water stages	No effect	LTS	LTS	None
	Export Service Area	Change in water surface elevation affecting flood control space	No effect	LTS	LTS	None
		Increase in the amount of inflow that could be captured during a flood event	No effect	Beneficial effect	Beneficial effect	None
Power	Project and Non-Project Reservoirs	Change in water surface elevation and reservoir release patterns affecting power generation efficiency	No effect	LTS	LTS	None
		Shift in pumping times to periods of higher electricity costs	No effect	PS, prior to mitigation	PS, prior to mitigation	Yes, see Table 2

Table 1. Summary Comparison of Effects of EWA Alternatives

Resources	Area of Analysis	Potential Effects	Effects Determination			Mitigation
			No Action/ No Project Alternative	Flexible Purchase Alternative	Fixed Purchase Alternative	
Power (continued)	Delta Pumping Facilities	Increase in electricity use at project pumps during summer months	No effect	LTS	LTS	None
		Shift in export pumping times to periods of higher electricity costs	No effect	PS, prior to mitigation	PS, prior to mitigation	Yes, see Table 2
	San Luis Reservoir	Change in water surface elevation and release patterns affecting power generation	No effect	LTS	LTS	None
		Shift in export pumping times to periods of higher electricity costs	No effect	PS, prior to mitigation	PS, prior to mitigation	Yes, see Table 2
	Export Service Area Pumping Facilities	Shift in pumping times to periods of higher electricity costs	No effect	PS, prior to mitigation	PS, prior to mitigation	Yes, see Table 2
Cultural Resources	Project and Non-Project Reservoirs	Change in water surface elevation beyond the normal operating range may expose cultural resources to increased cycles of inundation, drawdown, and erosion	No effect	Consultation will determine historic properties, assess effects, and resolve adverse effects, if necessary	Consultation will determine historic properties, assess effects, and resolve adverse effects, if necessary	Yes, see Table 2
	Export Service Area Reservoirs	Change in water surface elevation beyond the normal operating range may expose cultural resources to increased cycles of inundation, drawdown, and erosion	No effect	LTS	LTS	None
Visual Resources	Upstream from the Delta Region Rivers	Change in river flow affecting the landscape character or overall scenic attractiveness of the area	No effect	LTS	LTS	None
	Project and Non-Project Reservoirs	Decrease in water surface elevation affecting the landscape character or overall scenic attractiveness of the area	No effect	LTS	LTS	None

Table 1. Summary Comparison of Effects of EWA Alternatives

Resources	Area of Analysis	Potential Effects	Effects Determination			Mitigation
			No Action/ No Project Alternative	Flexible Purchase Alternative	Fixed Purchase Alternative	
Visual Resources (continued)	Counties with Crop Idling	Temporary conversion of rice land reducing waterfowl viewing opportunities or scenic attractiveness	No effect	LTS	LTS	None
	Sacramento-San Joaquin Delta	Reduction in Delta inflows affecting existing visual landscape	No effect	LTS	LTS	None
	Export Service Area Reservoirs	Decrease in water surface elevation affecting the landscape character or overall scenic attractiveness of the area	No effect	LTS	LTS	None
Environmental Justice	Counties with Crop Idling	Disproportionate effect on low-income and minority farm workers	No effect	No disproportion ate effect	No disproportion ate effect	None
Indian Trust Assets	Groundwater Basins	Increase in groundwater extraction costs or dry out wells on tribal property	No effect	Consultation will determine effects	Consultation will determine effects	See Ground-water

Notes:
[1]Upstream from the Delta Region Rivers include the Sacramento, Feather, Yuba, American, Merced, and San Joaquin
[2]Project and Non-Project Reservoirs include Shasta, Oroville, Folsom, New Bullards Bar, Sly Creek, Little Grass Valley, French Meadows, Hell Hole, and McClure
[3]Export Service Area Reservoirs include San Luis, Castaic Lake, Anderson, Lake Perris, Lake Mathews, and Diamond Valley Lake
[4]Counties with crop idling include Butte, Colusa, Glenn, Sutter, Yolo, Fresno, Kern, and Kings
[5]LTS – Less than significant
[6]PS – Potentially significant
[7]Groundwater basins include Redding, Sacramento, North San Joaquin, and South San Joaquin
[8]Conservation measures have been developed during informal consultation with USFWS and CDFG and proposed as a part of the Action Specific Implementation Plan to avoid or minimize effects on the giant garter snake, black tern, greater sandhill crane, and western pond turtle. These measures have been incorporated into the project description.

Table 2. Summary of Mitigation Measures[1] for Potentially Significant Effects of the EWA

Resources	Area of Analysis	Effects Relative to the Baseline Condition	Mitigation Measures	Effects Determination after Mitigation		
				No Action/ No Project Alternative	Flexible Purchase Alternative	Fixed Purchase Alternative
Water Supply and Management	Sacramento-San Joaquin Delta	Change in the rate and timing of Delta inflows and the amount and timing of diversions at the SWP and CVP pumps lowering South Delta water levels	Actions such as installation of temporary pumps or dredging would reduce effects to South Delta water users. The EWA agencies will pay their share for additional actions needed to increase South Delta water levels to the Baseline Condition.	No effect	LTS	LTS
	Sacramento Valley	Decreases in return flows due to crop idling and groundwater substitution could reduce flow of water to down drainage agriculture and other water users	Willing sellers will be required to maintain water levels in drainage systems that do not reduce supplies to downstream users.	No effect	LTS	LTS
Groundwater Resources	Sacramento Valley	Decrease in water levels in neighboring surface water channels.	Well Review to avoid potential effect.	No effect	LTS	LTS
		Reduction in groundwater levels in excess of seasonal variation.	Pre-Purchase Groundwater Evaluation to avoid potential effect.	No effect	LTS	LTS
			Monitoring Program	No effect	LTS	LTS
			Mitigation Program	No effect	LTS	LTS

Table 2. Summary of Mitigation Measures[1] for Potentially Significant Effects of the EWA

Resources	Area of Analysis	Effects Relative to the Baseline Condition	Mitigation Measures	Effects Determination after Mitigation		
				No Action/ No Project Alternative	Flexible Purchase Alternative	Fixed Purchase Alternative
Geology, Soils, and Seismicity	Fresno, Kern, and Kings Counties	Increase in soil erosion from crop idling	A Dust Suppression Plan, approved by the San Joaquin Valley APCD, must be implemented. Potential elements are: Crop shift (e.g., winter wheat) and harvest between mid-June and mid-July. The stubble and chaff would be left on the fields to increase surface roughness, vegetative cover, and soil moisture. Increase surface roughness to reduce wind speed at the soil surface so that the wind is less able to move soil particles. Several practices include ripping clay soil, listing, and furrowing fields.	No effect	LTS	LTS

Table 2. Summary of Mitigation Measures[1] for Potentially Significant Effects of the EWA

Resources	Area of Analysis	Effects Relative to the Baseline Condition	Mitigation Measures	Effects Determination after Mitigation		
				No Action/ No Project Alternative	Flexible Purchase Alternative	Fixed Purchase Alternative
Air Quality (continued)	Fresno, Kern, and Kings Counties	Increase of fugitive dust and PM10 emissions from crop idling	A Dust Suppression Plan, approved by the San Joaquin Valley APCD, must be implemented. Potential elements are crop shift (e.g., winter wheat). Harvest winter wheat between mid- June and mid-July. The stubble and chaff would be left on the fields to reduce the surface area exposed to wind. Increase surface roughness to reduce wind speed at the soil surface so that the wind is less able to move soil particles, which contribute to PM10. Several practices include ripping clay soil, listing, and furrowing fields.	No effect	LTS	LTS
	Sacramento, Yolo, Sutter, Merced, and Yuba Counties	Increased NOx and PM10 emissions from older diesel engines in non-attainment areas	EWA agencies will require the willing seller to reduce project related emissions through the use of alternative power, including electrical pumps, or by offsetting project-related emissions.	No effect	LTS	LTS
Land Use	Sacramento and San Joaquin Valleys	Land use changes from prime agricultural land to non-prime agricultural land	EWA agencies will minimize the amount of consecutive years a particular parcel is idled.	No effect	LTS	LTS

Table 2. Summary of Mitigation Measures[1] for Potentially Significant Effects of the EWA

Resources	Area of Analysis	Effects Relative to the Baseline Condition	Mitigation Measures	Effects Determination after Mitigation		
				No Action/ No Project Alternative	Flexible Purchase Alternative	Fixed Purchase Alternative
Power	Project and Non-Project Reservoirs	Shift in export pumping times to periods of higher electricity costs	The EWA agencies will be responsible for covering additional power costs per requirements specified in the CALFED ROD, under the Operating Principles Agreement.	No effect	LTS	LTS
	Delta Pumping Facilities	Shift in export pumping times to periods of higher electricity costs		No effect	LTS	LTS
	San Luis Reservoir	Shift in export pumping times to periods of higher electricity costs		No effect	LTS	LTS
	Export Service Area Pumping Facilities	Shift in pumping times to periods of higher electricity costs		No effect	LTS	LTS
Cultural Resources	Project and Non-Project Reservoirs	Lowering water levels in reservoirs beyond the normal operating level may expose cultural resources to increased cycles of inundation, drawdown, and erosion.	EWA agencies will consult with the Forest Service and State Historic Preservation Office to determine appropriate mitigation measure to be implemented by the willing seller.	No effect	LTS	LTS
			Inventory and evaluation.	NA[2]	NA	NA
			Historic property mitigation.	NA	NA	NA
			Mitigation for impacts to resources covered under U.S. Forest Service's California Native American policy (if required).	NA	NA	NA

Table 2. Summary of Mitigation Measures[1] for Potentially Significant Effects of the EWA

Resources	Area of Analysis	Effects Relative to the Baseline Condition	Mitigation Measures	Effects Determination after Mitigation		
				No Action/ No Project Alternative	Flexible Purchase Alternative	Fixed Purchase Alternative
Recreation	Lake Perris and Castaic Lake	Lowering of reservoir levels earlier in recreation season reducing recreational possibilities	For Lake Perris, EWA agencies with input from officials at Lake Perris will set a limitation on the amount of drawdown. For Castaic Lake, input from recreation officials will be considered.	No effect	LTS	LTS

Notes:
[1]This table presents a summary of the mitigation measures. The reader is referred to the respective resource area chapter of the 2004 EIS/EIR for details regarding the specific mitigation measure.
[2]NA = Not applicable.

Table 3. Summary of Beneficial Effects of the EWA Alternatives

Resources	No Action/No Project Alternative	Flexible Purchase Alternative	Fixed Purchase Alternative
Water Supply and Management	No change from existing conditions. ESA would trigger pump reductions to protect fish, and these actions would reduce water supply reliability to Project users.	Water supply replaced due to pump reductions up to 600 TAF. Fish actions would be taken prior to reaching incidental take thresholds. The volume of replacement water would reduce the probability of reaching jeopardy relative to the No Action/No Project Alternative, which could include uncompensated fish actions.	Water supply replaced due to pump reductions up to 185 TAF and any carry-over storage. Fish actions would be taken prior to reaching incidental take thresholds. If fish actions are not enough to avoid jeopardy, additional fish actions would be required where contractors may not be compensated.
Fisheries and Aquatic Ecosystems	Fishery protection regulatory standards required in NOAA Fisheries and USFWS Biological Opinions, the 1995 Delta WQCP, VAMP, and CVPIA would be implemented	Benefits the recovery of at-risk fish species by making available up to 600 TAF of EWA assets for fish actions. Fish actions could include closing DCC gates, increasing instream flows, and augmenting Delta outflows to improve spawning and rearing habitat and migration.	Contributes to the recovery of at-risk fish species by making available up to 185 TAF of EWA assets for fish actions. The same fish actions are available as in the Flexible Purchase Alternative. Fish actions taken would be limited by available assets; therefore, EWA agencies would need to prioritize fish actions. In most years, total assets available would be used for pumping reduction and repayments.
Regional and Agricultural Economics	No effect	Sale of water to EWA would increase net revenues to farmers/landowners	Sale of water to EWA would increase net revenues to farmers/landowners
Flood Control	No effect	Additional space made available from release of stored water would provide space for flood control	Additional space made available from release of stored water would provide space for flood control
	No effect	Metropolitan WD use of local storage during source shifting would provide additional storage space for inflow that could be captured during a flood event	Metropolitan WD use of local storage during source shifting would provide additional storage space for inflow that could be captured during a flood event

This page is intentionally left blank

Appendix B
Modeling Appendix

This page is intentionally left blank

Appendix B
Modeling Appendix

The modeling for this Supplement to the 2004 Environmental Impact Statement/Environmental Impact Report (EIS/EIR) used the 2004 Operations Criteria and Plan (OCAP) biological assessment (BA) modeling results to define the existing conditions. These model results, rather than the CALSIM II modeling conducted for the 2004 EIS/EIR, were used because the model more accurately reflected Project operations. During development of the 2004 EIS/EIR, the objective of the CALSIM II modeling was to assess impacts associated with the pumping of Environmental Water Account (EWA) assets in the July-September period. The analysis of benefits associated with pump reductions did not use CALSIM II; therefore, the CALSIM II modeling did not include fish actions. The pelagic organism decline (POD) has increased the focus on benefits of the EWA program. To complete a quantitative assessment of fish impacts that included benefits, the modeling needed to include fish actions.

An excel spreadsheet post-processing tool was developed to incorporate fish actions and purchases to simulate conditions with the EWA. The EWA agencies could not use the existing CALSIM II modeling associated with the 2004 biological assessment on the long-term operations of the Projects because this modeling included a different set of fish actions than included in the 2004 EIS/EIR and this Supplement. The change in use of models only affects modeling output related to the Delta.

Because of the POD, it is important to be as accurate as possible in characterizing the effects on fisheries; thus, the post processing tool was implemented, providing the following output:

- Banks and Jones Pumping
- Total Delta Outflow
- Delta Inflow
- Export/Inflow (E/I) Ratio
- X2 Salinity Indicator (defined in Section B.5)

Including fish actions in the post-processing tool results in Delta-related modeling output that differs from the output in the 2004 EIS/EIR modeling. Therefore, the effects analyses of resource areas affected by conditions in the Delta (fisheries and water quality) would also be expected to differ from those described in the 2004 EIS/EIR. In particular, this is the case for fisheries but not for water quality (see text below). Chapter 4 of this Supplement contains an analysis of the effects of the EWA program on fisheries, based on the new modeling that uses the post-processing tool.

An updated analysis for water quality was not necessary in this Supplement for several reasons:

1.) CALSIM II simulates Project operations using standards that govern water quality in the Delta as a constraint, and the standards were also upheld during post-processing. Neither tool allows a violation of these standards. Project exports were limited to a percentage of Delta inflow (E/I ratio) as described in the State Water Resources Control Board (SWRCB) D-1641 and Orders 2000-10 and 2001-5 (Table B-1).

Table B-1. Export/Inflow Ratio

Period	Percent of Total Delta Inflow
October – January	65
February	35 – 45
March – June	35
July – September	65

2.) Carriage water, defined as the additional water needed for Delta outflow to compensate for the additional exports made on behalf of a transfer to assure compliance with water quality requirements of the State Water Project (SWP) and Central Valley Project (CVP), was included in the transfers.

3.) Pumping of EWA assets in July, August, and September remained the same so the effects were those evaluated in the 2004 EIS/EIR.

B.1 Fish Actions

Modeled actions for this Supplement are simulated as SWP/CVP export changes. Actions are simulated as either a pumping reduction (i.e., monthly reduction in pumping volume relative to a baseline level) or a pumping restriction (i.e., reduction of pumping down to a target pumping level, regardless of baseline level). Tables B-2 and B-6 list the fish actions taken with the Flexible and Fixed Purchase Alternatives.

The assumptions that determine when, and to what level, a fish action is taken are designed for monthly simulation and do not equate to a collection of EWA actions that will be needed in any specific future year. Their complexity represents the extent of export-related fish actions that can be rationalized and simulated in post-processing. They are to be interpreted as monthly surrogates for an assumed set of potential fish actions expected to occur on daily to weekly time scales. Development of these assumptions was steered by EWA operations staff from California Department of Fish and Game (CDFG), U.S. Fish and Wildlife Service, (USFWS), and National Marine Fisheries Service (NMFS).

If EWA carryover debt was too high, the EWA agencies would choose not to take some actions. The model incorporates the debt limitations by including logic that either limits the action or increases purchases (in the Flexible Purchase Alternative). In the Flexible Purchase Alternative, debt-limited actions were taken based on the following guidelines:

- April and May shoulder
  - If carryover debt without action > 100,000 acre-feet, do not complete action, increase purchases
  - If carryover debt with action is 100,000 acre-feet to 150,000 acre-feet, complete action and increase purchases
  - If carryover debt with action > 150,000 acre-feet, do not do action, increase purchases
- June ramping
  - If carryover debt with action > 100,000 acre-feet, do not complete action

The Fixed Purchase Alternative would not take debt limited actions if carryover debt was greater than 150,000 acre-feet.

B.2 Operational Tools

Operational tools provide the EWA agencies with additional water and pumping capacity. The post-processing tool is limited in its capability to simulate operational assets. However, the model calculates debt spill in October, November, and December (if no fish action occurs) if there is excess outflow, available pumping capacity, available storage in San Luis Reservoir, and room under the E/I ratio.

B.2.1 Relaxation of the Section 10 Constraint

The SWP is limited to 6,680 cubic feet per second (cfs) diversion rate into Clifton Court Forebay. Permission has been granted by the U.S. Army Corps of Engineers to increase this diversion limit by 500 cfs during the months of July, August, and September. The 500 cfs increase is solely dedicated for pumping by the EWA. During summer months when the projects are constrained to use less than 6,680 cfs at Banks (e.g., for the sake of Delta salinity objectives), this conveyance asset is not available. During post-processing, Banks pumping capacity was set at 7,180 cfs in July, August, and September to convey EWA assets.

B.2.2 Joint Point of Diversion

The SWP will use excess capacity at Banks Pumping Plant to wheel water for the CVP and EWA. This excess capacity is assessed under the terms of Joint Point of Diversion (JPOD) granted by SWRCB D-1641. During post-processing, excess capacity at Banks Pumping Plant was used to convey EWA assets. The model allocated excess capacity solely to the EWA; in reality, capacity would be shared with the CVP, although it is unknown to what degree the CVP would make use of its share. This additional EWA-related pumping at Banks Pumping Plant would not lessen any potential impacts. On the contrary, a modeled increase in Banks pumping would result in a conservative estimate of potential impacts.

B.2.3 Carried-over Debt “Spill” at EWA San Luis

The post-processing tool also includes simulation of pumping to erase (or “spill”) carried-over storage debt at San Luis Reservoir. Debt “spill” occurs when EWA assets (in the form of purchases or water pumped from excess Delta outflow) are delivered to San Luis. Debt not “spilled” by the end of the year is carried over to the following year.

The post-processing tool constrained debt in San Luis Reservoir to not cause storage in San Luis to be lower than the minimum operating level of 80,000 acre-feet. Conversely, debt spill and storage of assets in San Luis Reservoir can not cause the reservoir to exceed its storage capacity of just over 2 million acre-feet.

B.3 Flexible Purchase Alternative

The Flexible Purchase Alternative allows EWA agencies to purchase up to 600,000 acre-feet of water, but does not restrict acquisition of the total quantities from each region (i.e., Upstream from the Delta and Export Service Area).

B.3.1 Fish Actions

Table B-2 lists the fish actions that are taken as part of the Flexible Purchase Alternative. Actions in December – March and Vernalis Adaptive Management Plan (VAMP) are taken to the extent that they are recommended. April and May shoulder and June ramping are limited by debt in many years. Debt-limited actions occur if forecasted carryover debt in September in San Luis Reservoir is less than 150,000 acre-feet.

Table B-2. Fish Actions in the Flexible Purchase Alternative

Months	Actions in the Model	Years Action is Taken/Years Action is Possible
December	30,000 AF reduction (split evenly between CVP/SWP) if monthly average of Sacramento River flow at Freeport > 23,000 cfs and < 28,000 cfs (surrogate for Freeport flows > 25,000 cfs in late December)	5/5
January	150,000 AF reduction (split evenly between CVP/SWP)	72/72
February	100,000 AF reduction (split evenly between CVP/SWP)	72/72
March	50,000 AF reduction (split evenly between CVP/SWP)	72/72
April 1-14	**Pre-VAMP shoulder during dry and critical years at SWP pumps (if b2 pre-VAMP is not taken)**	8/27
April 15 – May 15	VAMP export restriction on SWP	72/72
May 16 – 31	**Post-VAMP export restriction on SWP pumps**	17/72
June	**Ramping of exports**	14/72

Notes:
Debt-limited

B.3.2 EWA Assets

Annual purchase targets by year type are listed in Table B-3. The purchases were allocated Upstream from the Delta and in the Export Service Area. For modeling of the Flexible Purchase Alternative in this Supplemental EIS/EIR, the Upstream from the Delta share of total purchase target is assumed to decrease with wetter years, indicated by SWP allocation to agricultural contractors (Table B-4). The Upstream from the Delta share of the EWA annual purchase target was allocated Upstream from the Delta unless there was insufficient pumping capacity, in which case it was allocated to the Export Service Area.

Table B-3. Annual Purchase Targets for the Flexible Purchase Alternative

Sacramento 40-30-30 Index	Total Purchase Target (TAF)
Wet	285
Above Normal	264
Below Normal	270
Dry	275
Critical	318

Table B-4. Upstream from the Delta Share of EWA Annual Purchase Targets for the Flexible Purchase Alternative

SWP Ag. Allocation (%)	Share (%) of Annual Purchase Target
0-39	90
40-59	85
60-69	75
70-79	70
80-99	60
100	50

In addition to the target purchases, supplemental purchases were acquired if carryover debt in September in San Luis Reservoir was forecasted to be greater than 100,000 acre-feet. Supplemental purchases are first allocated Upstream from the Delta if Banks pumping capacity is available; the remainder is acquired from the Export Service Area. Table B-5 lists average combined target and supplemental purchases by year type.

Table B-5: Annual Total Purchases for the Flexible Purchase Alternative

Sacramento 40-30-30 Index	Total Purchases (TAF)
Wet	363
Above Normal	323
Below Normal	323
Dry	304
Critical	330

B.4 Fixed Purchase Alternative

The Fixed Purchase Alternative includes acquisition of 185,000 acre-feet of EWA assets annually, with a target of 35,000 acre-feet for total upstream from the Delta purchases and 150,000 acre-feet for total purchases in the Export Service Area.

B.4.1 Fish Actions

Table B-6 lists the fish actions that are taken as part of the Fixed Purchase Alternative. Actions in January – March and VAMP are taken to the extent that they are recommended. Debt-limited actions (December, April and May shoulder, and June ramping) were not taken in any years. Debt-limited actions occur if forecasted carryover debt in September in San Luis Reservoir is less than 150,000 acre-feet.

Table B-6: Fish Actions in the Fixed Purchase Alternative

Months	Actions in the Model	Years Action is Taken/Years Action is Possible
December	**30,000 AF reduction (split evenly between CVP/SWP) if monthly average of Sacramento River flow at Freeport > 23,000 cfs and < 28,000 cfs (surrogate for Freeport flows > 25,000 cfs in late December)**	0/5
January	100,000 AF reduction (split evenly between CVP/SWP)	72/72
February	75,000 AF reduction (split evenly between CVP/SWP)	72/72
March	50,000 AF reduction (split evenly between CVP/SWP)	72/72
April 1-14	**Pre-VAMP shoulder during dry and critical years at SWP pumps (if b2 pre-VAMP is not taken)**	0/28
April 15 – May 15	VAMP export restriction on SWP	72/72
May 16 – 31	**Post-VAMP export restriction on SWP pumps**	0/72
June	**Ramping of exports**	0/72

Notes:
Debt-limited

B.4.2 EWA Assets

Annual purchase targets by year type are listed in Table B-7. The purchases were allocated Upstream from the Delta and in the Export Service Area as defined by the Fixed Purchase Alternative. Supplemental purchases are not allowed under the Fixed Purchase Alternative. Therefore, if San Luis Reservoir carryover debt exceeded the target of 100,000 acre-feet, the amount over 100,000 acre-feet becomes a delivery reduction and would not be delivered during the following summer. Figure B-1 shows the estimated delivery reductions.

Table B-7: Annual Total Purchases for the Fixed Purchase Alternative

Sacramento 40-30-30 Index	Total Purchase Target (TAF)
Wet	185
Above Normal	185
Below Normal	185
Dry	185
Critical	185

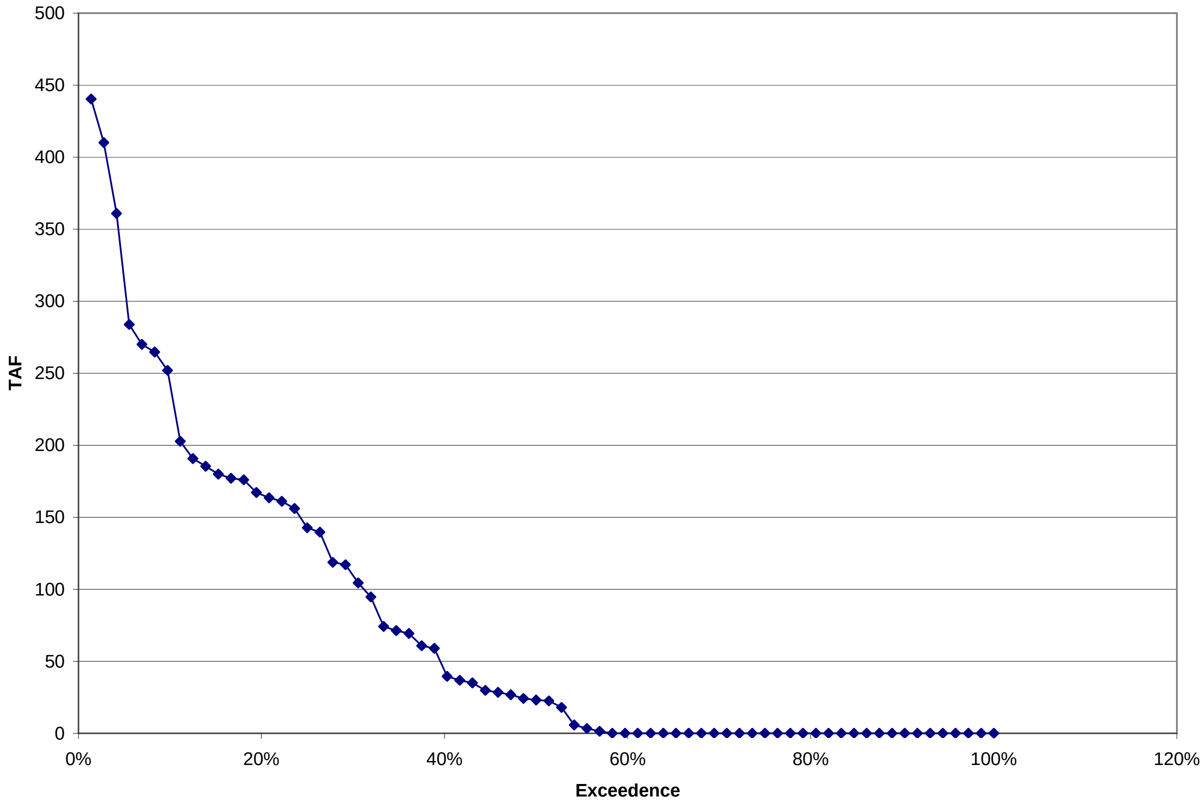

Figure B-1. Fixed Purchase Alternative Delivery Reductions

B.5 X2

The location of the 2 parts per thousand (ppt) salinity near-bottom isohaline (X2 location) has been identified as an indicator of estuarine habitat conditions within the Bay-Delta system. The location of X2 within Suisun Bay during the February through June period is thought to be directly and/or indirectly related to the reproductive success and survival of the early lifestages for a number of estuarine species. The post-processing tool was not capable of simulating X2 with the EWA program; therefore, a different equation (Miller 2002) was used to determine X2. The equation calculated X2 for both the existing conditions and action alternatives to make the comparison of the two consistent.

B.6 Cumulative Scenario

The cumulative scenario includes the programs described in Section 5.2. The sections below describe how the cumulative programs affect operations at Jones and Banks Pumping Plants.

B.6.1 Jones Pumping Plant

The Intertie between the Delta-Mendota Canal and the California Aqueduct would reduce a conveyance constriction, which would have the potential to enable pumping to increase at the Jones Pumping Plant. The cumulative scenario allows pumping up to 4,600 cfs at Jones Pumping Plant during months that do not have other reasons for restrictions. Increases in pumping were limited to months without EWA fish actions (July through November) and to times that the E/I ratio was under the required limits. This increase in pumping was assumed to be used to meet CVP needs, and was not associated with any of the other water acquisition programs.

B.6.2 Banks Pumping Plant

The water acquisition programs included in the cumulative scenario would need to move water through the Delta pumps. The cumulative modeling assumes that this water would be pumped through Banks Pumping Plant. The modeling assumptions associated with each program include:

- Lower Yuba River Accord: up to 60,000 acre-feet (Component 1) for the EWA and up to 140,000 acre-feet (Components 2-4) for Department of Water Resources (DWR) and U.S. Bureau of Reclamation (Reclamation) in dry years. Component 1 is included in the EWA modeling and Components 2-4 are included in the cumulative scenario. DWR and Reclamation would move the water through the Delta during July through September, depending on "(1) available Delta export capacity; (2) compliance with the E/I ratio; and (3) the transfer would occur on a "fish-friendly" basis consistent with the provisions identified in Reclamation's OCAP BA" (Yuba County Water Agency 2007).

- Sacramento Valley Water Management Agreement (SVWMA): 92,500 acre-feet for local use within the Sacramento Valley unless not needed, and 92,500 acre-feet for SWP and CVP to help meet requirements of D-1641. In some years, the SVWMA could produce up to 185,000 acre-feet that would need to be moved through the Delta. This quantity is not dependent on year type, and would be moved from July through October. Moving water would be contingent on compliance with the E/I ratio, and only up to half of the water could be moved in October.

- Dry Year Purchase Program and Governor's Drought Risk Reduction Investment Program: these programs could result in additional transfers in dry years, but the exact quantities are unknown.

In wet, above normal, and below normal years, only the SVWMA could have water to move through the Delta pumps; therefore, the maximum potential water transfer in those year types would be 185,000 acre-feet. In dry and critical years, the other programs could result in additional transfers. The maximum transfer in those years was assumed to be 500,000 acre-feet.

B.7 Model Limitations

The CALSIM II model used for this Supplement to the 2004 EIS/EIR features the most current assumptions for the CVPIA (b)(2) water policy (assumption date May 2003 (OCAP BA 2004, Chapter 8)) and represents the best available planning model of the CVP/SWP system at the time of analysis. Support for this statement was provided during peer review of CALSIM II by the CALFED Science Program (Close et al. 2003), where the panel found CALSIM II to meet the need for a large-scale, relatively versatile operations planning model that can enable analysis of water movement in the Central Valley.

Although CALSIM II is the best available planning tool describing SWP and CVP operations, there is still a significant uncertainty surrounding CALSIM II hydrologic, operational, and policy assumptions. These uncertainties limit the "absolute" predictive capabilities of the model. It is important to differentiate between "absolute or "predictive" modeling applications and "comparative" applications. In "absolute" applications the model is run once to predict a future outcome, where errors or assumptions in formulation, system representation, data, operational criteria, etc., all contribute to total error or uncertainty in model results. In "comparative" applications the model is run twice, once under an assumed condition and a second time with a specific system change to assess how the system change leads to different outcomes in system operations. In this mode (which was the mode used in this Supplement), the difference between two simulations is of principal importance and is used to reveal operational effects.

For this Supplement, the model was run once using CALSIM II and then the results were post-processed. Using CALSIM II and post-processing in a comparative analysis framework, in theory, ensures the inherent bias and inaccuracies of the model don't affect relative changes in project dynamics being assessed. In this context, the potential errors or uncertainties that exist in the Baseline Condition are also present in the action alternatives, and the influence of such uncertainties is minimal when comparing the change between simulations.

B.8 References

Close A., W.M. Haneman, J.W. Labadie, D.P. Loucks, J.R. Lund, D.C. McKinney, and J.R. Stedinger. (2003). A Strategic Review of CALSIM II and its Use for Water Planning Management, and Operations in Central California. Report to the California Bay-Delta Authority Science Program Association of Bay Governments, Oakland, CA.

Miller, William J. 2002. Estimating Population Level and Water Supply Effects of Delta Water Project Operations. Available at: http://www.sldmwa.org/pdf_documents/Delta%20Issues/popcalc%20paper.pdf Accessed on 9 May 2007.

Yuba County Water Agency and Bureau of Reclamation. 2007. Proposed Lower Yuba River Accord Draft EIR/EIS. Available at: http://www.usbr.gov/mp/nepa/nepa_projdetails.cfm?Project_ID=2549 Accessed on 9 July 2007.

This page is intentionally left blank

Appendix C
Appended Action Specific Implementation Plan

This page is intentionally left blank

Contents

Tables

Figures

Chapter 1 Introduction

1.1 Changes that Require Reinitiation of Consultation

The regulations implementing the Endangered Species Act require a reinitiation of consultation if:

> “a) the amount or extent of taking specified in the incidental take statement is exceeded; b) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; c) the identified action is subsequently modified in a manner or to an extent that causes an effect to the listed species or critical habitat not previously considered in the biological opinion; or, d) a new species is listed or critical habitat designated that may be affected by the identified action.” (50 CFR Part 402.16)

In the case of the EWA program, the essence of the project as originally proposed has not substantially changed; however, the implementation timeframe that was originally anticipated has been extended by four years. Additionally, several years have passed since the 2003 Action Specific Implementation Plan (ASIP) was completed and the existing environmental setting is now different relative to some environmental topics, and/or new information is now available. In that regard, the hydrologic modeling used in evaluating biological/aquatic resource impacts now has additional capabilities relative to understanding the implications of certain fish actions under the EWA program. This Amended ASIP has been prepared in light of the aforementioned changes in circumstances and new information in order to carefully and systematically evaluate if and how such changes and new information affect the analysis presented in the 2003 ASIP.

1.2 Background

The CALFED Bay-Delta Program is a collaborative effort of 23 Federal and State agencies that seek to resolve the Delta-related water supply conflicts. The CALFED Bay-Delta Program Programmatic Record of Decision (ROD) set forth a collaborative means for addressing the environmental effects (adverse and beneficial) of CALFED Program actions related to improving water supply reliability and recovery/restoration of the Delta environment and species dependent on the Delta. Through the implementation of the Multi-Species Conservation Strategy (MSCS), the CALFED agencies assessed the effects of potential CALFED Program actions on the environment, and then developed initial conservation measures that when implemented would meet the overall CALFED Program objectives.

The MSCS is an appendix of the CALFED Bay-Delta Program Programmatic Environmental Impact Statement/Environmental Impact Report (PEIS/EIR). One of the goals of the CALFED Program MSCS is to explain how CALFED Program actions will comply with the Federal Endangered Species Act (ESA), California Endangered Species Act (CESA), and the California Natural Community Conservation Planning Act (NCCPA) requirements. The MSCS presents a program-level environmental analysis of the CALFED Preferred Program Alternative that expands upon the PEIS/EIR analysis to address the conservation strategy and certain other issues pertinent to ESA and NCCPA compliance. The US Fish and Wildlife Service (USFWS) and the National Marine Fishery Service (NMFS) used the MSCS as the program-level biological assessment to develop the programmatic Biological Opinions (BOs) for the CALFED Preferred Program Alternative. The California Department of Fish and Game (CDFG) used the MSCS for compliance with the CESA and NCCPA.

The MSCS created a two-tiered approach to ESA and NCCPA compliance that corresponds to CALFED Program's two-tiered approach to compliance with the National Environmental Policy Act (NEPA) and the California Environmental Quality Act (CEQA). The first tier of compliance is embodied in the MSCS itself. For the CALFED Program project actions identified in the PEIS/EIR and ROD, an ASIP is developed to address the ESA, CESA, and NCCPA consultation requirements of Federal and State agencies. As a second tier document, this ASIP focuses on issues specific to the Environmental Water Account (EWA) Proposed Action[1]. This ASIP therefore addresses the biological assessment requirements related to extending the existing EWA Program water acquisition and management actions described in Chapter 2. The USFWS and NMFS will use this ASIP to develop new or update existing action-specific BOs relative to the existing EWA Program. The CDFG will use this ASIP to address compliance with the CESA and NCCPA.

This Amended ASIP updates the 2003 ASIP environmental effects analyses on aquatic species based on the updated EWA Proposed Action described in Chapter 2. Effects on terrestrial species and NCCP habitats are still covered by the 2003 ASIP; therefore, they are not repeated here. The USFWS, NMFS, and CDFG may issue take authorization for covered species using information and analyses contained in the Amended ASIP and will use this ASIP to further MSCS recovery goals for these species.

[1] The ASIP for the existing EWA Program was finalized with the EIS/EIR in March of 2004.

1.2.1 Project Overview

The EWA program consists of two primary elements: implementing fish actions that protect species of concern and acquiring and managing assets to compensate for the supply effects of these actions. Project water pumping by the State Water Project (SWP) and Central Valley Water Project (CVP) varies by season and hydrologic year and can affect fish at times when fish are near the pumps or moving through the Delta. EWA agencies may take actions to protect fish species that may include reduction of pumping at either or both of the SWP and CVP export pumping plants. Reducing pumping can reduce water supply reliability for the SWP and CVP service areas, causing conflicts between fishery and water supply interests. A key feature of the EWA is use of water assets to replace supplies that are lost during pump reductions. The EWA assets can also provide other benefits such as augmenting instream flows and Delta outflows. Chapter 2 provides greater detail on the EWA program.

Under the EWA Proposed Action (the Flexible Purchase Alternative), the EWA agencies would conduct water purchases to provide a potentially higher level of fish protection in response to differing hydrologic conditions and to take advantage of water acquisition/storage possibilities throughout the CVP/SWP service areas. The EWA Proposed Action would allow the EWA agencies (see Section 1.2.2 Implementing Entities) to purchase up to 600,000 acre-feet of water based on the water acquisition strategies, conservation, and mitigation measures introduced in the 2004 and Supplemental EIS/EIRs. The EWA agencies would also use variable assets and temporary modifications in CVP/SWP operations to manage water assets in order to effectively respond to annual changes in hydrology and fish behavior in the Delta.

Allowing flexibility to acquire and manage EWA assets differently each year could increase the EWA agencies' capability to respond to varying hydrologic conditions. During dry years when export pumps have more capacity to convey EWA assets, the agencies could acquire quantities up to that capacity (potentially up to 500,000 acre-feet) upstream from the Delta for storage, pre-delivery, or delayed delivery actions within the Export Service Area. The EWA Proposed Action would allow the EWA agencies to respond to changes in existing operations and allow for additional upstream fish actions, such as instream flow enhancements.

Under the EWA Proposed Action, EWA agencies would acquire and manage water using stored reservoir surface water, groundwater substitution, groundwater purchase, or crop idling actions. These actions would be conducted following conservation measures identified to minimize their effects on the environment or water supplies. Although EWA actions may affect some covered species and their habitats, the effects will be temporary, and conservation measures will help to minimize or avoid the effects. Chapter 2 of this ASIP describes those measures applicable to the covered species and NCCP communities addressed in this ASIP.

1.2.2 Implementing Entities

Three Federal and two State agencies are involved in administering the EWA. The California Department of Water Resources (DWR) and the Bureau of Reclamation (Reclamation) are responsible for acquiring water assets and for storing and conveying the assets through use of the SWP and CVP[2] and other facilities. The State and Federal fishery agencies (USFWS, NMFS, and the CDFG), manage EWA assets to protect and restore fish. These three agencies are responsible for making recommendations to Reclamation and DWR for actions to be taken to protect fish populations. Reclamation and DWR are responsible for implementing operational changes based on the recommendations.

1.2.3 ASIP Contents

To fulfill the requirements of ESA Section 7 and California Fish and Game Code Sections 2835 and 2081, as applicable, the 2003 and Amended ASIP includes the following information pursuant to the November 2001 Guide to Regulatory Compliance for Implementing CALFED Actions (CALFED 2001).

- A detailed project description (Proposed Action; Chapter 2);
- The list of covered species and any other special-status species[3] that occur in the action area that require reinitiation of consultation based (Chapter 3);
- A discussion of essential habitat (Chapter 3);
- The analyses identifying the direct and indirect effects on covered species and other special-status species occurring in the action area (along with an analysis of effects on any designated critical habitat) likely to result from the Proposed Action, as well as actions related to and dependent on the EWA Proposed Action (Chapter 4);
- An analysis of cumulative effects on covered species and other special-status species occurring in the action area (along with an analysis of effects on any designated critical habitat);
- The conservation measures the EWA agencies will undertake to minimize adverse effects to species (Chapters 2 and 4), and as appropriate, measures to enhance the condition of covered species along with a discussion of:

[2] DWR operates the SWP by storing available water upstream from the Delta and moving it along with unstored natural flows through the Delta to serve agricultural and urban users in the Central Valley, Bay Area, central coast, and southern California. Reclamation operates the CVP in the same fashion, providing water to agricultural and urban users in the Central Valley.
[3] Please see the glossary for definitions of covered and special status species.

  - A plan to monitor the impacts and the implementation and effectiveness of these measures (Chapter 7),
  - The funding that will be made available to undertake the measures (Chapter 7), and
  - The procedures to address changed circumstances (Chapter 8 – not reprinted here; can be found in the 2003 ASIP);
- The measures the EWA agencies will undertake to provide commitments to cooperating landowners that EWA actions will not alter their land classification (Chapter 7);
- The alternative actions considered by the EWA agencies that would not result in adverse effects, and the reasons why such alternatives are not being utilized (Chapter 7); and,
- The additional measures USFWS, NMFS, and CDFG may require as necessary or appropriate for compliance with ESA, and CESA; and a description of how and to what extent the action or group of actions addressed in this ASIP will help the CALFED Program to achieve the MSCS's goals for the affected species (Chapter 4).

The 2003 and Amended ASIPs are based in large part on biological data, proposed EWA actions, and the impact analysis and conservation measures in the MSCS. The 2003 and Amended ASIPs were developed to be consistent with the species goals, prescriptions, and conservation measures in the MSCS for covered species affected by the Proposed Action. Conservation measures developed for the MSCS have been reviewed for use in minimizing or eliminating the effects of EWA actions. The 2003 and Amended ASIPs include additional conservation measures to address actions not considered in the MSCS relative to EWA water acquisition and management effects.

1.3 ASIP Process

The relationship of the ESA, CESA and State NCCPA is illustrated on Figure 1-1. Because neither the programmatic BOs nor the programmatic NCCPA determination for the CALFED Program authorized incidental take of MSCS covered species, individual consultation documents, or ASIPs, are required for each project. Take authorization for entities implementing CALFED Program actions will follow a simplified compliance process that tiers from the MSCS and programmatic determinations. Entities implementing actions that may affect covered species are required to prepare an ASIP for each action or group of actions. An ASIP will be based on and tier from the data, information, analyses,

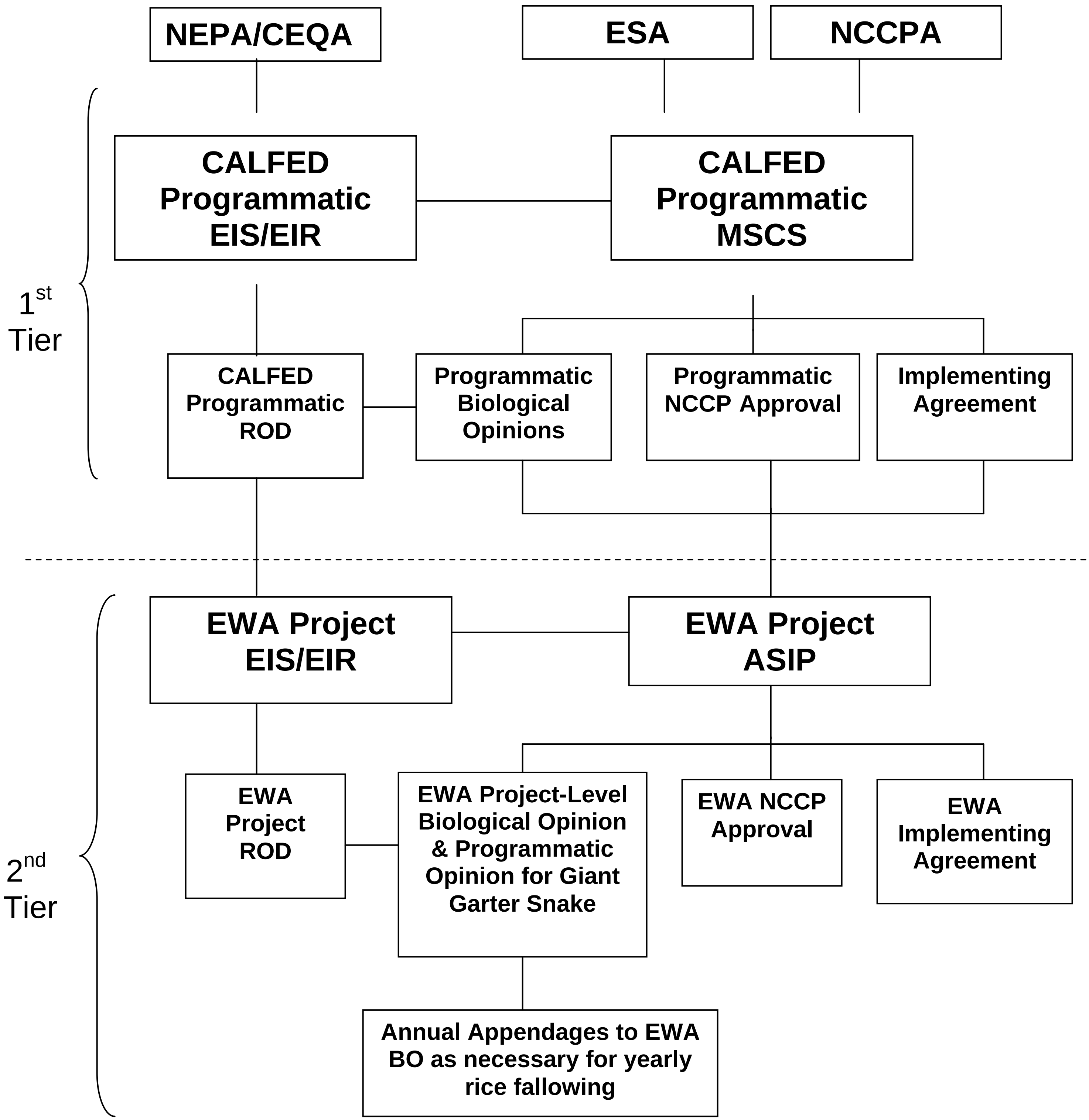

Figure 1-1. Relationships of CALFED Programmatic and EWA Compliance with NEPA/CEQA and ESA/NCCPA

and conservation measures in the MSCS. The implementing entity will coordinate development of an ASIP with USFWS, NMFS, and CDFG to ensure that an ASIP incorporates appropriate conservation measures for the proposed CALFED Program action(s), consistent with the MSCS.

The CALFED Program MSCS evaluates 244 species and 20 natural communities. Included within the MSCS are species identified by USFWS, NMFS, and CDFG that are covered under the USFWS and NMFS CALFED programmatic BOs and CDFG's NCCP determination. An ASIP is prepared for ESA- and NCCP-covered species potentially affected by a CALFED Program project. Typically, as in the case with the 2003 and Amended ASIPs, the species evaluated are a subset of the overall 244 species included in the MSCS.

1.3.1 Informal and Formal Consultation Processes

ASIPs are developed for individual CALFED Program actions or groups of actions when enough detailed information is available about the actions to analyze fully their effects on covered species and habitats. Informal consultation is often conducted in coordination with the development of an ASIP as with the 2003 ASIP. Informal consultation was not conducted as part of this Amended ASIP process; however, agency representatives that are part of the Environmental Water Account Team (EWAT) did hold a series of meetings on several new issues associated with the EWA. These included the pelagic organism decline and the availability of new hydrologic modeling.

Once complete, an ASIP will be submitted by the EWA agencies to USFWS, NMFS, and CDFG to initiate formal consultation. USFWS and NMFS will review an ASIP for compliance with ESA, under Section 7. NMFS will also review an ASIP for compliance with the Magnuson-Stevens Fishery Conservation Act (MSFCA). The conclusion of the formal consultation process is for USFWS and NMFS to prepare BOs on the species that the action is likely to adversely affect. As part of these BOs, USFWS and NMFS may authorize incidental take of endangered and threatened species.

CDFG will determine whether an ASIP complies with the NCCPA and CESA. If an ASIP is in compliance with the NCCPA, CDFG will prepare an NCCPA approval for CDFG and DWR actions and issue supporting findings. As part of these findings, CDFG may authorize take of covered species, including endangered and threatened species, whose conservation and management are provided for in an approved NCCP. Because the NCCPA allows CDFG to authorize incidental take of endangered and threatened species, an NCCP also may be used to comply with CESA (California Fish and Game Code Sections 2081[b] and 2835).

1.3.2 Current Management Direction

The EWA program, 2003 ASIP, and Amended ASIP have been developed against a backdrop of existing and ongoing Federal, State, and local efforts intended to conserve covered and other sensitive species within the EWA Action Area. Implementation of the EWA Proposed Action would be consistent with existing wildlife protection and recovery programs.

Consultation with USFWS, NMFS, and CDFG regarding effects of EWA actions on special-status species is based on the ESA policy for each agency and existing BOs and NCCPA guidance. The opinions and guidance documents used to support the development of the 2003 and Amended ASIPs are listed below:

- The CALFED Programmatic EIS/EIR;
- The CALFED Multi-Species Conservation Strategy;
- The 2005 USFWS Biological Opinion on the Long-Term CVP/SWP Operations and Criteria Plan;
- The 2004 NMFS Biological Opinion on the CVP/SWP Long-Term Operations and Criteria Plan;
- The 1993 NMFS Biological Opinion for CVP/SWP operations effects on Sacramento River winter-run Chinook salmon ESU (as amended August 2 1993, October 6 1993, May 17 1995, August 8 1995, and December 30 2004);
- USFWS' Programmatic BO on the CALFED Bay-Delta Program dated August 28, 2000;
- NMFS' CALFED Bay-Delta Program Programmatic BO dated August 28, 2000;
- CDFG's NCCPA Approval of the CALFED Bay-Delta Program Multi-Species Conservation Strategy dated August 28, 2000;
- The EWA ASIP (2003 ASIP) dated October 2003;
- NMFS' Supplemental BO on the Long-Term CVP/SWP Operation and Criteria Plan dated February 27, 2004;
- NMFS' Central Valley Technical Recovery Team Population Structure of Threatened and Endangered Chinook Salmon ESUs in California's Central Valley Basin dated April 2004;

- USFWS' Early Section 7 Endangered Species Consultation for the CVP/SWP coordinated operations and the Operation Criteria and Plan dated February 16, 2005; and,

- NMFS' Central Valley Technical Recovery Team Historical Population Structure of Central Valley Steelhead and its Alternation by Dams dated February 2006.

1.3.3 Consultation to Date

Table 1-1 below lists consultation activities on the Environmental Water Account Program to date.

Table 1-1. Consultation Activities

Date	Activity
August 2000	USFWS and NMFS issue Programmatic Biological Opinions on the CALFED Program including the Environmental Water Account.
April 2002	The 5 EWA implementing agencies request initiation of informal consultation with USFWS, NMFS, and CDFG on the existing EWA Program.
October 2003	Reclamation requests initiation of formal consultation or concurrence (as applicable) on behalf of the 5 EWA implementing agencies with USFWS, NMFS, and CDFG on the existing EWA Program.
December 2003	NMFS issues a letter of concurrence for the existing EWA Program.
January 2004	USFWS issues a Programmatic Biological Opinion for the giant garter snake on the existing EWA Program, and concurred with the Not Likely to Adversely Affect determination for delta smelt and its critical habitat.

EWA agencies have held meetings with USFWS, NMFS, and CDFG throughout the development of the 2003 EWA Proposed Action, the 2003 ASIP, and the development of the 2007 EWA Proposed Action. At these meetings, issues pertaining to development of the Amended ASIP were discussed by representatives from Reclamation, DWR, USFWS, NMFS, CDFG, and other CALFED agencies.

1.3.4 Compliance with Federal Endangered Species Act

USFWS and NMFS share responsibility for administering ESA. NMFS has primary responsibility for implementing ESA with respect to marine fishes and mammals, including migratory or anadromous fish species such as salmon and steelhead. USFWS has primary responsibility for other species.

The purpose of the ESA Section 7(a)(2) consultation requirement is to ensure that any action authorized, funded, or carried out by any Federal agency is not likely to jeopardize the continued existence of any covered species or result in the destruction or adverse modification of critical habitat. Typically, a biological assessment is prepared to analyze effects on listed and proposed species and designated and proposed critical habitat in order to comply with ESA. This ASIP is intended to act as a biological assessment and fulfill the requirements of the EWA pursuant to the ESA as amended.

1.3.5 Compliance with Magnuson-Stevens Fishery Conservation and Management Act

The MSFCMA, as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267), established procedures designed to identify, conserve, and enhance EFH. Federal agencies are required to consult with NMFS on all actions that may adversely affect EFH (MSFCMA Section 305(b)(2)). The EFH mandate applies to all species managed under a Federal Fishery Management Plan (FMP). In California there are three FMPs covering Pacific salmon, coastal pelagic species, and groundfish. NMFS, under Section 305(b)(1) of the MSFCMA, is required to provide EFH conservation and enhancement recommendations to Federal and State agencies for actions that adversely affect EFH.

The objective of an EFH assessment is to determine whether the proposed action(s) “may adversely affect” designated EFH for relevant commercially, federally managed fisheries species within the Action Area. It also describes conservation measures proposed to avoid, minimize or otherwise offset potential adverse effects to designated EFH resulting from the proposed action.

This ASIP will meet all the compliance requirements that have been identified for consulting with NMFS on effects to EFH, as outlined in the MSFCMA.

1.3.6 Compliance with California Endangered Species Act and the Natural Community Conservation Planning Act

The CESA (Fish and Game Code Sections 2050 to 2097) is similar to the ESA. California’s Fish and Game Commission is responsible for maintaining lists of threatened and endangered species under the CESA. CESA prohibits the “take” of listed and candidate (petitioned to be listed) species. “Take” under California law means to “hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch capture, or kill.” (California Fish and Game Code, Section 86.) Because CDFG may authorize incidental take of listed species pursuant to a CDFG approved NCCP, State EWA agencies will not require a separate incidental take permit pursuant to CESA for ASIP covered species if the EWA actions adhere to MSCS goals and CDFG’s NCCP Approval.

The NCCPA (California Fish and Game Code, Section 2800, et seq.) was enacted to form a basis for broad-based planning to provide for effective protection and conservation of the State’s wildlife heritage, while continuing to allow appropriate development and growth. State of California NCCP General Process Guidelines define an NCCP as “…a plan for the conservation of natural communities that takes an ecosystem approach and encourages cooperation between private and governmental interests. The plan identifies and provides for the regional or area-wide protection and perpetuation of plants, animals, and their habitats, while allowing compatible land use and economic activity. An NCCP seeks to anticipate and prevent the controversies caused by species' listings by focusing on the long-term stability of natural communities" (CDFG 2002). The purpose of natural community conservation planning is to sustain and restore those species and their habitat identified by CDFG that are necessary to maintain the continued viability of biological communities impacted by human changes to the landscape. A NCCP identifies and provides for those measures necessary to conserve and manage natural biological diversity within the plan area while allowing compatible use of the land. CDFG may authorize the take of any identified species, including listed and non-listed species, pursuant to Section 2835 of the NCCPA, if the conservation and management of such species is provided for in an NCCP approved by CDFG.

The CALFED Programmatic Multi-Species Conservation Strategy was approved by CDFG as a program-level NCCP. The MSCS' project-level compliance process centers on a multi-purpose project-level environmental document called an "ASIP," which is intended to provide one format for all information necessary to initiate project-level compliance with the ESA and the NCCPA. State EWA agencies will comply with the NCCPA through an ASIP, which contains all the necessary components of a project-level NCCP for the EWA study area.

On February 2, 2002, Governor Davis signed SB 107, which completely repealed and replaced the NCCPA with a new NCCPA. SB 107 became effective on January 1, 2003. However, in accordance with Section 2830 (c) of SB 107, the MSCS will remain in place as an approved NCCP, and CDFG may authorize take of Covered Species pursuant to the MSCS and CDFG's NCCP Approval.

The 2003 ASIP serves as the project-specific NCCP for EWA water acquisition and management actions. The document meets all the compliance requirements that have been identified for (a) preparing an NCCP and (b) other requirements associated with CESA consultation. The 2003 and Amended ASIPs will fulfill the requirements of the California Fish and Game Code Sections 2835 and 2081. Additionally, they will incorporate appropriate conservation measures relevant to the EWA proposed action. This approach is consistent with the NCCP conservation strategy for the conservation of natural communities and related species before these species reach a point for having to become listed.

1.4 Relationship to CALFED Program and CALFED Documents

1.4.1 CALFED Program

A more detailed discussion of the CALFED Program can be found in the 2003 ASIP Section 1.3.1. The text below updates the discussion of CALFED's Ecosystem Restoration Program (ERP).

A component of the CALFED Program is the Ecosystem ERP. The goal of the ERP is to improve and increase aquatic and terrestrial habitats and improve ecological functions in the Bay-Delta to support sustainable populations of diverse and valuable plant and animal species. In addition, the ERP, along with the Water Management Strategy (WMS), is designed to achieve or contribute to the recovery of covered and at-risk species found in the Bay-Delta and, thus, achieve goals in the MSCS. Improvements in ecosystem health will reduce the conflict between environmental water uses and other beneficial uses and allow more flexibility in water management decisions. EWA agencies are coordinating EWA actions with the ERP to ensure that EWA is consistent with the ERP goals.

Representative ERP actions identified in the CALFED Programmatic ROD include:

- Protecting, restoring, and managing diverse habitat types representative of the Bay-Delta and its watershed;
- Acquiring water from sources throughout the Bay-Delta's watershed to increase flows and improve habitat conditions for fish protection and recovery;
- Restoring critical instream and channel-forming flows in Bay-Delta tributaries;
- Improving Delta outflow during key periods;
- Reconnecting Bay-Delta tributaries with their floodplains through the construction of setback levees, the acquisition of easements, and the construction and management of flood bypasses for both habitat restoration and flood protection;
- Developing assessment, prevention, and control programs for invasive species;
- Restoring aspects of the sediment regime by relocating instream and floodplain gravel mining by artificially introducing gravels trapped by dams; modifying or eliminating fish passage barriers, including the

removal of some dams; constructing fish ladders; and constructing fish screens that use the best available technology; and,

- Targeting research to provide information that is needed to define problems sufficiently and to design and prioritize restoration actions.

"Since 1995, the CALFED ERP has funded more than 300 ecosystem restoration projects. The ERP invested a total of $335 million in ecosystem restoration projects from 1995 through 2001. Terrestrial and aquatic habitat protection and restoration activities account for approximately 51% ($172 million) of that investment. The ERP also invested heavily (27%, $90 million) in improving fish passage (both upstream and downstream) through the design and construction of new fish screens and ladders and the removal of several dams. The Sacramento River Region and the Delta and East Side Tributaries Region jointly account for approximately 60% of the ERP investments. Projects are distributed relatively evenly among the other two CALFED regions (Bay, San Joaquin River), and projects located in more than one region (Multi-Region).

Through the end of 2001, the ERP had funded proposals for approximately:

- 58,000 acres of habitat proposed for protection, including 12,000 acres dedicated to wildlife-friendly agriculture and 16,000 acres of floodplain;
- 39,000 acres of habitat proposed for restoration, including 9,500 acres of shallow water tidal and marsh habitat;
- 63 miles of instream habitat proposed for protection and/or restoration;
- 93 miles of riparian corridor proposed for protection and/or restoration;
- 75 fish screens, accounting for an additional 2,700 cubic feet per second (cfs) of diversion capacity;
- 16 fish ladders and 10 dam removals to provide better upstream passage;
- 31 projects involving analysis of environmental water and sediment quality;
- 18 projects intended to specifically address nonnative invasive species; and
- 75 projects supporting local watershed stewardship and environmental education.

The vast majority of ERP projects address Goal 1 of the Ecosystem Restoration Program Plan (ERPP), which focuses on At-Risk Species. A large percentage of the projects also address Goal 2 (Ecological Processes), and Goal 4 (Habitats). Much smaller percentages of the funded projects address Goal 3 (Harvestable Species) and Goal 5 (Nonnative Invasive Species) (16% and 9%, respectively)" (Kleinschmidt and JSA 2003).

A mid-Stage 1 assessment of progress was completed in July 2004. A total of 416 ERP contracts, 83 Watershed Program contracts, 68 Central Valley Project Improvement Act contracts, and an efficacy review of the EWA were considered as part of the assessment. "Highlights from the assessment include:

- Nearly 80 percent of the 119 milestones provided for in CALFED's Stage 1 are on or ahead of schedule.
- More than 11,000 acres of wildlife friendly agriculture was protected in the Delta, meeting the Stage 1 target for the region.
- CALFED-funded cooperative projects are contributing to the restoration and protection of 7,000 acres of wetlands in San Pablo Bay and Suisun Marsh exceeding the Stage 1 target for tidal marsh restoration in San Pablo Bay.
- More than 50,000 acres of seasonal wetlands in the Sacramento River Region are being enhanced, protected, or restored.
- About 500 acres of fresh emergent wetland in the San Joaquin River Region are being enhanced, protected, or restored.
- Most of the environmental water quality milestones are being addressed by the 51 projects funded by the ERP; approximately 40 percent of those projects affect multiple regions." (CALFED 2005)

1.5 Species Addressed in this ASIP

To comply with ESA, CESA, and NCCP requirements, the EWA agencies must identify a list of special-status species to be evaluated in an ASIP. Special-status species include those species that fit into at least one of the following categories:

- MSCS covered species identified in the programmatic BOs and NCCP approval for the CALFED Program;
- Listed as threatened or endangered under ESA;

- Proposed for listing under ESA;
- Candidates for listing under ESA;
- Has had EFH identified by NMFS;
- Listed as threatened or endangered under CESA;
- Candidates for listing under CESA;
- Plants listed as rare under the California Native Plant Protection Act;
- Fully protected species or specified birds under various sections of the California Fish and Game Code;
- California species of special concern (CSC);
- Plants included on California Native Plant Society (CNPS) List 1A, 1B, 2, or 3; or
- Other native species of concern to CALFED Program.

A detailed description of the process used to identify the species that are covered in the 2003 ASIP and this Amended ASIP is described in the following subsection.

1.5.1 Identification of Species Analyzed in Detail in the 2003 and Amended ASIPs

Pursuant to Section 7(c) of ESA, species lists were requested from USFWS and NMFS regarding any species listed or proposed for listing as threatened or endangered, including designated or proposed critical habitats under ESA and CESA, that may be present in the EWA Action Area. Additionally, a list of special-status species known to occur or with the potential to occur within the Action Area was compiled from the California Natural Diversity Database (CNDDB) and California Native Plant Society's Inventory of Rare and Endangered Plants. More than 400 special-status fish, wildlife, and plant species considered in the MSCS were combined with the results from the species request lists and the database search to generate a preliminary species list. In the 2003 ASIP Appendix A, Table A-1 provides the list of species considered for incorporation into the 2003 and Amended ASIPs.

Initial screening of the overall species list eliminated from further consideration those species that only inhabited areas outside areas where EWA actions would take place. The second level of screening was based on species that occasionally visited (their life cycles are not dependent on) habitats affected by EWA actions. These included mostly migratory species that may be observed infrequently in areas where EWA actions could occur. Details regarding the life histories and status of the species that may be observed within the EWA Action Area, and the rationales why they are not covered in the 2003 and Amended ASIPs, are presented in 2003 ASIP Appendix A. In the 2003 ASIP, Table 1-1 lists the species analyzed in detail in that document and considered for analysis in this Amended ASIP.

The geographic area of the EWA has not changed since the 2003 ASIP; therefore, only those species that were newly listed since the 2003 ASIP or that would be affected by the Proposed Action or would benefit from reanalysis based upon new hydrologic modeling were identified for analysis in this Amended ASIP. These species are listed in Table 1-2.

Table 1-2. Species Addressed in the Amended ASIP

Species	Scientific Name	Status
Central Valley Fall/Late Fall Run Chinook Salmon	*Oncorhynchus tshawytscha*	Federal and State species of concern
Sacramento River Winter Run Chinook Salmon	*Oncorhynchus tshawytscha*	Federal and State listed endangered species
Central Valley Spring Run Chinook Salmon	*Oncorhynchus tshawytscha*	Federal and State listed threatened species
Central Valley Steelhead	*Oncorhynchus mykiss*	Federal threatened species
Delta Smelt	*Hypomesus transpacificus*	Federal and State threatened species
Green Sturgeon	*Acipsenser medirostirs*	Federal threatened and State species of concern

1.5.2 Critical Habitat

ESA-designated critical habitat for four covered species is present in the EWA Action Area. The entire legal Delta as defined by California Water Code of 1969 and portions of Suisun Bay and Suisun Marsh are designated critical habitat for the delta smelt. Areas within the Delta, the upstream EWA Action Area, and portions of the Sacramento River and its tributaries are also designated as critical habitat for the Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook, and Central Valley steelhead. Pursuant to ESA requirements, the 2003 and Amended ASIPs also analyze potential effects of EWA actions on designated critical habitats in the EWA Action Area.

1.5.3 Essential Fish Habitat (EFH)

NMFS has determined that there are no species requiring Essential Fish Habitat (EFH) consultation under the Magnuson-Stevens Fishery Conservation and Management Act (MSA) related to the EWA Program (NMFS 2004).

1.6 NCCP Habitats

A total of 20 natural communities were analyzed on a broad, programmatic basis in the MSCS – 18 habitats and 2 ecologically based fish groups. The term “NCCP communities” refers to both habitats and fish groups. Fifteen of the 20 habitats were evaluated in the 2003 ASIP. Affects on these habitats can be found in the 2003 ASIP and are not updated here.

1.7 Organization of this ASIP

This ASIP is a combined Federal ESA and California NCCPA compliance document that amends the 2003 ASIP. To address the requirements of both acts and update the 2003 ASIP, this Amended ASIP is organized as follows:

Chapter 1, “Introduction” provides an introduction to the project and the ASIP process, describes the relationship of the ASIP to CALFED Program, lists the species and habitats to be addressed in this document, and outlines the organization of the document.

Chapter 2, “Description of the Proposed Action” describes the EWA Action Area and EWA Proposed Action.

Chapter 3, “Environmental Basis of Comparison – Special Status Species Accounts and Status in EWA Action Area” provides the species accounts for ASIP covered species analyzed as part of the Amended ASIP.

Chapter 4, “Species Assessment Methods and Impact Analyses” provides an analysis of the direct, indirect, and cumulative effects on covered species within the Action Area likely to result from implementation of the updated EWA Proposed Action, as well as actions related to and dependent on that action. This analysis also includes a discussion of the conservation measures to avoid, minimize, and compensate for such effects, as appropriate.

Chapter 5, “Environmental Basis of Comparison – NCCP Community Descriptions” are not represented in the Amended ASIP and can be found in the 2003 ASIP.

Chapter 6, “Effects of the Proposed Action on NCCP Communities inside the Action Area” is not presented in the Amended ASIP and can be found in the 2003 ASIP.

Chapter 7, “Monitoring, Adaptive Management, and other Disclosures” assesses the cumulative effects of the EWA Proposed Action. Chapter 7 also outlines a plan to monitor the effects and the implementation and effectiveness of the conservation measures; discusses the funding sources available and that will be provided for implementation of the EWA Proposed Action; identifies measures the implementing entity will undertake to provide commitments to cooperating landowners; and discusses the alternatives that were considered that would not result in take and the reasons why such alternatives are not being utilized.

Chapter 8, "Changed Circumstances" is not represented in the Amended ASIP and can be found in the 2003 ASIP.

Chapter 9, "Effects Determination Conclusion" summarizes the potential cumulative effects with implementation of the EWA Proposed Action.

Appendix A has not been repeated in this Amended ASIP.

Appendix B has not been repeated in this Amended ASIP.

Appendix C has not been repeated in this Amended ASIP.

1.8 References

CALFED Bay-Delta Authority (CALFED). 2001. Guide to Regulatory Compliance for Implementing CALFED Actions.

CALFED. 2005. Ecosystem Restoration Multi-Year Program Plan (Years 6-9) and Year 6 Annotated Budget. July.

California Department of Fish and Game (CDFG). 2002. Natural Community Conservation Planning General Process Guidelines. Available at: http://www.dfg.ca.gov/nccp/genproc2.htm

California Fish and Game Code Section 86. Available at: http://www.leginfo.ca.gov/cgi-bin/displaycode?section=fgc&group=00001-01000&file=1-89.

California Fish and Game Code Section 2800-2840. Available at http://www.dfg.ca.gov/nccp/ displaycode.html

Code Federal Regulations (CFR). Title 50--Wildlife and Fisheries. Chapter IV – Joint Regulations (United States Fish and Wildlife Service, Department of the Interior and National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Department of Commerce). Endangered Species Committee Regulations. Part 402.16 – Interagency Cooperation – Endangered Species Act of 1973, as amended. Reinitiation of Formal Consultation.

Kleinschmidt and Jones and Stokes Associates, Inc. 2003. Ecosystem Restoration Program Project Evaluation Phase 2 Report.

Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) Section 305(b)(2). Title III National Fishery Management Program. Other Requirements and Authority.

National Marine Fisheries Service (NMFS). 2004. Biological Opinion on long-term Central Valley Project and State Water Project Operations Criteria and Plan. Southwest Region. October 2004.

This page is intentionally left blank

Chapter 2
Description of the EWA Proposed Action

This chapter includes an overview of the EWA program and a description of the Proposed Action. Portions of the Proposed Action from the 2003 ASIP are repeated and/or summarized below for the reader's convenience. In addition, certain sections in this chapter reflect minor changes and updates to the EWA Proposed Action that was presented in the 2003 ASIP. As described below, these changes are minor and/or of a nature that do not warrant revising the 2003 ASIP analysis (i.e., would not result in materially different conclusions) based on these changes.

- Regulatory Commitments (see Section 2.3.8). The regulatory commitments described in the 2003 ASIP were agreed to by the CALFED agencies through 2007; these commitments would not be in place past 2007 and are therefore not included in this Amended ASIP. The lack of regulatory commitments reflects a change in the regulatory environment, but would not affect how the EWA agencies would operate the EWA or the impacts caused by the EWA program.

- BOs (see Section 2.3). Section 2.3 includes flow-related actions to protect fish; however, it does not include two BOs (1993 NMFS BO for winter-run Chinook salmon and the 1995 USFWS BO for delta smelt) included in the 2003 ASIP. These BOs have been deleted from this Amended ASIP because they were replaced by the 2004 NMFS BO and the 2005 USFWS BO on the long-term operations of the CVP and SWP. DWR and Reclamation have reinitiated consultation under the Federal ESA for these BOs. As Section 2.3 describes, it is reasonable to assume that these new BOs would include some limited fish actions, albeit fewer than the fish actions contained in the EWA program. This assumption is very similar to what was contained in the BOs governing the 2003 ASIP; therefore, the different BOs will not affect the analysis of the impacts of the EWA program.

- January through March Fish Actions (see Section 2.4.2.1.5). This section is added to the Amended ASIP because it includes additional detail regarding how the EWA agencies would take fish actions in January, February, and March. The type of fish action (export reduction) is the same as described in the 2003 ASIP; however, the logic for the timing and duration of the reduction are based on new scientific information. The 2003 ASIP described and evaluated pump reductions in January – March, and the new logic falls within the patterns described in the 2003 ASIP. Therefore, the new text in Section

2.4.2.1.5, which would provide the EWA agencies with an updated basis for taking fish actions, would not result in a substantive change to the text included in the 2003 ASIP.

- EWA Participants (see Section 2.4.3). Section 2.4.3 lists participants that were included in the 2003 ASIP, but are not included in this Amended ASIP. The 2003 ASIP described transfers both locally (effects on the specific agency from implementing the transfer), and regionally (effects on the region from many agencies implementing transfers). Deletion of an agency would eliminate the local effects, and would not change the overall proposed action regionally or the analysis provided in the 2003 ASIP because the majority of the participants (17 out of 19) would still be involved in the EWA program. No new participants have been added to this Amended ASIP relative to the 2003 ASIP.

- Pumping to Decrease Debt (see Section 2.4.3.2.5). Pumping to decrease debt was not specifically described in the 2003 ASIP although its action was included in the EWA program operations and analysis. (The action was considered part of the Joint Point of Diversion because that was one tool the EWA agencies used to decrease debt.) It is included separately in this Amended ASIP to provide additional information regarding EWA operations. Because pumping to decrease debt was included in the analysis of the 2003 ASIP, including it in the proposed action of this Amended ASIP would not result in any different analysis conclusions.

2.1 EWA Action Area

The EWA Action Area encompasses a portion of the overall CALFED Study Area (See Figure 2-1). The Action Area for the 2003 and Amended ASIPs includes all areas affected directly or indirectly by EWA water asset acquisition, storage, conveyance, transfer, or release activities performed to support fish actions (as described later in this Chapter). This includes the majority of the Sacramento and San Joaquin Valleys, south San Francisco Bay area (Santa Clara County), the south central California coast, and southern California service area. No new facilities would be constructed and no existing facilities would be altered for the management of EWA water assets. EWA agencies would use existing facilities of the CVP, SWP, and non-Project entities to manage the assets.

For purposes of effects analysis in the 2003 and Amended ASIPs, the EWA Action Area has been divided into three primary regions and sub-regions based on the types of actions proposed in each region. The three regions are Upstream from the Delta, the Delta, and the Export Service Area. The sub-regions of the

Export Service Area include the northern San Joaquin Valley, the Tulare Basin in southern San Joaquin Valley, and southern California. A more detailed description of each region can be found in the 2003 ASIP.

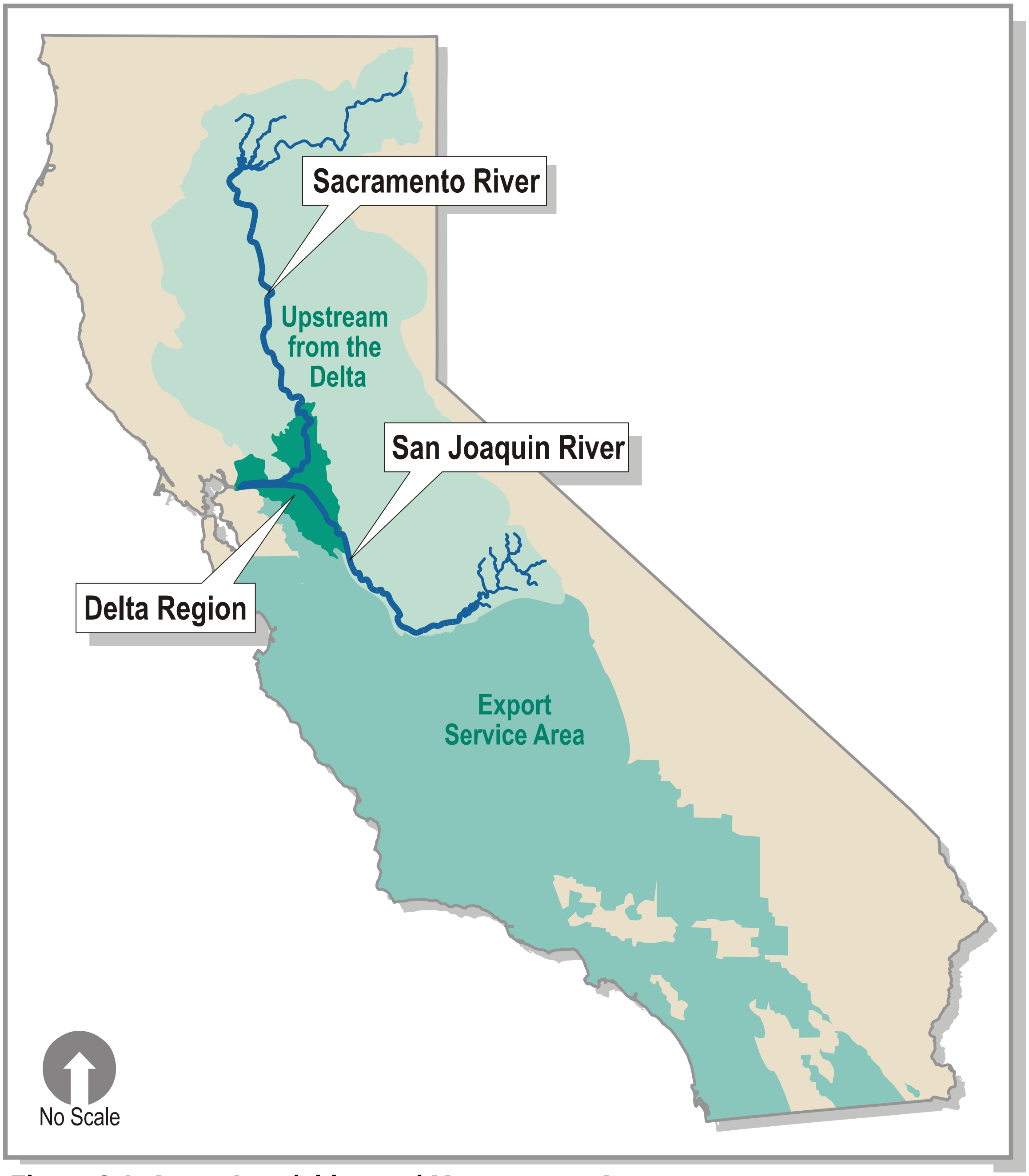

Figure 2-1. Asset Acquisition and Management Areas

The fish species inhabiting each of the regions, rivers, and reservoirs, and their relationship to the regional setting are described in Chapter 3. Descriptions of terrestrial species and NCCP habitats and their relationships to each regional setting were presented in Chapter 5 of the 2003 ASIP and not reiterated here.

2.2 EWA Program Overview

The EWA is a cooperative management program; the purpose of the EWA program is to provide protection to at-risk native fish species of the Bay-Delta estuary through environmentally beneficial changes in SWP/CVP operations at no uncompensated water cost to the Projects' water users. This approach to fish protection involves temporary modifications of Project operations to benefit fish and the acquisition of alternative sources of project water supply, called the "EWA assets," which the EWA agencies use to replace the regular Project water supply lost by pumping reductions.

2.3 Baseline Level of Fishery Protection

This section presents the existing environmental regulation, biological opinions, and SWP/CVP operational parameters currently being implemented to protect at-risk native fish species in the Delta. These items all represent the "baseline level of fishery protection" that the EWA program builds upon in addressing the EWA goal of providing protection to the fish of the Bay-Delta estuary through environmentally beneficial changes in SWP/CVP operations at no uncompensated water cost to the Projects' water users.

2.3.1 Overview

The CALFED ROD identified baseline level of fishery protection requirements for Project operations. Existing regulatory programs established these requirements prior to implementation of the CALFED ROD, and these programs alter Project operations in ways that improve Delta water conditions for fish. The baseline level of fishery protection includes the environmental requirements identified below, updated to include the September 2002 BO on Spring-run Chinook and Steelhead, and includes the following environmental requirements:

- 1995 Delta Water Quality Control Plan (1995 Delta WQCP) and SWRCB's Decision 1641;
- Vernalis Adaptive Management Plan (VAMP);

- Implementation of Sections 3406(b)(1-3) of the Central Valley Project Improvement Act (CVPIA) pursuant to USDOI policy dated May 9, 2003; and
- Level 2[1] Refuge Water Supplies.

The 2003 ASIP included the governing biological opinions at that time (1993 NMFS BO for winter-run Chinook salmon and the 1995 USFWS BO for delta smelt), but these biological opinions are now outdated. Reclamation and DWR have reinitiated consultation on the current biological opinions, and the actions to protect fish in these new biological opinions are not yet known. The EWA is included in the project description of the current BOs, but may or may not be carried forward into the project description for the reinitiated consultation. If the EWA agencies choose not to go ahead with the EWA program, they would need to have biological opinions that did not include the EWA program. The exact contents of these biological opinions are speculative, but it is reasonable to assume that they would include some fish actions like those discussed below.

To implement these fish protection requirements, fishery and Project agencies could take several actions described in the sections below.

2.3.2 Delta Export Pumping Reductions

On going pumping water through the Jones and Banks pumping plants alters Delta hydrodynamics, changing conditions for fish rearing and migration. Fish mortality at the pumps can result directly from entrainment[2] through fish screens, impingement[3], losses to predators, and handling of captured fish in the salvage process. The operation of the pumping plants may also have indirect effects on fish. Altered net flow patterns sometimes changes migratory patterns and increases the likelihood of predation. Pumping reductions help to reduce these effects on Delta hydrodynamics and reduce entrainment of fish at the pumping facilities.

Under the baseline level of fishery protection inexistence at the time of the CALFED ROD, Project Agencies would implement pumping reductions when the fish protection requirements mandated the reduction. Table 2-1 shows the times that these protections are likely to require pump reductions and the reasons that reductions help fish.

---

[1] The Reclamation Report on Refuge Water Supply Investigations (March 1989) defined four levels of refuge water supplies: existing firm water supply (Level 1), current average annual water deliveries (Level 2), full use of existing development (Level 3), and permission for full habitat development (Level 4). CVPIA Section 3406(d) committed to providing firm water through long-term contractual agreements for Level 2 refuges.

[2] "Entrainment" occurs when fish are drawn into the pumps, which can injure fish or place them into unsuitable habitat. (Reclamation 2003).

[3] "Impingement" occurs when fish are trapped against the outer surface of a fish screen. (Environmental Protection Agency 2001)

Table 2-1. Pump Reductions Under the Existing Baseline Level of Fishery Protection

Timeframe	Benefiting Fish[4]	Reason	Regulatory Mechanism
December – January	Juvenile salmonids	Protect outmigrating juvenile salmonids	Biological opinion
	Adult smelt[5]	Protect upmigrating adult smelt	Biological opinion
February – March	Juvenile salmonids	Protect outmigrating juvenile salmonids	Biological opinion
	Adult smelt	Protect upmigrating adult smelt	Biological opinion
April – May 31 days	Salmon smolts	Determine how export pumping affects survival and passage of salmon smolts through the Delta	D-1641 (VAMP) (SWP may not follow if it were not reimbursed)
April - June	Juvenile smelt	Protect juvenile smelt near the pumps	Biological opinion

Under the baseline level of fishery protection, the Projects would attempt to recover the water from reduced pumping through a variety of actions. The CVP would use a portion of the 800,000 acre-feet consistent with the May 9, 2003 Policy on Implementation of CVPIA 3406(b)(2) to account for the pumping reductions. Both the SWP and CVP would use operational flexibility to recover additional water. These sources are not likely to be sufficient to compensate for all pump reductions.

2.3.3 Delta Cross Channel Gates Closure

The Delta Cross Channel (DCC), near the town of Walnut Grove, diverts Sacramento River water eastward to the Mokelumne River system where it more directly affects flows across the central Delta to the Project pumps. Movement of water in a southerly direction through the Delta is not a natural hydrological process and can confuse migrating salmon that are attempting to follow stream flows. Avoiding this effect is particularly important during the winter, when the winter-run Chinook salmon, a Federal- and State-listed endangered species, is migrating upstream to spawn. (The late fall-runs are also migrating at this time, classified as candidate species.) DCC gate closure during the winter also helps reduce the chance that emigrating spring-run and winter-run Chinook salmon and steelhead smolts, might travel through the central Delta and swim toward the pumps instead of taking their natural route to the Bay.

Closing the DCC gates increases the likelihood that juvenile spring-run and winter-run Chinook salmon and steelhead smolts remain in the mainstem Sacramento River, improving their likelihood of successful outmigration

[4] "Benefiting Fish" only include the fish that require pumping reductions through a regulatory mechanism. Incidental benefits to other fish would also result from some reductions.
[5] Effects on adult delta smelt at the pumps have not yet exceeded allowable take limits specified in the 1995 biological opinion, but the effects could trigger a reduction at the pumps.

through the western Delta and San Francisco Bay. The closure, however, also reduces the contribution of the Sacramento River to the central Delta, which may aggravate salinity intrusion. With the DCC closed, for the same exports, more flow comes from the western Delta, which is closer to the bay and has lower water quality. The Project Agencies may reduce export pumping in response to the changes in flow direction.

The following factors dictate DCC gate operations:

- Reclamation standing operating procedures call for gate closure when flow on the Sacramento River reaches 20,000 to 25,000 cubic feet per second (cfs).

- State Water Resources Control Board Decision 1641 requires the following operations of the DCC gates:

    - From November 1 through January 31 the gates will be closed for up to 45 days as requested by USFWS, NMFS, and CDFG. These closures are determined as follows:

        - If the Knight’s Landing catch index (KLCI) is > 5 and ≤ 10 salmon, the DCC gates will be closed for 4 days within 24 hours. If after 4 days the KLCI still exceeds 5, the gates will remain closed for another 4 days.

        - If the KLCI is > 10 salmon, the DCC gates are to be closed until the KLCI is ≤ 5.

    - The gates will be closed continuously from February 1 through May 20.

    - From May 21 through June 15 the gates will be closed for a total of 14 days, again as requested by USFWS, NMFS, and CDFG.

2.3.4 Increasing Instream Flows

Increasing flows year-round in upstream river reaches would improve habitat conditions for anadromous and resident fish populations. Reclamation and USFWS may use CVPIA §3406(b)(2) supplies to meet these objectives; therefore, the water would be used to increase flows on CVP-controlled streams, such as the Sacramento, American, and Stanislaus Rivers and Clear Creek. The improved flows would:

- Provide improved spawning and rearing habitat for salmon and steelhead;

- Improve survival of downstream migrating Chinook salmon smolts;

- Improve habitat conditions for white sturgeon, green sturgeon, American shad, and striped bass to migrate upstream, spawn, and allow progeny to survive;
- Aid in the downstream transport of striped bass eggs and larvae;
- Improve water temperatures and increase habitat for rearing juvenile steelhead; and
- Benefit delta smelt and other estuarine species.

The rationale and scientific basis for the improved flows are found in a variety of sources (including the Anadromous Fish Restoration Program[6] documents, published literature, CDFG reports, and other restoration programs) and are generally based on results of instream flow and temperature studies conducted by the FWS, CDFG, or others, as well as relationships between flow and adult fish returns, correlation analyses, and other life-history information.

The flow objectives for each stream are generally consistent with the Anadromous Fish Restoration Program's January 2001 Final Restoration Plan (AFRP Plan). These flow objectives would be higher than current minimum flow requirements in each stream. The targeted flow objectives are based on thresholds of CVP reservoir storage and forecasted inflow and the amount of CVPIA §3406 (b)(2) water available to meet the objectives. Fisheries and hydrologic monitoring trigger higher flow releases. In general, spawning flows are initiated in October or November when adult salmon are observed in the streams and river temperatures are 60 degrees or less.

2.3.5 Augmenting Delta Outflows

Water from the Delta flows to the San Francisco Bay, which is more saline than the Delta estuary. The water mixes in the Suisun Bay area, and the mixing zone location varies depending on the Delta outflow. Higher amounts of Delta outflow push the saltwater mixing zone farther out to the Bay, and lower flows allow the saltwater zone to move farther into the Delta. The baseline level of fishery protection would include actions related to Delta outflow required by the SWRCB's Decision 1641.

2.3.6 Non-Flow Related Actions

In the absence of the EWA, a number of ongoing projects and programs (e.g., CVPIA and CALFED ERP) are expected to continue, the purpose of which is to

[6] The U.S. Department of the Interior established the Anadromous Fish Restoration Program to satisfy Section 3406 (b)(1) of the CVPIA: "develop within three years of enactment and implement a program which makes all reasonable efforts to ensure that, by the year 2002, natural production of anadromous fish in Central Valley rivers and streams would be sustainable, on a long-term basis, at levels not less than twice the average levels attained during the period of 1967-1991..."

improve the condition of species and habitats. Under the CVPIA, funding was dedicated to projects in 2002 that would be designed and implemented during the EWA timeframe. Under the CALFED Ecological Restoration Program (ERP), funding was dedicated to projects in 2002 that would be designed and implemented during the EWA timeframe. These activities are considered a part of the baseline level of fishery protection because their purpose is for fish protection and environmental protection and because they may create beneficial and/or adverse effects during the EWA timeframe on similar resources, in the absence of the EWA.

2.3.7 Water Management

Under the CALFED baseline for fishery protection, it could be reasonably predicted that, in the foreseeable future, pumping reductions could result in reduced CVP and SWP exports. The CVP and SWP could use operational flexibility within the Delta to try to make up for the water lost during pump reductions. If the Projects could not access enough water, they would then reduce their deliveries to water users. The water users would likely then implement actions to reduce or address their shortages. These two groups of water management actions are described below.

2.3.7.1 Delta Operational Flexibility

Under the baseline for fishery protection, the Projects would be able to access water from flexibly operating the Delta export facilities through Joint Point of Diversion, relaxation of the Rivers and Harbors Act Section 10 constraint in some months, and relaxation of the Export/Inflow (E/I) ratio. These types of flexible operations were defined prior to the EWA and would be available for the Projects to help repay their users for pump reductions. Only the third item, relaxing the E/I ratio, would provide additional water for the Projects. The other two options would provide additional capacity for the Projects to move water through the Delta, but they would not provide additional water to reimburse water users for lost water, except in relatively rare circumstances such as excess Delta conditions in the summer. Under the baseline for fishery protection, these actions would be unlikely to provide enough water or capacity to replace the water lost during fish actions.

2.3.7.2 Water Users' Actions

If EWA were not implemented and export users received reduced deliveries due to pumping reductions described in Section 2.3.2, the export users could engage in one or more of the following options: accept the shortage, increase local water supplies, idle or retire agricultural lands, transfer water from northern California via groundwater substitution or crop idling, or pursue independent water transfers.

2.3.8 Existing Regulatory Commitments

The 2003 ASIP includes a description of certain regulatory commitments beginning in 2008. The CALFED MSCS Conservation Agreement (CALFED 2000) and the CALFED BOs included commitment by several CALFED agencies (USFWS, NMFS, Reclamation, Bureau of Land Management, USEPA, U.S. Army Corps of Engineers (USACE), Natural Resources Conservation Service, the Resources Agency of California, CDFG, and the DWR) that there would be no additional CVP or SWP export reductions from actions conducted to protect fish under the federal ESA, California ESA, or NCCPA beyond the regulatory baseline of fishery protection. This commitment was subject to specified conditions and legal requirements for 4 years of CALFED Stage 1 implementation and was later extended by the EWA agencies for another 3 years. This commitment is based on the conditions in Section VIII-B of the MSCS Conservation Agreement and the availability of three tiers of EWA assets.

Based on current circumstances, these three tiers are no longer an accurate way to describe EWA assets. Tier 1 included baseline water, which included the biological opinions on winter-run salmon (1993) and delta smelt (1995). Tier 2 included the EWA and a fully funded Ecosystem Restoration Program (ERP). Tier 3 consisted of assets beyond Tiers 1 and 2 that would be based upon the commitment and ability of the CALFED agencies to make additional water available should it become needed. At the time that these tiers were envisioned, the biological opinions governing operations did not include an EWA. The biological opinions on the long-term operations of the Projects (NMFS 2004, USFWS 2005) did include the EWA, which made it difficult to differentiate between baseline water and the EWA. DWR and Reclamation have reinitiated consultation under the Federal Endangered Species Act for the BOs on the long-term operations of the Projects, and it is unclear whether the EWA will be included in the revised opinions. The discussion of tiers has been deleted to reduce confusion.

The EWA agencies are not proposing to renew the regulatory commitments through this EWA extension process, partially because the pelagic organism decline has caused uncertainty regarding necessary fish actions. The lack of regulatory commitments does not affect how the EWA agencies would operate the EWA.

2.4 Proposed Action (Flexible Purchase Alternative)

2.4.1 Overview

The Proposed Action would allow the EWA agencies to use water for a broad range of fish actions. These actions would include reduction of Delta export pumping, closing the Delta cross channel, augmenting Delta outflow, or increasing instream flows. The EWA agencies would have the flexibility to choose from these actions to best protect at-risk fish, and would not need to solely focus on actions within the Delta. The Proposed Action would allow the EWA agencies to respond to changes in base condition operations, and at the same time providing for anticipated levels of fish actions. The Proposed Action would be limited primarily by funding in that the EWA agencies would determine the amount of assets to acquire largely based on available funding and asset prices. The Proposed Action would have flexibility to respond to changing fish and hydrologic conditions midway through a year.

The Proposed Action would allow the EWA agencies to vary water asset purchases from those defined in the CALFED ROD to meet water needs in a specific year. The CALFED ROD identified a minimum of 185,000 acre-feet of water purchases per year, with at least 35,000 acre-feet coming from areas that are upstream from the Delta and 150,000 acre-feet from the export service areas. The Proposed Action would allow the EWA Project Agencies to purchase up to 600,000 acre-feet of water, although the EWA agencies would typically acquire 200,000 to 300,000 acre-feet except in wet years or years with high fish needs (see Section 2.4.4 for a discussion of a typical year). Water purchases under the Proposed Action would be neither fixed at 185,000 acre-feet per year nor held to specific purchase quantities upstream from the Delta or in the Export Service Area. The EWA agencies would use the concept of functional equivalence to combine methods, water sources, and operational flexibilities under the Proposed Action to provide a broad range of fish actions, or to increase the EWA in the future. Variable assets would be acquired at the same manner as specified in the EWA Operating Principles Agreement.

The Proposed Action would allow the EWA Project Agencies to acquire up to 200,000 acre-feet of storage capabilities if a reasonably priced option were available; this ASIP assesses the environmental effects of groundwater storage because it is the most likely storage option. If groundwater storage could not be implemented for financial or technical reasons, the Proposed Action would allow other actions to achieve similar objectives.

Providing flexibility to operate differently each year could help the EWA agencies address varying needs for water in different year types. Fish actions at the export pumps are dependent on the presence of the fish near the pumps, a factor that is not always dependent on the hydrologic year type. After the EWA agencies undertake a fish action, the program must repay water to the affected CVP or SWP water users. As explained previously, the EWA agencies owe the Projects the amount of water that could have been pumped during the time of a pump reduction. During a typical dry year the pumps are not very active because there is less exportable water in the Delta. The Projects do not pump as much water in dry years because supplies are limited. Therefore, the level of compensation required to the Projects would be less than in below normal to wet years. In wet years, the amounts of water in the Delta allow the Project Agencies to operate the export pumps at their maximum permitted capacity. The water that would have been pumped in a wet year is much greater than in a dry year. In wet years, the EWA agencies must be able to provide more water to repay the Projects than in dry years.

The next two sections (2.4.2 and 2.4.3) describe the components of the Proposed Action, including the EWA agencies' actions to protect fish and benefit the environment, and the actions to acquire and manage assets. Section 2.5 includes the conservation measures required to mitigate any potential effects of the Proposed Action.

2.4.2 Actions to Protect Fish and Benefit the Environment

The EWA agencies have established operating tools that allow them to protect fish. These operational tools include (1) reducing export pumping, (2) closing the DCC gates, (3) increasing instream flows, and (4) augmenting Delta outflow. These actions take place throughout the year, under various conditions. The EWA agencies use their acquired assets to meet protection objectives for at-risk fish species within the Sacramento and San Joaquin Rivers and their tributaries and the Delta.

2.4.2.1 Export Pumping Reductions

Actual EWA pump reductions would vary each year depending on fish conditions, hydrology, available EWA assets, and other factors. The potential reductions are discussed below by time of year.

2.4.2.1.1 Export Reductions in December and January Reducing exports in December and January during critical outmigration periods is intended to increase survival of outmigrating salmonids from the Sacramento basin, including listed winter-run and spring-run Chinook, steelhead trout, and candidate late-fall and fall-run Chinook. Adult delta smelt are also migrating upstream to spawning areas at this time.

This reduction is intended to increase the survival of juvenile Chinook salmon smolts (including winter-run presmolts and spring-run yearlings) migrating through the Delta in the winter. It is scientifically supported by several years (1993 – 2002) of mark/capture data that indicate the survival of juvenile late fall-run Chinook salmon in the central Delta decreases as exports increase.

Typical actions would reduce combined pumping at Harvey O. Banks (Banks) and C.W. "Bill" Jones (Jones) Pumping Plants to 6,000 cfs for 5 days at a time, and in some years those reductions occur several times during these months. For example, in four out of the last six years, the EWA reduced pumping in December and January and used approximately 5,000 to 121,000 acre-feet annually of assets. During these months, the EWA agencies usually reduce pumping in conjunction with closing the DCC gates.

2.4.2.1.2 Export Reductions in February and March Reducing pumping in the critical out-migration period in February and March is intended to increase survival of out-migrating juvenile Chinook salmonids from the Sacramento basin, with a focus on ESA listed winter-run Chinook salmon and steelhead trout. Adult delta smelt also are migrating upstream to spawning areas at this time.

This reduction is intended to increase the survival of juvenile salmonid smolts migrating through the Delta in the late winter. Several years (1993 – 2002) of mark/recapture data indicate that the survival of juvenile late fall-run Chinook salmon in the central Delta decreases as exports increase. These export reductions would supplement the primary protective action of closing the DCC gates during this period. Reduced exports also decrease ESA incidental take of juvenile winter-run salmon, and spawning adult delta smelt when the species are in the south/central Delta. Typical actions would reduce pumping to 6,000 cfs – 8,000 cfs for 5-10 days at a time in February through March.

2.4.2.1.3 Export Reductions in April and May Reducing Delta exports during April and May is intended to help out-migrating juvenile fall-run and spring-run Chinook salmon. As described in the baseline level of fishery protection, the VAMP program calls for specific flow releases from the Stanislaus, Tuolumne, and Merced Rivers and specific pump reductions during 31 days, generally from mid-April to mid-May. These actions are intended to evaluate the relative effects of export and inflow to juvenile San Joaquin basin Chinook salmon survival and assist in providing protection for both anadromous and estuarine species. The CVP would use CVPIA §3406 (b)(2) water to undertake the VAMP study as under the baseline level of fishery protection; ; the Flexible Purchase Alternative would enable the SWP to provide the difference between what is mandated by D-1641 and what is indicated by the VAMP protocols.

The Proposed Action could also include pumping reductions before April 15 to protect juvenile anadromous or resident species (including delta smelt). After May 15, the EWA agencies could request that exports continue at some reduced stable level or allow exports to ramp up gradually between May 16 and June 1. These additional days of reduced exports would provide additional protection for juvenile anadromous and resident estuarine species.

2.4.2.1.4 Export Reductions in June and July Delta pumping reductions in June could minimize entrainment of juvenile delta smelt in some years. Also, a gradual increase (ramp up) rather than a rapid increase of exports during June may be used to increase survival of both anadromous and resident estuarine species in the south/central Delta. In some years, these actions may continue into the early part of July.

Pumping reductions are intended to decrease the effects of CVP/SWP export facilities on listed resident fish in the south Delta and would enable juvenile resident estuarine and anadromous species to migrate away from the export facilities where they are less vulnerable to direct loss and/or indirect mortalities associated with export operations. Data indicate "incidental take" is greater when fish population densities are high near the export facilities or when exports increase. Additional information indicates that, generally, a gradual increase in export pumping could minimize entrainment loss of Delta smelt by delaying the increase until most of them have moved to the north and west away from the influence of the pumping.

2.4.2.1.5 January through March Export Reductions (not included in 2003 ASIP) During water year 2007, the Delta Smelt Working Group (Working Group) as part of the EWA recommended that fish actions be based on the flows in Old and Middle Rivers rather than a specified level of exports. USGS studies have found a relationship between negative flow (i.e., upstream flow) in Old and Middle Rivers and winter salvage of delta smelt (DWR and DFG 2007). Old and Middle River flows are influenced by flows on the San Joaquin River, export pumping, and local diversions in the south Delta. Historically, VAMP has maintained Old and Middle River flows that are neutral or positive during part of the delta smelt spawning period to minimize entrainment of larval delta smelt (Delta Smelt Working Group 2006). However, VAMP starts too late in many years to be maximally protective. Therefore, beginning in 2007, the Working Group has recommended fish actions be taken to reduce exports such that net upstream flows in Old and Middle River not exceed -4000 cfs with the intention of avoiding or reducing salvage. In 2007, the Projects chose to modify net Old and Middle River flows using export curtailment. The technical basis for these recommendations is based on new scientific information, but the means of implementation, e.g., export curtailment, is the same as those described in the 2003 ASIP proposed action.

2.4.2.2 Closing the Delta Cross Channel Gates

With the Proposed Action, EWA agencies could take action to close the DCC gates beyond closures required under the regulatory baseline included under the baseline level of fishery protection. EWA must compensate for water supply losses from these reductions. Additional gate closures would typically occur in November, December, January, May, or June, if additional closures were needed after the regulatory requirements under the baseline level of fishery protection were met.

2.4.2.3 Increasing Instream Flows

Increasing instream flows is intended to improve habitat conditions in tributary rivers and the Delta for anadromous and resident fish. The Proposed Action would include flow increases beyond those under the baseline level of fishery protection. Table 2-2 shows fish species that could require supplemental flows in various rivers and tributaries to meet habitat requirements for the various life history stages. The table also displays the timing of each life history stage and the rivers (those affected by EWA actions) in which each fish species can be found.

Table 2-2. Anadromous Fish Life History Stages and Locations

Fish	Run	Stage	Month	Location
Chinook Salmon	Fall	Immigrating adult	July - December	Sacramento, Feather, Yuba, American, San Joaquin, Merced
		Spawning	October - December	
		Emigrating juvenile	January - June	
	Late-fall	Immigrating adult	October - April	Sacramento, Feather, Yuba
		Spawning	December - April	
		Emigrating juvenile	May - December	
	Winter	Immigrating adult	December - July	Sacramento
		Spawning	Late April - mid-August	
		Emigrating juvenile	August - March	
	Spring	Immigrating adult	March - September	Sacramento, Feather, Yuba
		Spawning	Mid-August - October	
		Emigrating juvenile	November - June	
Steelhead	Central Valley	Immigrating adult	August - March	Sacramento, Feather, Yuba, American, San Joaquin, Merced
		Spawning	December - April	
		Emigrating juvenile	January - October	
American Shad		Immigrating adult	April - May	Sacramento, Feather, Yuba, American, San Joaquin
		Spawning	June - July	
		Emigrating juvenile	August - October	
Green Sturgeon		Immigrating adult	February - June	Sacramento
		Spawning	March - July	
		Emigrating juvenile	June - August	
White Sturgeon		Immigrating adult	February - May	Sacramento, American, San Joaquin
		Spawning	May - June	
		Emigrating juvenile		

Source: Final Restoration Plan for the anadromous Fish Restoration Program (AFRP Plan) (USFWS 2001)

Supplemental flows, over the existing baseline for fishery protection requirements for instream flows, provide additional water primarily to benefit salmon and steelhead adult immigration, spawning, egg incubation, rearing, and emigration of juveniles through the regulation of pulse flows, water temperature, water quality, and the maintenance of attraction and flushing flows. While not the primary objectives of the EWA, instream flows may also aid white and green sturgeon emigration, spawning, egg incubation, and rearing and American shad spawning, incubation, and rearing.

2.4.2.4 Augmenting Delta Outflows

The Proposed Action could include actions to augment Delta outflow in addition to outflows required by the SWRCB’s Decision 1641 and existing baseline level of fishery protection. Augmenting Delta outflow would also help to restore a westward-moving flow pattern through the Delta, which would help outmigrating fish.

In addition to taking direct actions to augment Delta outflows, other actions within the Proposed Action would have the secondary benefit of increasing Delta outflows. When the EWA agencies reduce Delta export pumping, outflows would increase initially as water that would have been pumped becomes Delta outflow. Carriage water (defined in Section 2.4.3.1) would also augment Delta outflow.

2.4.2.5 Decision-Making Process

A multi-agency team called the EWA Team (EWAT) would recommend when fish actions should be taken, using a consensus process based on biological indicators for the species considered to be at immediate risk. EWAT would consider the technical input of the Data Assessment Team (DAT), which includes stakeholder representatives, when deciding when fish actions should be taken. When the EWAT cannot reach consensus or decides issues should be elevated, issues would be presented to the Water Operations Management Team (WOMT) for resolution. Decisions would be reported to the CALFED Operations Group involving agency and stakeholder representatives.

Additionally, should month by month criteria listed in the delta smelt risk assessment matrix be exceeded, a meeting of the Delta Smelt Working Group (Working Group) will be held. The Working Group consists of experts in delta smelt biology from the USFWS, Reclamation, USEPA, DWR, and CDFG. Working Group members review monitoring and survey data and decide whether to recommend changes in water project operations. The 2003 ASIP Appendix C includes the existing decision matrices/trees for Delta smelt and Chinook salmon used by the Working Group and DAT. Their technical input is not solely based on the take limits at the export pumps.

In November and December, the EWA agencies would begin the process of identifying placeholders[7] for the next year in coordination with the CVPIA §3406(b)(2) interagency team. These placeholders would be determined based upon biological objectives and hydrology (which includes the latest forecast/allocation study for both the CVP and SWP). These placeholders would then be evaluated monthly to determine whether they are still applicable for the current month or for the following months (up until June). The use of the EWA placeholders in a particular month would be based upon the biological decision trees for salmon and Delta smelt and real-time monitoring. If not used in a particular month the placeholders would be reassigned and used in another month. The purpose in identifying these placeholders is to assist the Project

[7] Placeholders are the best available estimate of the water that the fish would need in the upcoming year.

Agencies in acquiring contracts for water purchases and to inform the EWA agencies of upcoming EWA actions.

2.4.3 Asset Acquisition and Management

This section is organized according to the geographic areas in which the EWA Project Agencies acquire and/or manage assets for the Proposed Action: upstream from the Delta, the Delta, and the Export Service Area. Figure 2-1 shows each of these areas.

The EWA Project Agencies can use any of the acquisition methods described below to purchase water. Flexibility to purchase from any of these sources is critical to helping the EWA run efficiently because it allows the Project Agencies to purchase the least expensive water available in any given year. The 2003 ASIP listed agencies that may be willing to sell water to the EWA or have sold water to the EWA in past years[8], along with a general range of potentially available water volumes. This Amended ASIP assumes the same list of agencies and range of transfers with the following exceptions: Placer County Water Agency and Tulare Lake Basin Water District would no longer transfer water to the EWA. [9]

2.4.3.1 Upstream from the Delta Region

As shown on Figure 2-1, the Sacramento and San Joaquin Rivers flow into the Delta; therefore, these rivers and their tributaries are designated in the analysis as the Upstream from the Delta Region. Potential asset acquisitions in the Upstream from the Delta Region include stored reservoir water, groundwater substitution, crop idling/substitution, and stored groundwater purchase. The EWA protects fish at the pumps by reducing pumping when it would help at-risk fish species, then transferring EWA assets across the Delta at other times to repay CVP and SWP users for water lost during pump reductions. Typically, EWA water would be moved through the Delta from July through September, although the Project operators could start moving EWA water in mid-June if fish were not in the area of the export pumps.

Shifting pumping to times that are less sensitive to fish would increase pumping during times when fish are absent, which sometimes requires increased Delta outflow to comply with water quality regulations in the Delta. Carriage water is defined as the additional water needed for Delta outflow to compensate for the

---

[8] Information on past EWA transactions can be found online at http://wwwoco.water.ca.gov/calfedops/2001ops.html; http://wwwoco.water.ca.gov/calfedops/2002ops.html; http://wwwoco.water.ca.gov/calfedops/2003ops.html; http://wwwoco.water.ca.gov/calfedops/2004ops.html; http://wwwoco.water.ca.gov/calfedops/2005ops.html; or http://wwwoco.water.ca.gov/calfedops/2006ops.html.

[9] Since publication of the 2003 ASIP, the EWA agencies have decided that they would not purchase water through crop idling from the Friant Division. Tulare County contains primarily Friant Division contractors; therefore, Tulare County was removed from the Export Service Area. Placer County Water Agency has indicated that they would not sell water through crop idling to the EWA agencies; therefore, Placer County was removed from the Upstream from the Delta region.

additional exports made on behalf of a transfer to assure compliance with water quality requirements of the SWP and CVP. EWA transfers originating along the Sacramento River and its tributaries would incorporate enough carriage water to maintain water quality within the Delta at without-EWA constituent levels.

2.4.3.1.1 Stored Reservoir Water The EWA Project Agencies could acquire water by purchasing surface water stored in reservoirs owned by non-Project entities (those that are not part of the CVP or SWP). To ensure that purchasing this water would not affect downstream users, EWA agencies would limit assets to water that would not have otherwise been released downstream.

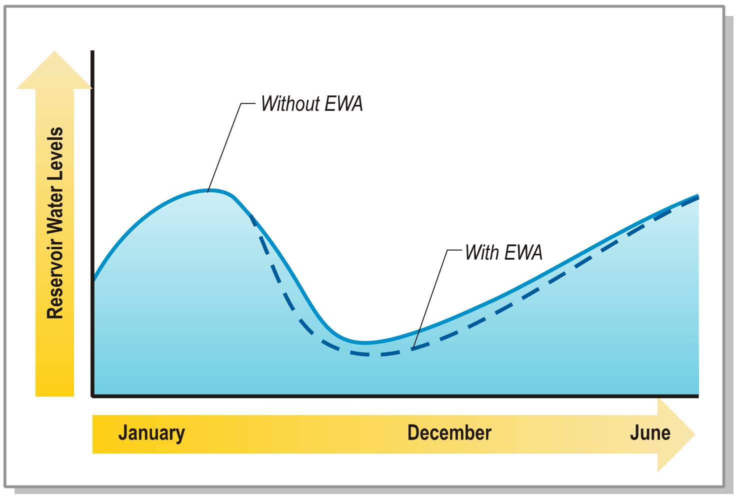

Figure 2-2. Reservoir Level Changes Due to Stored Reservoir Purchases

When the EWA purchases stored reservoir water, these reservoirs would be drawn down to lower levels than without the EWA, as shown in Figure 2-2. To refill the reservoir, a seller must prevent some flow from going downstream. Sellers must refill the storage at a time when downstream users would not have otherwise captured the water, either in downstream Project reservoirs or with Project pumps in the Delta. Stored reservoir water is released in addition to reservoir water that would be released without the EWA, thereby increasing flows in downstream waterways.

2.4.3.1.2 Groundwater Substitution Groundwater substitution transfers occur when users forego their surface water supplies and pump an equivalent amount of groundwater as an alternative supply. Because the EWA's potential groundwater substitution transfers are from agricultural users, the water from this acquisition method would be available during the irrigation season of April through October. Typically, surface water made available through groundwater substitution is stored upstream until the Delta pumps have the capacity available for EWA assets (except on the Sacramento River where water often cannot be held in Lake Shasta because of downstream temperature and flow requirements).

The Delta pumps would be unlikely to have available capacity for the EWA at the start of the irrigation season. EWA water that would have been released for irrigation would instead be held in reservoirs until later in the season, which would cause reservoir levels to be slightly higher than without the EWA while the water is held back (except on the Sacramento River).

The reservoir levels would not reverse their typical summer declines because the EWA would not add new water to the reservoir; rather, the levels would decrease more slowly (see Figure 2-3). EWA water acquired through groundwater substitution would be released later in the irrigation season, typically mid-June through September, at times when Delta pumping capacity is available. The change in reservoir elevations as the water is released would depend on the Delta conveyance capacity. If the conveyance capacity were available constantly throughout the period of mid-June through September, then the reservoir elevations would slowly return to the without-EWA levels (see Scenario 1 on Figure 2-3). If more conveyance capacity were available in July than later in the summer, then the EWA could borrow water from the storage facility and release additional water at those times that the conveyance capacity is available (see Scenario 2 on Figure 2-3). The Projects would determine if the EWA could borrow water on a case-by-case basis.

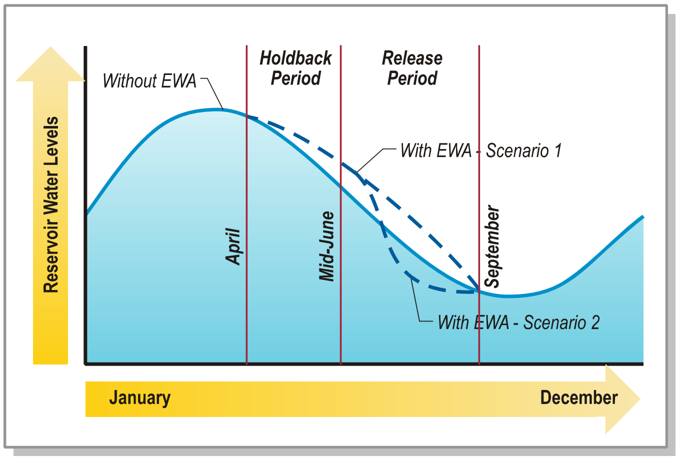

Figure 2-3. Reservoir Level Changes Due to Groundwater Substitution Transfers

2.4.3.1.3 Crop Idling or Crop Substitution Crop idling transfers come from water that would otherwise have been used for agricultural production. For crop idling acquisitions, the EWA agencies would pay farmers to idle land that they would otherwise have placed in production. Crop idling acquisitions would be retained in reservoirs upstream from the selling water agencies until they could be transferred through the Delta and pumped south. The effects on reservoir levels would be similar to that described for groundwater substitution (see Figure 2-3). Payment by the EWA agencies for water transferred would be computed based on pre-agreed consumptive use values, which may be refined as the science for generating these values improves. The EWA agencies would purchase water from idled rice crops in the Upstream from the Delta Region.

The potential also exists for the EWA agencies to purchase water through crop substitution, in which water users substitute a crop with lower water needs than the crop that they would have otherwise planted. The associated decrease in water use could be transferred to the EWA or other programs. Crop substitution would have similar but lesser effects than crop idling, so it is considered to be a part of the crop idling discussion for the remainder of the document.

To minimize socioeconomic effects on local areas, the EWA agencies would not purchase water via crop idling if more than 20 percent of recent harvested rice acreage in the county would be idled through EWA water acquisitions.

2.4.3.1.4 Stored Groundwater Purchase The EWA Project Agencies could obtain water by purchasing groundwater assets that were previously stored by the selling agency with the intent to sell a portion of those assets at a later date. This option differs from groundwater substitution in that groundwater substitution transfers would not come from water that had been previously stored.

2.4.3.2 Delta Area

The EWA Operating Principles specify methods for gaining assets in addition to those described above. These additional methods do not involve active acquisition; assets obtained by these other methods are termed “variable assets.” The EWA agencies could obtain variable assets (water or pumping capacity) through changes in Delta operations.

2.4.3.2.1 Sharing of CVPIA §3406(b)(2) and ERP Water The SWP and the EWA would share, on a 50-50 basis, water pumped by the SWP that meets the following requirements:

- Water released from storage or made available for upstream purposes under either CVPIA §3406(b)(2) or the ERP, arrives in the Delta with no further CVPIA §3406(b)(2) or ERP purposes to serve, and exceeds the export capacity of the CVP Jones Pumping Plant;
- Water that the SWP and/or EWA have demand for south of the Delta; and
- Water the SWP has capacity to pump.

This type of variable asset would result in additional water for the EWA.

2.4.3.2.2 Joint Point of Diversion The SWP could use excess capacity at its Harvey O. Banks Pumping Plant to pump water for both the CVP and the EWA, to be shared on a 50-50 basis, if the Projects meet the conditions in D-1641.

2.4.3.2.3 Relaxation of the Section 10 Constraint The USACE granted permission to the SWP to relax the Section 10 constraint (of the Rivers and Harbors Act) and increase the base diversion rate by the equivalent of 500 cfs to an average of 7,180 cfs for the months of July through September. This 500 cfs would be dedicated to pumping for the EWA, but the EWA agencies would still need to provide the assets to be pumped.

2.4.3.2.4 Relaxation of the Export/Inflow Ratio The EWA agencies would seek relaxation of the E/I ratio as appropriate to create EWA assets in the

Export Service Area. However, opportunities to relax the E/I ratio may not be as numerous as assumed in the 2003 ASIP, and thus may not result in the acquisition of as much water as assumed in the CALFED ROD.

2.4.3.2.5 Pumping to Decrease Debt (not included in 2003 ASIP) As described in Section 2.4.3.3.2 Borrowing Project Water, the EWA agencies would borrow water from San Luis Reservoir during pumping reductions to provide an uninterrupted supply to Project contractors. The EWA agencies would repay the water to San Luis Reservoir with variable or purchased assets. In some years, the assets might not provide enough water to repay all of the debt. Debt that was not repaid by the end of the year would be termed carryover debt. The EWA agencies could accrue up to 100,000 acre-feet of carryover debt in the SWP's share of San Luis Reservoir. The EWA agencies would be able to pump excess water in the Delta to decrease the carryover debt if there were excess water in the Delta, all Project contracts had been filled, and Article 21 demands had been met.

2.4.3.3 Export Service Area

The Export Service Area includes the areas served by the CVP and SWP Delta pumping facilities, encompassing agricultural and urban development in the Central Valley and central and southern coasts.

The EWA Project Agencies could acquire assets from sources within the Export Service Area. The EWA agencies would not need to arrange to move these assets through the Delta. This advantage is especially important during wet years, when Delta pumping capacity for the EWA is limited because the export pumps are fully utilized to move Project water. Assets purchased in the Export Service Area, however, are often more expensive than other assets because potential sources in the Export Service Area are more limited; water agencies usually are paying for facilities needed to capture and convey the limited supplies.

2.4.3.3.1 Water Acquisition Types The EWA Project Agencies have two potential methods for acquiring water in the Export Service Area, crop idling and stored groundwater purchase, as described below.

Crop Idling or Crop Substitution Crop idling transfers in the Export Service Area also involve agricultural water users leaving their fields idle and selling their surface water allotment to the EWA. Sellers in this area normally receive CVP or SWP water that is stored in San Luis Reservoir or pumped directly out of the Delta.

To minimize socioeconomic effects on local areas, the EWA agencies would not purchase water via crop idling if more than 20 percent of recent harvested cotton acreage in the county would be idled through EWA or other program water acquisitions.

In the Export Service Area, the EWA agencies would receive crop idling water at O'Neill Forebay (adjacent to San Luis Reservoir) on the same schedule that would have otherwise been employed for water user deliveries. Operations in conjunction with San Luis Reservoir will be discussed in greater detail in Section 2.4.3.3.2, Borrowed Project Water.

Stored Groundwater Purchase Stored Groundwater Purchases in the Export Service Area would function in the same way as the upstream stored groundwater purchases, in which entities would sell water to the EWA that they had previously stored in the ground. The EWA agencies could receive this water through two mechanisms:

- The selling agency could exchange its surface water allocation with the EWA and pump stored groundwater to satisfy local needs; or
- The selling agency could pump water out of its aquifer directly into the California Aqueduct for transfer to the EWA.

Stored groundwater is available to the EWA year-round, although the delivery would generally be during the irrigation season, usually April through September, if the water were delivered through surface water exchange.

If the EWA agencies acquire stored groundwater through a transfer of the selling agency's surface water allocation, the exchange would be made primarily at O'Neill Forebay. (In the case of Santa Clara Valley Water District, the exchange of SWP surface water would be in Bethany Reservoir.) The EWA agencies would acquire water on the same delivery schedule that the selling agency would have had without the transfer. If the selling agencies pump groundwater directly into the California Aqueduct, the seller must work cooperatively with DWR to ensure that the groundwater meets DWR's water quality requirements.

2.4.3.3.2 Asset Management The EWA requires facilities and operational arrangements in order to make its assets available when needed for accomplishing EWA objectives. The CALFED ROD defined several tools to manage assets, including the ability to borrow Project water if needed and store it for use at a time other than when the asset was acquired. Project facilities and agencies assist the EWA by conveying, storing, and loaning water when possible.

Borrowed Project Water Borrowing Project water is a management arrangement available to the EWA agencies, as long as the borrowed water could be repaid without affecting the current or following year's allocations and deliveries to Project contractors. Borrowing of Project water, specifically in San Luis Reservoir, is intended to enhance the effectiveness and use of EWA assets. Borrowing could take place only when the borrowed water would not exacerbate water quality and supply problems associated with the San Luis low point and if the reservoir could still meet reasonable carryover storage objectives.

The EWA agencies would use borrowed Project water from the San Luis Reservoir in conjunction with Upstream-from-the-Delta transfers. If the Projects are unable to convey water through the Delta because of EWA pumping reductions, the EWA agencies could borrow water from San Luis Reservoir, provide it to Project Contractors during the reduction, then repay the water to the reservoir later by moving EWA assets from upstream reservoirs when the Delta pumps have capacity. (See Figure 2-4) EWA agencies may thus at times carry a debt to the San Luis Reservoir that would affect water elevations in the reservoir.

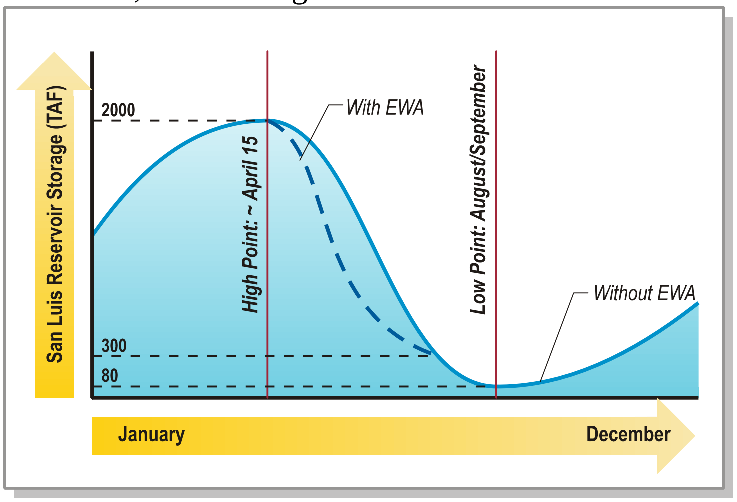

Figure 2-4. Reservoir Level Changes Due to Borrowing Water from San Luis Reservoir

In addition to borrowing Project water, as described above, the EWA agencies could also borrow Project storage if space were available. Some EWA assets are available at times when they cannot immediately be used for fish actions, such as the variable assets described above. The EWA agencies could store these assets in San Luis Reservoir (or other Project facilities such as Lake Shasta, Lake Oroville, and Folsom Lake), but they would have the lowest priority for storage (other than water stored for non-Project entities).

Groundwater Storage   Groundwater storage requires the ability to percolate or inject the excess water into a groundwater basin for later extraction, or have Project water that could be transferred to the EWA as a mechanism to return the water to the EWA. Having facilities for groundwater storage of EWA assets would provide the EWA the flexibility to acquire and store water throughout the year, which would allow additional flexibility in asset acquisition.

Groundwater storage is different from the acquisition method of purchasing stored groundwater because the EWA agencies would be providing the assets to be stored (after the initial purchase of the full storage area). If the EWA agencies purchased stored groundwater, it would purchase water that the sellers had previously stored in the ground.

Stored groundwater could be returned to the EWA through two mechanisms:

- The banking entity could extract the water out of the ground and into a waterway or Project conveyance facility; or

- The entity could transfer its surface water allotment to the EWA and pump groundwater for local use.

Source Shifting Source shifting is a tool that was developed in the CALFED ROD to help make the EWA more flexible. With source shifting, the EWA agencies would hold scheduled water from a Project contractor for a fee, delivering the water at a later date. The result of this option is to delay delivery of SWP or CVP contract water.

The purpose of implementing source shifting would be to help protect the San Luis Reservoir against reaching storage volumes where the low point problem begins earlier with the EWA than it would have without the EWA. Source shifting would allow the EWA to hold water from one or more Project contractors and use it to repay debts to the San Luis Reservoir before the low point problem has begun.

At the start of source shifting operations, water surface elevations in the reservoirs or groundwater basins used as the alternate supply source by the source shifting contractor would decrease relative to non-EWA conditions. The water levels would then return to non-EWA conditions as the water was paid back, which could continue into the next year. Source shifting does lower water levels temporarily, but only within existing operating parameters. The reservoirs or groundwater aquifers would not be operated outside their standard operations.

Pre-Delivery As a permutation of source shifting, the EWA agencies could engage willing partners to receive water earlier than they would typically receive water. The EWA agencies would consider this tool if the EWA had water in storage in San Luis Reservoir during the winter that could convert to Project water as San Luis fills. To implement pre-delivery, the EWA agencies would deliver water to users in the Export Service Area that have their own storage facilities in which to store that water. The EWA would essentially be borrowing storage space from these users. This action would increase reservoir levels in surface storage facilities.

Exchanges The EWA agencies could engage willing partners to receive water earlier than their normal delivery schedule. The EWA agencies would consider using this tool if they had remaining assets at the end of June and they did not anticipate using these assets before the end of the water year. In a dry summer period, the EWA could exchange its surplus assets with an agricultural contractor with the agreement that the contractor return the water on request in the next relatively wet year; for example, a year with SWP allocations of 70 percent or higher. The agricultural contractor would then take delivery of the EWA water from July through the end of the irrigation season instead of pumping local groundwater or drawing on other sources. The exchange would reduce groundwater pumping in the first year of the exchange, and would require the contractor to reduce dependence on contract supplies in the year of the return of the water.

Similarly, the EWA agencies could exchange surplus assets with a contractor that has available surface water storage. The contractor would take deliveries of the EWA water during the same time period instead of drawing on local surface water supplies. The exchange would result in slightly higher reservoir levels throughout the winter and until the contractor returns the water to the EWA in a relatively wet year.

2.4.4 Typical Year EWA Operations

In a typical year, the EWA would purchase 200,000-300,000 acre-feet for its annual operations. In the driest years, and when assets were carried over from the prior year, the total acquisitions could be closer to 200,000 acre-feet. In near average water years, the acquisition target would be closer to 300,000 acre-feet or even higher.

In the wetter years when operational curtailments would be expected to cost more water because the base Delta pumping rate would be higher or when the EWA ends the prior year with substantial debt, water needs for fish may be in the 400,000-600,000 acre-foot range. Initial acquisition targets may be lower in those years.

2.4.5 Acquisition Strategy

The EWA agencies would acquire water using an acquisition strategy that meets multiple goals and objectives when acquiring water. These goals include:

- Acquire water at a unit cost that is most effective considering the benefits achieved;
- Protect assets by creating arrangements to carry over water between years;
- Continue coordination with other water purchase programs;
- Maximize the existing and future funding opportunities; and
- Improve flexibility by:
  - Expanding the types of purchases and the number of potential sellers;

- Developing actions that continue for more than 1 year.

The sections below describe several components of the strategy that would continue into the future and are relevant to assessing the environmental effects of the Proposed Action.

2.4.5.1 Tie Water Purchases to Hydrologic Conditions to Minimize Costs

The amount of water available for transfer is typically greater in areas upstream from the Delta than in the export service areas because more than 70 percent of runoff comes from northern California (DWR 1998). This difference is reflected in the market rates received by willing sellers in these two areas. The differences in water prices upstream from the Delta and the export service areas are greater than simply the costs of transporting water across the Delta. The differences reflect a structural difference in the water economies of these two areas.

Water from the areas upstream from the Delta is less expensive, but the EWA has limited conveyance capacity to convey water across the Delta in some hydrologic conditions. Therefore, the EWA would pursue a strategy in which it maximizes purchases from areas that are upstream from the Delta to the extent that it can convey water across the Delta.

Some water purchases in areas upstream from the Delta are generally less expensive, have fewer environmental effects, and are more flexible; therefore, the EWA Project Agencies would prioritize these types of acquisitions for purchase. The highest priority would be stored reservoir purchase, followed by groundwater substitution and stored groundwater purchase. The lowest priority would be crop idling transfers because of their increased environmental effects and decreased flexibility. In some cases (e.g. Sacramento River area idling transfers), the foregone consumptive use in April, May, and parts of June may not be effectively captured and exported by the EWA because the water must be released to meet downstream requirements, yet it cannot be pumped in the Delta.

Acquisitions in the Export Service Area generally follow the same pattern: stored groundwater purchase is less expensive, more flexible, and has fewer environmental effects than crop idling transfers. Unfortunately, potential stored groundwater supplies in the Export Service Area are decreasing, and may not be available into the future. For purchases from the Export Service Area, the EWA Project Agencies would prioritize stored groundwater purchases if available.

2.4.5.2 Continued Coordination with other Acquisition Programs

Other water acquisition programs would also acquire water in the same regions as the EWA, and some programs would seek to use this water to achieve similar goals. Coordination of the programs would be critical to help maximize environmental benefits of these programs and avoid cumulative effects.

2.4.5.3 Set Water Purchase Targets

With a high upper limit on the purchases for the Proposed Action, the EWA would try to set water purchase targets based on Management Agencies' predictions of fish needs for different year types. Setting these purchase targets before the EWA Project Agencies negotiate acquisitions would help in purchasing enough assets to meet fish needs.

2.4.5.4 Aggressively Use Purchase Options

DWR could negotiate purchase options, in which they secure a contractual ability to call upon water to be transferred at a future date. Aggressive use of options upstream from the Delta would provide the EWA agencies flexibility to deal with changing hydrologic conditions. One concern related to options is that in many cases the call dates needed by the sellers occur early in the year, before much is known about the hydrologic conditions. The EWA would seek option call dates as late into the year as possible, consistent with the needs of the sellers.

2.4.5.5 Increase Use of Multi-Year Transfers

The EWA Project Agencies could negotiate longer-term contracts with willing sellers to acquire water from the same source in multiple years. Multi-year agreements would likely decrease the cost of the water and improve flexibility by having a source that is available without additional negotiations.

2.4.6 EWA Action Effects Monitoring and Adaptive Management

The EWA agencies would implement a multifaceted monitoring program to assess the benefits and effects of EWA asset acquisition and management actions. A portion of the monitoring program would draw upon the findings of ongoing fish monitoring efforts being performed in the Delta, at the Delta pumps, Sacramento River, San Joaquin River, and tributaries. Another portion of the monitoring program would be the development of new monitoring efforts for locations where monitoring is now not occurring. The existing CALFED science review processes would continue the current evaluation of all efforts related to fish population recovery in the CALFED focus area. The data collected and reviewed through these processes would be used in an adaptive management process to suggest changes in relation to the acquisition and management of EWA assets.

Regarding terrestrial wildlife and vegetation, the EWA agencies would update species distribution maps, as introduced in Chapter 3 of the 2003 ASIP, to focus and avoid areas for rice farmland idling. The idling of rice farmland has been determined in this ASIP to be the only EWA asset acquisition and management action with potential adverse effects to terrestrial species. As part of the water acquisition and implementation strategy, the Project and Management Agencies would monitor in the field rice farmland idling patterns in relation to core wildlife areas and ensure that the conservation measures, presented in Section 2.5, are adhered to by the willing sellers.

Chapter 7 of this ASIP provides details regarding the EWA monitoring and adaptive management programs.

2.5 Conservation Measures

The CALFED MSCS, the document from which the 2003 and Amended ASIPs tier, presents the basis for conservation measures developed to address CALFED actions overall, as outlined in the Programmatic CALFED EIS/EIR. The CALFED MSCS follows the two-tiered approach to FESA, CESA, and NCCPA compliance initiated by the CALFED Programmatic EIS/EIR and MSCS. The MSCS provides the CALFED programmatic compliance with FESA, CESA, and NCCP while the 2003 and Amended ASIPs provide the project-level compliance with these acts. As such, the 2003 and Amended ASIPs represent the project-level biological assessment for initiating consultation with USFWS and NOAA-Fisheries under the Section 7 of the FESA and the project-level NCCPA compliance.

Many of the conservation measures introduced in the MSCS address CALFED construction and habitat improvement/conversion projects that are not components of the EWA Proposed Action. The MSCS does introduce EWA actions at the programmatic level and water transfers at a policy level. As such, the majority of the MSCS conservation measures are either too specific to other CALFED actions or too general to address specific EWA actions. The principles and expected outcomes of the MSCS conservation measures were used by a multiple agency team of biologists in the process of modifying the MSCS conservation measures to address (reduce or eliminate the effects) of EWA actions or in the development of new conservation measures not addressed in the MSCS. Included in the development of the EWA conservation measures was the assessment of the trade-offs between additional water for fish actions and water that could be used to support other environmental projects.

This section presents the EWA conservation measures developed to avoid, minimize, and compensate for effects on special-status species and NCCP communities. Conservation principles the EWA measures are based on and the conservation strategy driving the development of the EWA measures can be found in the 2003 ASIP.

2.5.1 EWA Conservation Measures

Conservation measures that would be applied to the EWA actions for each species and NCCP habitat were originally described in the 2003 ASIP. These conservation measures are repeated below. Additionally, new analysis shows the potential for fishery impacts in December; therefore, application of the second conservation measure for "General Fish Species" would prevent those impacts. The cost of any conservation measures or additional environmental measures for EWA actions would be paid for from those funds identified for implementation of EWA.

2.5.1.1 General Conservation Measures

The conservation measures presented in this section apply to all species and NCCP habitats in general.

Conservation Measure Applicable to all Species. The EWA agencies will coordinate EWA water acquisition and transfer actions with Federal (Reclamation, USFWS and NOAA Fisheries), State (DWR and CDFG), other CALFED agencies, and regional programs (e.g., the San Francisco Bay Ecosystem Goals Project, the Anadromous Fish Restoration Program, the Senate Bill [SB] 1086 program, the U.S. Army Corps of Engineers' [USACE's] Sacramento and San Joaquin Basin Comprehensive Study, the Riparian Habitat Joint Venture, the CVPIA, the Central Valley Habitat Joint Venture, and the Grassland Bird Conservation Plan) that could affect management of evaluated species. Coordination will avoid conflicts among management objectives and will be facilitated through CALFED's water transfer program.

General Fish Species Conservation Measures

- In implementing the EWA, the EWA agencies will avoid acquisition and transfer of water that will reduce flows essential to maintaining populations of native aquatic species in the source river.

- In implementing the EWA water acquisition and transfers, the EWA agencies will not increase exports during times of the year when anadromous and estuarine fish are most vulnerable to damage or loss at project facilities or when their habitat may be adversely affected.

- In implementing the EWA, the EWA agencies will avoid acquisition and transfer of stored reservoir water quantities that will impair compliance with flow requirements and maintenance of suitable habitat conditions in the source river in subsequent years.

2.5.1.2 Federal Threatened or Endangered Species – Fish Species

Delta Smelt (T-FESA; T-CESA)

- In implementing the EWA, the EWA agencies will fully adhere to the terms and conditions in all applicable CESA and FESA biological opinions and permits for CVP and SWP operations.

- In implementing the EWA, the Project Agencies will not initiate EWA water exports in July until Management Agencies agree that Delta smelt will not be harmed.

Salmonids – General Conservation Measures - Central Valley Fall/Late-Fall Run Chinook Salmon (C-FESA; SSC-CDFG); Sacramento River Winter Run Chinook Salmon (E-FESA; E-CESA); Central Valley Spring Run Chinook Salmon (T-FESA; CT-CESA); Central Valley Steelhead (T-FESA)

- In implementing the EWA, the EWA agencies will fully adhere to the terms and conditions in all applicable CESA and FESA biological opinions and permits for CVP and SWP operations.

- In implementing the EWA, the EWA agencies will minimize flow fluctuations resulting from the release of EWA assets from project reservoirs to reduce or avoid stranding of juveniles.

- The EWA agencies will consult with the local river management teams regarding management of EWA water on those rivers.

Central Valley Fall/Late-Fall Run Chinook Salmon (C-FESA; SSC-CDFG)

- In May, the EWA agencies will evaluate Folsom Reservoir coldwater pool availability to benefit returning adult fall-run Chinook salmon prior to releasing EWA assets.

Central Valley Steelhead (T-FESA)

- In May, the EWA agencies will evaluate Folsom Reservoir coldwater pool availability to benefit over-summering juvenile steelhead prior to releasing EWA assets.

- In implementing the EWA, EWA agencies will consult with the local river management team regarding ramping considerations before and after EWA transfers to avoid downstream movement of juvenile steelhead.

2.5.1.3 Federal Threatened or Endangered Species – Terrestrial Species

Giant Garter Snake (T-FESA; T-CESA) Within the Sacramento River valley, the giant garter snake (GGS) is highly dependent on rice fields and associated irrigation ditches. EWA actions, or cumulatively, water acquisitions, could idle up to 20 percent of flooded rice fields in each county. The following text provides the proposed approach and conservation measures to protect the GGS.

As part of the EWA consultation, the USFWS will give programmatic approval to crop idling, followed by a site-specific consultation process to ensure consistency with the programmatic approval. The programmatic consultation will include three main elements: 1) the process by which site-specific agreements will be attained; 2) the list of conservation measures (avoidance, minimization, and conservation measures) which would be used wholly or in part to minimize effects of water transfers involving fallowing or crop-shifting; and 3) a description of GGS conservation strategy in Chapter 4 of this ASIP.

USFWS EWA consultation with the Project Agencies will outline a year-by-year “site specific” process to address crop idling impacts to GGS and will put boundaries on upper limit on the amount of crop idling that may occur in any given year, considering the existing 20 percent limit. Additional measures to those presented in this EIS/EIR may be incorporated as a part of consultation based on site-specific conditions.

Each year, once it has been determined that crop idling will occur, the EWA Project Agencies will contact USFWS staff to begin informal consultation and will put together a package describing where the idling activities will take place and what proposed minimization measures will be followed. This package will include maps of the proposed idled fields. USFWS will work with the EWA Project Agencies to determine if minimization measures proposed are sufficient and if additional compensatory habitat is required.

The EWA agencies will ensure through contract terms or other requirements that the following conservation measures will be implemented:

- The EWA agencies will ensure parcels from which water is to be acquired are outside of mapped proscribed areas (see 2003 ASIP Figure 3-13), which include:
    - *Refuges* – Land adjacent and within 1 mile of Sacramento, Delevan, Colusa, Sutter, and Butte Sink National Wildlife Refuge (NWR), and the Llano Seco Unit of the Sacramento River NWR, Gray Lodge Wildlife Area (WA), Upper Butte Basin WA, Yolo Bypass WA, and Gilsizer Slough CE;
    - *Corridors Between Refuges* – Lands adjacent to Hunters and Logan Creeks between Sacramento River NWR and Delevan NWR; Colusa Basin Drainange Canal between Delevan NWR and Colusa NWR; Little Butte Creek between Llano Seco units of Sacramento River NWR and Upper Butte Basin WA, and Howards Slough Unit

of the Upper Butte Basin WA, Butte Creek Upper Butte Basin WA, and Gray Lodge WA;

– *Waterways Serving as Corridors* – Land adjacent to Butte Creek, Colusa Basin Drainage Canal, Gilsizer Slough, land side toe drain along east side of the Sutter Bypass, Willow Slough and Willow Slough Bypass in Yolo County, North Drainage Canal and East Drainage Canal in Natomas Basin

– *Other Core Areas* – East of SR99 and between Sutter-Sacramento County line and Elverta Road in Natomas Basin, Yolo County east of Highway 113;

- The water seller will ensure that water is maintained in irrigation and drainage canals to provide movement corridors;
- The water agency will ensure that the block size of idled rice parcels will be limited to 160 acres (includes rice fields shifting to another crop);
- The water agency will ensure that mowing along irrigation and drainage canals will be minimized and mowers will be elevated to at least 6 inches above the ground level;
- The EWA Agencies will avoid purchasing water from the same rice field more than two consecutive years or from a rice field that was idled for another program in the previous year;
- The water agency will ensure that, if canal maintenance such as dredging is required, vegetation will be maintained on at least one side; and
- The EWA agencies will maximize geographic dispersal of idled lands.

GGS conservation measures <u>may</u> include the following, as appropriate:

- The EWA agencies will recommend that sellers replace culverts already planned for repair or replacement with oversized culverts to facilitate better wildlife dispersal;
- The EWA agencies will recommend that sellers replace water control structures with those requiring less maintenance and less frequent replacement in order to minimize maintenance impacts (steel or wooden control boxes with pre-poured concrete boxes); and
- The water agencies may fund research or surveys.

2.5.1.4 State Special Status Species

Greater Sandhill Crane (T/FP-CESA) Crop idling of seasonally flooded agricultural land could reduce the amount of over winter forage for migratory birds.

- Avoid or minimize actions near known wintering areas in the Butte Sink (from Chico in the north to the Sutter Buttes, and from Sacramento River in the west to Highway 99) that could adversely affect foraging and roosting habitat.

Black Tern (SSC-CDFG) Crop idling of seasonally flooded agricultural land could reduce the amount of nesting and forage habitat during the summer rearing season.

- As part of the review process for the identification of areas acceptable for crop idling, the Management Agencies will review current species distribution/occurrence information from the Natural Diversity Database and other sources (including rookeries, breeding colonies, and concentration areas). The Management Agencies will then use the information to make decisions that will avoid EWA crop idling actions that could result in the substantial loss or degradation of suitable habitat in areas that support core populations of evaluated species that are essential to maintaining the viability and distribution of evaluated species.

- As part of contractual agreements, the willing seller will be required to maintain quantities of water in agriculture return flow ditches that maintains existing wetland habitat providing habitat to the covered species.

Western Pond Turtle (SSC-CDFG) Ditches and drains associated with rice fields provide suitable habitat for the western pond turtle. The following conservation measures will ensure effects of crop idling actions on western pond turtle habitat are avoided or minimized.

- The willing seller will be required to maintain water levels in irrigation and drainage canals to within 6 inches of non-program conditions and do not completely dry out canals.

2.5.1.5 NCCP Communities

Non-tidal Freshwater Permanent Emergent, Natural Seasonal Wetland, and Valley/Foothill Riparian Communities Natural and Managed Seasonal Wetlands and Riparian Communities often depend on surface water-groundwater interactions for part or all of their water supply. The following conservation measures will ensure effects on these communities from groundwater substitution actions are avoided or minimized.

- A *Well Adequacy Review*. Before groundwater substitution actions are initiated the hydrogeologic conditions of wells used to transfer EWA water will be examined to minimize the potential risk of depleting surface water sources and adversely affecting associated vegetation; and

- A *Monitoring Program.* The Project Agencies will implement a monitoring program that will provide data to determine if direct or indirect effects exist.

Valley/Foothill Riparian and Montane Riparian Communities Riparian plant germination, establishment, growth, and distribution are driven by water availability and floodplain and channel geomorphology that conform to historical patterns. The following conservation measure will ensure effects on these communities will be avoided or minimized.

- The EWA agencies will implement a monitoring program, in cooperation with other programs, that will provide flow data and observations of habitat changes to determine if changes in flows are having a direct or indirect effect on riparian communities, particularly establishment of seedlings and survival of middle age classes.

Managed Seasonal Wetlands Landowners with managed seasonal wetland communities often depend upon agricultural return flows for part or all of their water supply. The following conservation measure will ensure effects on this wetland community will be avoided or minimized.

- As a part of the contractual agreements, the EWA agencies will require the willing seller of water for crop idling to maintain their drainage systems at a water level that will maintain existing wetlands providing habitat to covered species. As part of monitoring program to ensure compliance with the contractual requirements, EWA agencies will periodically verify that the seller is adhering to the agreement and that no effects are occurring.

Seasonally Flooded Agricultural Lands Conservation measures for seasonally flooded agricultural lands are provided for the giant garter snake. The primary measures applicable to seasonally flooded agricultural lands include limiting the size of idled land blocks to less than 160 acres, maintaining ditch habitat and ditch water flows, and not idling the same field more than 2 years in a row.

Anadromous Fish Community Conservation measures for the anadromous fish community are presented in Section 2.5.3.2 for the salmonid fish species.

Estuarine Fish Species Community Conservation measures for the estuarine fish community are presented in Section 2.5.3.2 for the delta smelt.

2.6 References

CALFED Bay-Delta Program (CALFED). 2000. CALFED Bay-Delta Program Multi-Species Conservation Strategy.

California Department of Water Resources (DWR). 1998. The California Water Plan Update: Bulletin 160-98.

California Department of Water Resources and California Department of Fish and Game (DWR and DFG). 2007. Pelagic Fish Action Plan. March. Available from: http://www.publicaffairs.water.ca.gov/newsreleases/2007/030507pod.pdf. Accessed on 11 July 2007.

Delta Smelt Working Group. 2006. *Meeting/Conference Call Minutes.* Accessed 11 July 2007. Available from: http://www.fws.gov/sacramento/es/documents/ds_working_group/DSWG_Minutes_21Aug06.pdf

Environmental Protection Agency. 2001. Economic Analysis of the Final Regulations Addressing Cooling Water Intake Structures for New Facilities. When accessed: March 12, 2003. Available from: http://www.epa.gov/waterscience/316b/economics/economics.html

National Marine Fisheries Service (NMFS). 2004. Biological Opinion on long-term Central Valley Project and State Water Project Operations Criteria and Plan. Southwest Region. October 2004.

U.S. Bureau of Reclamation (Reclamation). 2003. Fisheries Applications Research Group website. When accessed: March 12, 2003. Available from: http://www.usbr.gov/tsc/tsc8290.html

U.S. Fish and Wildlife Service (USFWS). 2001. Final restoration plan for the Anadromous Fish Restoration Program. Prepared for the Secretary of the Interior under authority of the Central Valley Project Improvement Act.

USFWS. 2005. Reinitiation of Formal and Early Section 7 Endangered Species Consultation on the Coordination Operations of the Central Valley Project and State Water Project and the Operational Criteria and Plan to Address Potential Critical Habitat Issues. February 16, 2005. Sacramento Fish and Wildlife Office. Available online at: http://www.fws.gov/sacramento/ea/news_releases/2004%20News%20Releases/Delta_Smelt_OCAP_NR.htm

This page is intentionally left blank

Chapter 3
Environmental Basis of Comparison–Special Status Species Accounts and Status in EWA Action Area

3.1 Introduction to Species Accounts

Chapter 3 presents species accounts for the species assessed in detail in this Amended ASIP. The species addressed in this chapter are based on the screening process presented in Chapter 1, Section 1.5. In summary, the species addressed in the remaining portions of this Amended ASIP were selected based on several considerations related to EWA asset acquisition and management actions that could affect the species or the habitat of species covered in this Amended ASIP.[1]

Chapter 3 presents basis of comparison descriptions at the species level. In accordance with ESA, the ESA environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in an action area, the anticipated impacts of all proposed Federal projects in an action area that have already undergone formal or early Section 7 consultation, and the impact of State or private actions that are contemporaneous with the consultation in process. [50 CFR 402.02] Unrelated Federal actions affecting the same species or critical habitat that have completed formal or informal consultation also are part of the ESA environmental baseline, as are the Federal and other actions within the action area that may benefit listed species or critical habitat (USFWS & NMFS 1998). As a part of this environmental basis of comparison, the EWA agencies will define a baseline of population and habitat quantity and quality for listed and proposed species and designated and proposed critical habitat.

Species account updates are organized by Federal, then State designation within each of these sections.

[1] Based on the Proposed Action description provided in Chapter 2 the following EWA actions are most likely to affect covered species: 1) the pumping of EWA assets to the Export Service Area, 2) reduction in Delta outflows, 3) changes in timing of releases of water from reservoirs, and 4) crop idling involving seasonally flooded agriculture (rice).

3.2 Species Accounts for Fish

3.2.1 Chinook Salmon

The life history and habitat requirements of Chinook salmon have been well documented (e.g., Myers *et al.* 1998 Healey 1991, Moyle 2002, Bjornn and Reiser 1991). Chinook salmon are anadromous and spend most of their life in the ocean. The freshwater period of their lives consists of four general life stages: upstream adult migration (immigration), spawning, juvenile rearing and downstream migration of juveniles (emigration). These life stages and the current conditions supporting them within the area of analysis are generally discussed below.

The Central Valley supports four principal Chinook salmon runs. The runs are recognized and named for the timing of their entry into the freshwater environment: 1) fall-run; 2) late-fall-run; 3) winter-run; and 4) spring-run (Moyle 2002, Healey 1991). Table 3-1 lists the general temporal life stage distributions that distinguish the four runs.

Table 3-1. Generalized Life History Timing of Central Valley Chinook Salmon Runs

Run	Adult Migration Period	Peak Migration Period	Spawning Period [1]	Peak Spawning Period	Fry Emergence Period	Juvenile Stream Residency	Juvenile Emigration Period
Fall	July-December	September-October	October	October – November	March	1-7 months	January-June
Late-fall	October-April	December	December	February – March	June	7-13 months	June-January
Winter	December-July	March	April	May – June	September	5-10 months	July-March
Spring	Jan-July	April-May	August	Mid-September	March	3-15 months	November - April

Sources: Moyle 2002, Vogel and Marine 1991, and CDFG 1992, 1995, and 1998.
Notes:
[1]The time periods identified for spawning include the time required for incubation and initial rearing, prior to emergence of fry from spawning gravels.

Chinook salmon are essentially present within areas of analysis yearlong. The relative number and distribution of the various life stages changes throughout the year depending upon the temporal and spatial distribution of the runs. All four runs of Chinook salmon inhabit the Sacramento River and some of the smaller tributaries in its uppermost reach. The Yuba and Feather Rivers support spring and fall runs while the American and San Joaquin Rivers (Stanislaus, Tuolumne, and Merced Rivers) provide habitat for fall run.

3.2.1.1 Central Valley Fall/Late Fall-Run Chinook Salmon (Oncorhynchus tshawytscha)

Legal Status. Federal jurisdiction of the fall-run Chinook salmon ESU is the responsibility of NMFS. The ESU includes all naturally spawned populations of fall-run Chinook salmon in the Sacramento and San Joaquin River Basins and their tributaries east of Carquinez Strait, California (64 FR 50394, September 16, 1999). On September 16, 1999, after reviewing the best available scientific and commercial information, NMFS determined that listing Central Valley fall-run Chinook salmon was not warranted. On April 15, 2004, the Central Valley fall-run Chinook salmon ESU was reclassified as a Species of Concern (69 FR 19975).

Federal jurisdiction of the late-fall run Chinook salmon ESU is the responsibility of NMFS. NMFS does not consider this run to be distinct from the fall-run Chinook salmon, although they are generally considered so by other entities, and therefore are discussed separately here. The ESU includes all naturally spawned populations of late fall-run Chinook salmon in the Sacramento and San Joaquin River Basins and their tributaries east of Carquinez Strait, California (64 FR 50394, September 16, 1999). On September 16, 1999, after reviewing the best available scientific and commercial information, NMFS determined that listing Central Valley late fall-run Chinook salmon was not warranted. On April 15, 2004, the Central Valley late fall-run Chinook salmon ESU was reclassified as a Species of Concern (69 FR 19975).

Historical and Current Distribution and Status. Fall-run/late-fall-run Chinook salmon historically inhabited many streams of the Sacramento-San Joaquin watershed. Fish barriers (typically dams) on many streams and rivers currently limit upstream habitat. Subgroups commonly referred to include 1) San Joaquin fall-run, which includes populations in the Stanislaus, Tuolumne, and Merced Rivers; 2) populations from eastside tributaries that include the Cosumnes and Mokelumne Rivers; 3) populations from westside tributaries that include the Putah, Clear, and Cottonwood Creeks; 4) fall-run populations in the Sacramento River and its tributaries; and 5) late-fall-run populations in the Sacramento River and selected tributaries. Late-fall-run Chinook are generally the second least numerous run in the Sacramento River (after winter-run) (CDFG 1995). NMFS (1999a) summarizes long-term population trends for fall-run salmon as generally stable to increasing. However, it is unclear if these populations are self-sustaining, because at least 20 to 40 percent of the spawners are of hatchery origin (NMFS 1999a). In addition, 40 to 50 percent of spawning and rearing habitats have been lost or degraded. Fall-run Chinook are currently the most numerous of the Central Valley runs (Myers *et al*. 1998). The late-fall-run Chinook salmon population in the Sacramento River appears to be stable, despite its low abundance (NMFS 1999a). Reliable estimates at Red Bluff Diversion Dam (RBDD) from years prior to 1992 suggest escapement was 6,700 to 9,700 adults. Estimates made from 1992-97 are considered unreliable. In 1998, a more reliable estimate of 9,717 adults was made using carcass survey methodology. The similarity in results suggests that late-fall-run populations appear to be stable; however, there is still much uncertainty due to changes in estimation methodology (NMFS 1999a). More recently, estimates from 2002 through 2005 for carcass counts of natural spawners and fish spawned at Coleman Fish Hatchery range from approximately 9,295 to 39,700 (PFMC 2006).

Distribution in the CALFED Solution Area and EWA Action Area. Fall-run/late-fall-run Chinook salmon are found in all the ecological zones of the Central Valley except the West San Joaquin Basin Ecological Zone. Adults migrate upstream through the bay and Delta ecozones from summer through early winter, generally migrating from September through February with a peak in late December-early January. Adults are found in river and tributary ecozones generally from late summer into winter. Most young move out of tributary spawning areas in winter and spring. Young may be found in the river, Delta, and bay ecozones from winter into early summer.

Life History and Habitat Requirements. The largest run of Chinook salmon in the Central Valley is the fall run. The Central Valley, in turn, supports one of the largest fall-run Chinook salmon populations along the Pacific Coast (Healey 1991). Fall run support significant commercial and recreational fisheries along the Pacific Coast and in the area of analysis.

Fall-run Chinook salmon are already sexually maturing as they enter the freshwater environment and are typically ready to spawn within days once they reach their spawning areas. Adult Chinook salmon annually migrate upstream from July through December (Figure 3-1). The spawning peak occurs from October through November, depending upon the spawning location. More than 90 percent of the entire run has entered all the rivers by the end of November and migration and spawning can continue into December.

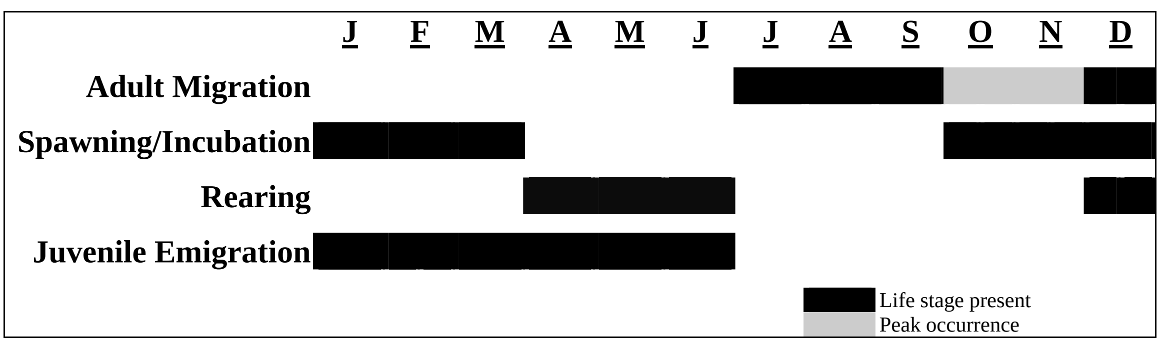

Figure 3-1. General Periodicity of Central Valley Fall-run Chinook Life Stages

Fall-run Chinook are very sensitive to pre-spawning water temperatures. Developing gametes can be harmed when an adult is exposed to temperatures >-60°F (Meehan and Bjornn 1991); migration can be deterred if temperatures exceed 70°F (NMFS 2004b). The upper limit of suitable spawning temperatures is from 56 to 58°F (Bjornn and Reiser 1991). Spawning does not typically occur until water temperatures are 60°F or less (Water Forum 2002). CDFG (1980) reported egg mortalities of 80 percent and 100 percent for Chinook salmon at water temperatures of 61°F and 63°F, respectively. Egg incubation survival is highest at water temperatures at or below 56°F (Bjornn and Reiser 1991). Water temperatures from 53°F to 64°F have been reported to be optimal for rearing of Chinook salmon fry and juveniles (Myrick and Cech 2004).

Within the EWA area of analysis, fall-run Chinook salmon incubation occurs from October through March. Many fry leave natal rivers shortly after emerging while others may rear until June. Fry emergence generally occurs from October through March. There is usually a large peak of emigration in February. In the Sacramento River basin, fall-run Chinook salmon juvenile emigration (downstream migration) occurs from January to June (CDFG 2001a). Juvenile emigration from the natal stream typically occurs within a short time of emergence. Less than 10 percent of the emigrating population observed in the Feather, American and Sacramento Rivers were smolt-sized fish (Painter et al. 1977). Rearing occurs in the Sacramento River from Redding to Princeton and in most of the tributaries where fall-run spawn downstream to the confluence with the Sacramento River. The Delta is considered to be the major rearing area for fall-run juveniles from the fry to smolt life stages (Figure 3-2).

Adult immigration of late-fall-run Chinook salmon into the Sacramento River generally begins in October, peaks in December, and ends in April (Moyle 2002) during a period of typically high, fluctuating flows (Figure 3-3). Spawning also has been observed in tributaries to the upper Sacramento River (e.g., Battle, Cottonwood, Clear, Big Chico, Butte and Mill Creeks) and the Feather and Yuba Rivers, although these fish do not comprise a large proportion of the late-fall-run Chinook population (USFWS 1995). Spawning in the main-stem Sacramento River occurs primarily from Keswick Dam (RM 302) to Red Bluff Diversion Dam (RM 258), and generally occurs from January through April (NMFS 2004b). Late-fall-run Chinook salmon fry emerge from April through June. Juveniles may reside in the stream from 7 to 13 months prior to emigrating to the ocean. Rearing occurs from Redding to Princeton and in the tributaries of Battle, Mill, Big Chico and Butte Creeks and the Feather River (Figure 3-4). Late-fall-run juveniles emigrate from their spawning and rearing areas to the Delta from June through January (Vogel and Marine 1991, Snider and Titus 2000a,b). The majority of emigrating juveniles are smolt sized by the time they reach the lower Sacramento River and Delta, typically from November through January. The relative abundance of juveniles reaching the Delta appears to be related to fall flow conditions. More juveniles appear to reach the lower river and Delta when runoff occurs earlier in the fall. Fall flows in the lower river are predominantly agriculture return water until the first major storms of the season. Occurrence of late-fall-run juveniles in the lower river appears to coincide with the first storms. However, the later the first storm

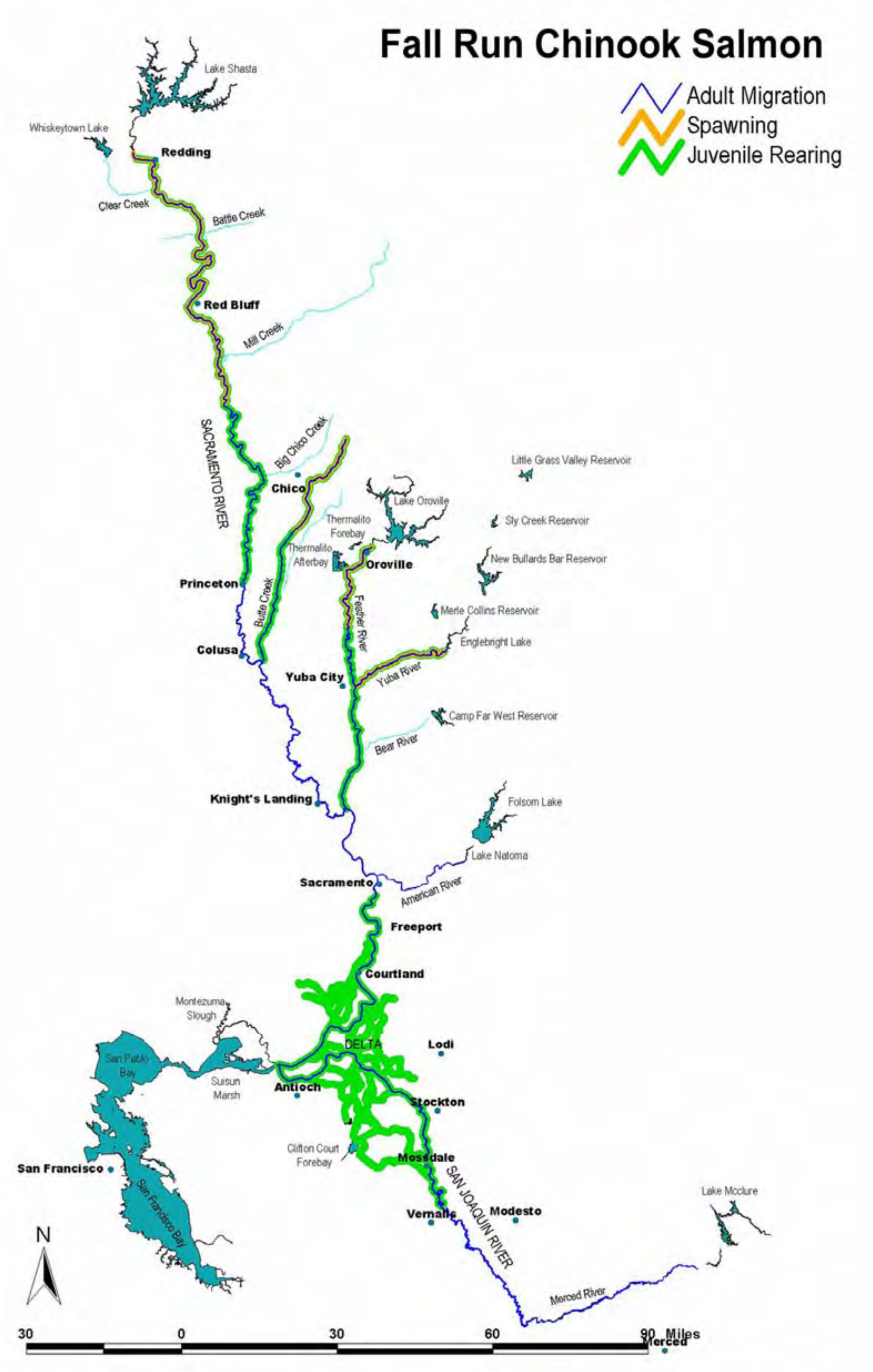

Figure 3-2. Distribution of Fall-run Chinook Salmon in the Central Valley

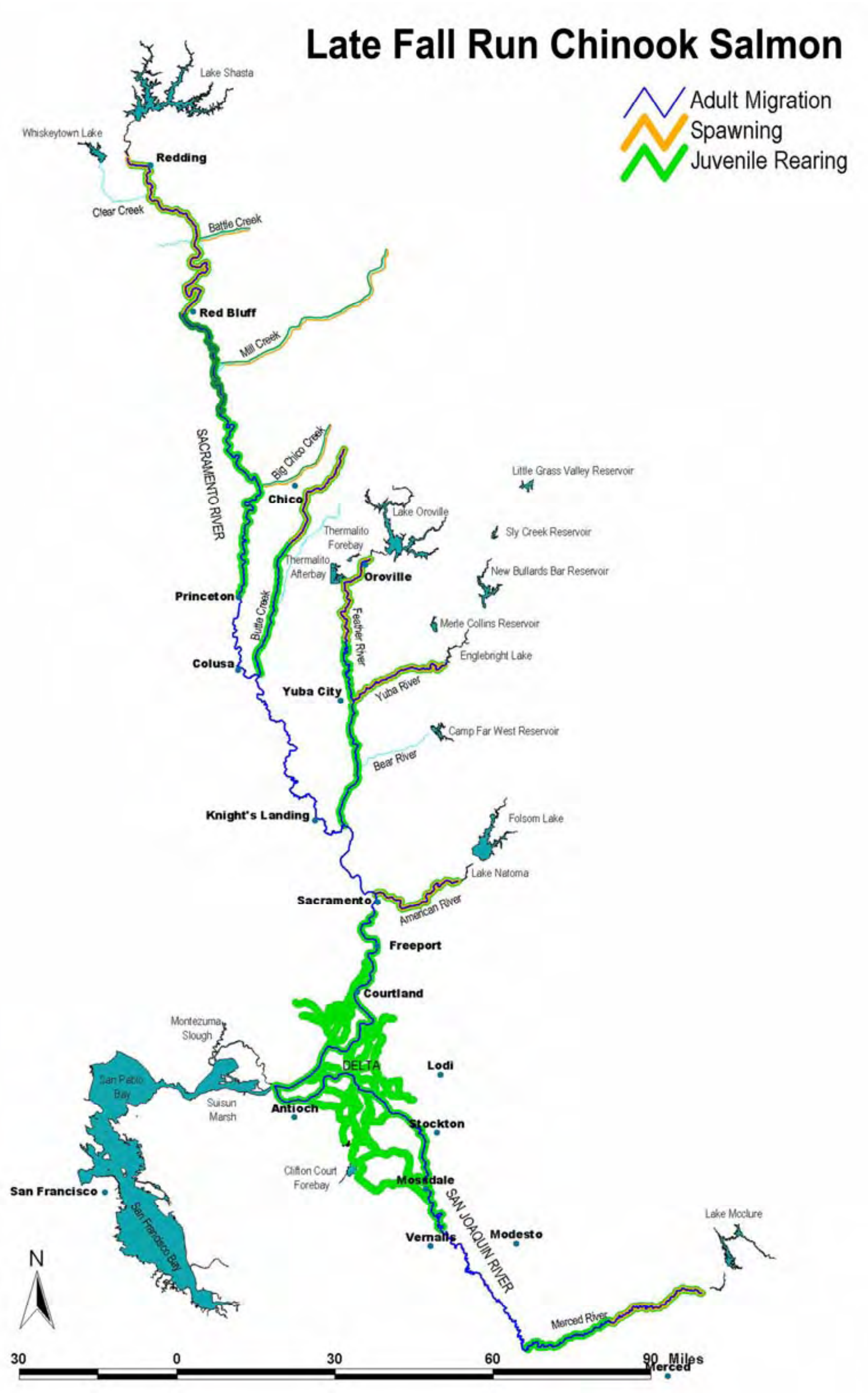

Figure 3-4. Distribution of Late Fall-run Chinook Salmon in the Central Valley

occurs, the fewer late-fall-run juveniles that successfully migrate to the Delta (Snider and Titus 2000a,b).

Figure 3-3. General Periodicity of Central Valley Late Fall-run Chinook Life Stages

Reasons for Decline. Loss and degradation of spawning and rearing habitat; alteration of streamflows; overharvest; entrainment into water diversions; blockage of migration routes; exposure to toxins; and, possibly, loss of genetic viability from interbreeding with hatchery stocks have contributed to the population decline of Central Valley fall-run/late-fall-run Chinook salmon. The human-caused factor that perhaps has had the greatest effect on the abundance of all Chinook salmon runs is loss of habitat, primarily in the rivers upstream from the Delta. Dams have presumably blocked some upstream access to habitat or impaired passage of adult fall-run and late-fall-run Chinook salmon (CDFG 1995). However, most of the historical spawning habitat for these runs has been downstream from impassable dams (Myers *et al.* 1998). Harvest rates of wild stocks are a potential contributing factor to the decline of the population; ocean harvest indices (i.e., percent of population harvested) range from 50 to 79 percent and averaged over 70 percent between 1990 and 1997 (PFMC 1998).

Designated Critical Habitat or Essential Fish Habitat. Critical habitat has not been proposed or designated. Essential fish habitat has been identified in the Pacific Coast Salmon Plan (PFMC 1997, 2000).

Conservation Efforts. The agencies implementing the CVPIA and CALFED actions are working to improve the quality of anadromous fish habitat, improving fish passage, and contributing to population recovery (AFRP 2001; CALFED 2000b).

Recovery Plan and Recovery Guidance. Measures for recovery of the Sacramento late-fall-run and San Joaquin fall-run Chinook salmon populations are presented in the Anadromous Fish Recovery Plan (AFRP 2001), CDFG (1995), and the Native Fishes Recovery Plan (USFWS 1996).

Research and Monitoring Gaps. The specific habitat requirements and causes of population declines of the fall-run and late-fall-run Chinook are not well known (CDFG 1995). Research is needed to characterize the genetic makeup of all Central Valley fall-run Chinook to compare populations in the San Joaquin River to other watersheds (Myers *et al.* 1998). In addition, the amount of spatial and seasonal overlap and genetic introgression between all runs in the Sacramento River is an important topic for study (CDFG 1995).

Fall-run/Late-fall-run Chinook Salmon Citations. Anadromous Fish Restoration Program (AFRP). 2001. Final Restoration Plan for the Anadromous Fish Restoration Program. U.S. Fish and Wildlife Service and Anadromous Fish Restoration Program Core Group, CA. Available online at: http://www.delta.dfg.ca.gov/afrp/restplan_final.asp.

Bjornn T.C. and D.W. Reiser. 1991. Habitat Requirements of Salmonids in Streams. Influences of Forest and Rangeland Management on Salmonid Fishes and their Habitats. p. 83-138. American Fisheries Society Special Publication 19.

CALFED. 2000b. Multi-Species Conservation Strategy; Final Programmatic EIS/EIR Technical Appendix. Available online at: http://calwater.ca.gov/Programs/EcosystemRestoration/EcosystemMultiSpeciesConservationStrategy.html

California Department of Fish and Game (CDFG). 1995. California's Plants and Animals: Chinook Salmon – Fall/Late Fall-run. Habitat Conservation Planning Branch: Sacramento, CA. Available online at: http://www.dfg.ca.gov/hcpb/species/ssc/sscfish/sr_lf_chnok.htm

California Department of Fish and Game (CDFG). 2001a. Central Valley anadromous fish-habitat evaluations October 1999-September 2000. Stream Evaluation Program Technical Report No. 01-3.

Healey, M.C. 1991. Pacific Salmon Life Histories. University of British Columbia Press. Vancouver.

Meehan W.R. and T.C. Bjornn. 1991. Salmonid Distributions and Life Histories. Influences of Forest and Rangeland Management on Salmonid Fishes and their Habitats. p. 47-82. American Fisheries Society Special Publication 19.

Moyle, P. B. 2002. Inland fishes of California: revised and expanded. University of California Press, Berkeley, CA. 502 pp.

Myers, J.M., R.G. Kope, G.J. Bryant, D. Teel, L.J. Lierheimer, T.C. Wainwright, W.S. Grant, F.W. Waknitz, K. Neely, S.T. Lindley, and R.S. Waples. 1998. Status Review of Chinook Salmon from Washington, Idaho, Oregon, and California. NOAA Technical Memorandum NMFS-NWFSC-35. February. Available online at: http://www.nwfsc.noaa.gov/publications/techmemos/tm35/index.htm

Myrick, C.A. and J.J. Cech, Jr. 2004. Temperature effects on juvenile anadromous salmonids in California's central valley: what don't we know? Rev. Fish Biol. Fisheries 14:113-123.National Marine Fisheries Service (NMFS). 1993. Biological Opinion for Winter-Run Chinook Salmon. February 12, 1993.

National Marine Fisheries Service (NMFS). 1999a. Endangered and threatened species: threatened status for two Chinook salmon evolutionarily significant units (ESUs) in California. Federal Register 64 (179): 50394-50415.

National Marine Fisheries Service (NMFS). 2004b. Biological Opinion on long-term Central Valley Project and State Water Project Operations Criteria and Plan. Southwest Region. October 2004.

Pacific Fishery Management Council (PFMC). 1997. Pacific Coast Salmon Plan. Portland, OR.

Pacific Fishery Management Council (PFMC). 1998. Review of 1997 ocean salmon fisheries. Portland, OR.

Pacific Fishery Management Council (PFMC). 2000. Amended Sections of the Pacific Coast Salmon Plan: Fishery Management Plan for Commercial and Recreational Salmon Fisheries off the Coasts of Washington, Oregon, and California as Revised by Amendment 14. Available online at: http://www.pcouncil.org/salmon/salfmp/a14.html.

Pacific Fisheries Management Council (PFMC). 2006. Review of 2005 ocean salmon fisheries. Portland, OR. Available online at: www.pcouncil.org/salmon/salsafe.html

Painter, R.E., L.H. Wixom, and S.N. Taylor. 1977. An evaluation of fish populations and fisheries in the post-Oroville project Feather River. Sacramento. CDFG-Anadromous Fisheries Branch.

Snider, B. and R. Titus. 2000a. Timing, Composition, and Abundance of Juvenile Anadromous Salmonid Emigration in the Sacramento River Near Knights Landing October 1996-September 1997. CDFG, Habitat Conservation Division Stream Evaluation Program, Technical Report No. 00-04.

Snider, B. and R. Titus. 2000b. Timing, Composition, and Abundance of Juvenile Anadromous Salmonid Emigration in the Sacramento River Near Knights Landing October 1997-September 1998. CDFG, Habitat Conservation Division Stream Evaluation Program, Technical Report No. 00-05.

United States Fish and Wildlife Service (USFWS). 1995. Draft Anadromous Fish Restoration Plan, A Plan to Increase Natural Production of Anadromous Fish in the Central Valley of California. Prepared for the Secretary of Interior under authority of the CVPIA. With assistance from the Anadromous Fish Restoration Core Group.

U.S. Fish and Wildlife Service (USFWS). 1996 Recovery plan for the Sacramento/San Joaquin Delta Native Fishes. U.S. Fish and Wildlife Service. Portland, OR.

Vogel, D.A. and K.R. Marine. 1991. Guide to upper Sacramento River Chinook salmon life history. U.S. Bureau of Reclamation Central Valley Project. CH2M Hill, Redding, CA.

Water Forum. 2002. Water Forum Year 1 Water Conservation Report. June 2002.

3.2.1.2 Sacramento River Winter-Run Chinook Salmon (Oncorhynchus tshawytscha)

Legal Status. Winter-run Chinook salmon were listed as endangered on January 4, 1994. This status was reaffirmed on June 28, 2005. The ESU includes all naturally spawned populations of winter-run Chinook salmon in the Sacramento River and its tributaries in California, as well as two artificial propagation programs: winter-run Chinook from the Livingston Stone National Fish Hatchery (NFH) and winter-run Chinook in a captive broodstock program maintained at Livingston Stone NFH and the University of California Bodega Marine Laboratory. Critical habitat for winter-run Chinook salmon was established effective July 16, 1993. The critical habitat designation includes the Sacramento River from Keswick Dam to Chipps Island, and all waters between Chipps Island and the Golden Gate Bridge and to the north of the San Francisco/Oakland Bay Bridge.

Historical and Current Distribution and Status. Sacramento River winter-run Chinook salmon primarily spawn in the mainstem Sacramento River below Keswick Dam (NMFS 1997, CDFG 2002). Adult winter-run Chinook salmon immigration (upstream spawning migration) through the Delta and into the lower Sacramento River occurs from November through June, with peak immigration during the period extending from January through April (USFWS 1995, Myers *et al.* 1998). These salmon spawn between late-April and mid-August, with peak spawning generally from May to June (NMFS 1997, Myers *et al.* 1998). Most young move out of spawning areas in November through June. Young may be found in the Sacramento River, Delta, and Bay ecozones from winter into early summer.

The historical distribution of winter-run Chinook prior to construction of Shasta Dam included the headwaters of the McCloud, Pit, and Little Sacramento Rivers and tributaries like Hat Creek and Fall River (Myers *et al.* 1998, NMFS 1999, NMFS 2003). Since completion of Shasta Dam, the Sacramento River, Battle Creek, and Calaveras River are the only habitats where winter-run Chinook have been known to occur (USFWS 1987, NMFS 1999). Fish still have access to Battle Creek through the Coleman NFH weir from a fish ladder that is opened during the peak of winter-run Chinook salmon migration period

(Ward and Kier 1999). Currently, if a winter-run Chinook salmon population exists in Battle Creek its population size is unknown and likely very small. In addition, a winter-run to the upper Calaveras River took place between 1972 and 1984, but this population seems to have been eliminated by drought, irrigation diversions, and access blocked by the New Hogan Dam (NMFS 1997, NMFS 1999). Calaveras River winter-run Chinook salmon appear to be extirpated (NMFS 2003).

Winter-run Chinook salmon fry and juveniles generally emigrate past Red Bluff Diversion Dam (RBDD) from July through March, peaking in September and October (Hallock and Fisher 1985, USBR 1992, CDFG 2002, Vogel and Marine 1991). The abundance of juvenile salmon in the upper Sacramento River peaks during September, while the abundance of juveniles in the Delta generally peaks during December to March (CDFG 2002). The differences in peak periods of the river and Delta suggest that juvenile winter-run Chinook salmon may rear in the middle or lower Sacramento River or upper Delta prior to seaward migration. The location and extent of this middle-area rearing is unknown, but the duration of fry presence in an area may be related to the magnitude of river flows and water temperatures during the rearing period (Stevens 1989). In addition, Maslin *et al.* (1999) have found that substantial numbers of winter-run juveniles use tributaries for non-natal rearing. While small tributaries generally have insufficient flow for spawning adults, juvenile Chinook move upstream to rear, depending on the size, gradient, and quality of the tributary.

Historically, winter-run Chinook abundance during spawning was tens of thousands of adult salmon (NMFS 2003). Since 1970, winter-run salmon abundance has declined dramatically into the early 1990s, when average returns were in the hundreds (PFMC 2003). Escapement estimates of winter-run Chinook salmon between 1995 and 2002 ranged from approximately 600 to 7,600 adults (PFMC 2003); from 2003-2005 estimates ranged from 2,588 to 6,172 (PFMC 2006). Some evidence suggests that the winter-run Chinook population has been growing since the 1990s, but still remain far below the proposed recovery level (NMFS 2003, PFMC 2003, 2006).

Distribution in the CALFED Solution Area and EWA Action Area. Winter-run Chinook salmon are generally found in the mainstem Sacramento River, with use of tributaries by rearing juveniles (NMFS 1997, Maslin *et al.* 1999). Winter-run Chinook salmon are found in the Sacramento River, Sacramento-San Joaquin Delta, and Suisun Marsh/North San Francisco Bay Ecological Zones. They also may rear in the lower portions of tributaries in the north Sacramento Valley (e.g., Battle Creek), Butte Basin, Feather River/Sutter Basin, American River Basin, Calaveras Creek, Cottonwood Creek, Yolo Basin, and Colusa Basin Ecological Zones (CALFED 2000).

Life History and Habitat Requirements. Adult winter-run Chinook salmon immigration occurs from December through July, with a peak during the period extending from January through April (USFWS 1995) (Figure 3-5). Winter-run

Chinook salmon primarily spawn in the main-stem Sacramento River from Keswick Dam (RM 302) to Battle Creek (RM 271), from late-April to September, with the peak generally occurring from late June to early July.

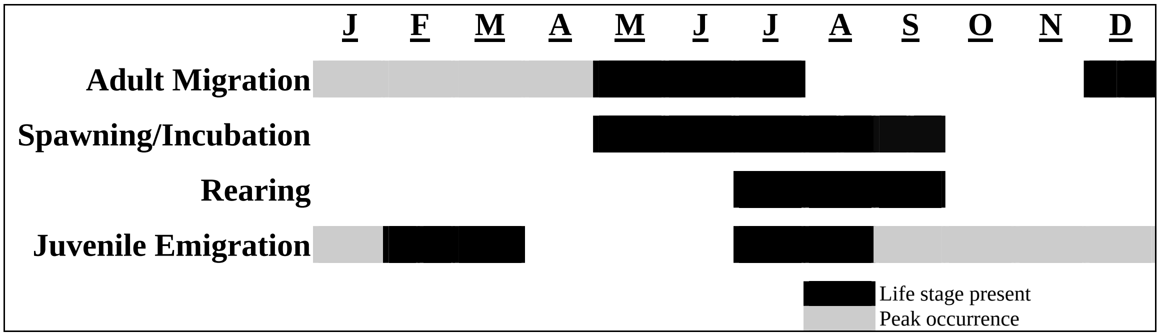

Figure 3-5. General Periodicity of Central Valley Winter-run Chinook Life Stages

Most winter-run Chinook salmon fry only rear for a short period in the upper Sacramento River. They used the Sacramento River from about Red Bluff to the Delta for rearing and emigration from July through March (Vogel and Marine 1991; USBR 1992, CDFG 2001a). Emigration past Knights Landing, approximately 155.5 river miles downstream of the Red Bluff Diversion Dam and 90 miles upstream of the Delta, occurs from November to March peaking from December to January. Emigration continues through May in some years (Snider and Titus 2000a; Snider and Titus 2000b). Juvenile abundance at Knights Landing appears to be related to timing and magnitude of the early season flows similar to the observation of late-fall-run emigration (Snider and Titus 2000a; Snider and Titus 2000b). Additional information on the life history and habitat requirements of winter-run Chinook salmon is contained in the NMFS Biological Opinion on the effects of long-term Project operations for this species that specifically evaluate impacts on winter-run Chinook salmon associated with CVP and SWP operations (NMFS 1993, NMFS 2004b).

The Sacramento River winter-run Chinook salmon ESU is listed as “endangered” under both the Federal and State ESA. In 1993, critical habitat for winter-run Chinook was designated to include the Sacramento River from Keswick Dam, (River Mile [RM] 302) to Chipps Island (RM 0) at the westward margin of the Sacramento-San Joaquin Delta (Figure 3-6). Also included are waters of Suisun Bay to Carquinez Bridge, San Pablo Bay, and San Francisco Bay north of the Oakland Bay Bridge (NMFS 1993).

Reasons for Decline. Loss and degradation of spawning and rearing habitat, alteration of streamflows, overharvest, high summer water temperatures, entrainment into water diversions, blockage of migration routes, predation of juveniles, exposure to toxins, and natural environmental variability have all contributed to the population decline of Sacramento River winter-run Chinook salmon (NMFS 1993, 1997, 2003; Myers *et al.* 1998; CALFED 2000, NMFS

Figure 3-6. Distribution of Winter-run Chinook Salmon in the Central Valley

2003). Sharp population declines of this salmon roughly correlate with increased water exports, operation of the RBDD, and unsuitable water temperatures (NMFS 1997). Habitat has been altered through the construction of dams and export facilities which can cause unsuitable water conditions for adult migration and fry development with respect to flows, temperature, pollution levels, oxygen deficiency, sedimentation, and gravel availability (NMFS 1993, 1997). Structures such as these can also block access to upstream habitat, delay migration of adults, and potentially increase predation on downstream-migrating juvenile salmon (USBR 1983). Environmental fluctuations, such as drought and strong El Nino conditions, also exacerbate these poor habitat conditions (NMFS 1997).

Commercial or recreational harvest has not been implicated as a major factor in the decline of winter-run salmon, although historical harvests of substantial levels may have contributed to declines of specific annual classes in the past (NMFS 1997).

Designated Critical Habitat or Essential Fish Habitat. In 1993, critical habitat for winter-run Chinook was designated to include the Sacramento River from Keswick Dam (River Mile [RM] 302) to Chipps Island (RM 0) at the westward margin of the Sacramento-San Joaquin Delta (CALFED 2000). Also included are waters west of the Carquinez Bridge, Suisun Bay, San Pablo Bay, and San Francisco Bay north of the Oakland Bay Bridge (NMFS 1993). Essential fish habitat has been identified in the Pacific Coast Salmon Plan (PFMC 1997, 2000).

Critical habitat for winter-run Chinook also includes those areas possessing the primary constituent elements (PCEs) essential to the conservation of winter-run Chinook salmon. The proposed rule for the determination of critical habitat for the winter-run Chinook provides details on these constituent elements. In particular, PCEs for winter-run Chinook include specific water temperature criteria, minimum instream flow criteria, water quality standards, unimpeded adult upstream migration routes, spawning habitat, egg incubation and fry emergence areas, rearing areas for juveniles, and unimpeded downstream migration routes for juveniles. Specifically:

> “To achieve the maximum conservation and recovery benefits for winter-run Chinook salmon, the average daily water temperature in the Sacramento River should not exceed 56*F (13.3*C) between Keswick Dam and Red Bluff Diversion Dam from April 15 through September 30, and at no more than 60*F (15.5*C) from October 1 through October 31. Survival of winter-run Chinook’s developing eggs are adversely affected at temperatures above 56 (13.3*C).
>
> Similarly for maximum recovery, instream flows should be no less than 6,000 cubic feet per second (cfs) at Keswick Dam from April 15 through October 15. Flows below 6,000 cfs at Keswick Dam during this critical

> period may increase mortality to a level that is not acceptable. In addition, reductions in flows from 8,000 to 6,000 cfs at Keswick Dam should not occur at a rate of more than 1,000 cfs per day. Finally, instream flows in the Sacramento River should be maintained at levels necessary to ensure that a 500 cfs bypass flow occurs in the lower side channel between the fish bypass outlet at the Glenn-Colusa Irrigation Districts facility and the Sacramento River between July 31 and October 31. Absent unusual circumstances, the 500 cfs bypass flow in this area is considered the minimum necessary to ensure this portion of the winter-run Chinook's critical habitat is not degraded.
>
> Water quality is another essential feature of winter-run Chinook habitat. In particular, dredging activities may degrade critical habitat used by winter-run Chinook in San Francisco Bay and elsewhere. In the past, NMFS has evaluated dredging projects both in terms of their quantitative and qualitative impact on water quality. In general small scale dredging projects, typically 100,000 cubic yards or less, were thought to have a minor impact while larger projects, especially projects involving contaminated sediments were thought to have potentially significant adverse impacts on water quality. NMFS is attempting to evaluate and establish more specific criteria for use in dredging activities may have on this important habitat feature" (57CFR36626)

Conservation Efforts. The agencies implementing CVPIA and CALFED actions are working to improve the quality of anadromous fish habitat, fish passage, and contributing to population recovery (CDFG 2002). Recently initiated conservation actions include restoration of Battle Creek, ocean harvest reductions, screening of water diversions, remediation of Iron Mountain Mine, and improved water temperature control (NMFS 2003). The Winter-run captive Brood stock Program (WRCBP), designed as a hedge against the potential of a catastrophic cohort failure or extinction of the run in the wild, currently houses winter-run Chinook salmon at Bodega Marine Laboratory and Livingston Stone NFH (CDFG 2002). From 2001 to 2004, USFWS yearly released from 166,000 to 252,500, juvenile winter-run Chinook salmon brood stock progeny (CDFG 2002, 2004).

Recovery Plan and Recovery Guidance. The NMFS (1997) has prepared a proposed recovery plan for winter-run Chinook. The recovery goals include protecting and restoring spawning and rearing habitat; improving the survival of downstream migrants; improving adult upstream passage; reducing harvest; reducing impacts of management programs; and improving understanding of life history and habitat requirements. The delisting criteria are 1) mean annual spawning abundance of 10,000 females over 13 consecutive years; 2) a cohort replacement rate (CRR) greater than 1.0; and 3) a standard error less 25 percent of the spawning population estimate (CALFED 2000, NMFS 2003). Additional recovery guidance is presented in the Anadromous Fish Recovery Plan (AFRP 2001).

In order to develop a recovery plan, the NMFS first studied the historical structure of the winter-run Chinook population. The Central Valley Technical Recovery Team (TRT) was initiated to develop recovery criteria for all listed ESUs in the Central Valley, including the Sacramento winter-run Chinook, Central Valley spring-run Chinook, and the Central Valley steelhead. The focus of the TRT is to describe population structure to determine appropriate criteria for the evaluation of viable salmonid populations (Lindley et al. 2004). Populations of salmonids with structures similar to those historically are thought to be viable in the current system. A single, current, independent population of winter-run Chinook was identified by the TRT between Keswick Dam and Red Bluff on the Sacramento River. The TRT suggested that the winter-run Chinook salmon persisted in this area due to temporal isolation from the fall-run Chinook.

Research and Monitoring Gaps. Research into the behavior and use of juvenile winter-run Chinook in estuarine habitats would help ascertain key limiting factors for this species. For example, the effect of high water temperatures on growth and the cues for juvenile migration from the estuary are not well known (NMFS 1997). In addition, the extent and duration of juvenile salmon rearing in the middle to lower Sacramento River is not clear. Studying genetic differentiation of different Central Valley salmon runs has provided insight into the genetic status of the winter-run Chinook and development protocols for use in artificial propagation (CDFG 2002). Experimental captive rearing programs at Bodega Marine Laboratory and Livingston Stone NFH continue to rear winter-run Chinook salmon to maturity in captivity (CDFG 2002).

Sacramento River Winter-run Chinook Salmon Citations. Anadromous Fish Restoration Program (AFRP). 2001. Final Restoration Plan for the Anadromous Fish Restoration Program. U.S. Fish and Wildlife Service and Anadromous Fish Restoration Program Core Group, CA. Available online at: http://www.delta.dfg.ca.gov/afrp/restplan_final.asp.

CALFED Bay-Delta Program. 2000. Programmatic Record of Decision. Sacramento, CA.

California Department of Fish and Game (CDFG). 2001a. Central Valley anadromous fish-habitat evaluations October 1999-September 2000. Stream Evaluation Program Technical Report No. 01-3.

California Department of Fish and Game (CDFG). 2002. Sacramento River winter-run Chinook Salmon: Biennial Report, 2000-2001. Unpublished report prepared for the Fish and Game Commission by the California Department of Fish and Game, Sacramento, CA.

California Department of Fish and Game (CDFG). 2004. Sacramento River winter-run Chinook Salmon: Biennial Report, 2002-2003. Unpublished report prepared for the Fish and Game Commission by the California Department of Fish and Game, Sacramento, CA. Available online at: http://www.dfg.ca.gov/nafwb/pubs/2004/ChinookWR0203.pdf.

Hallock, R.J. and F.W. Fisher. 1985. Status of the winter-run Chinook Salmon (Oncorhynchus tshawytscha) in the Sacramento River. Prepared for the CDFG.

Lindley, S.T., R. Schick, B.P. May, J.J. Anderson, S. Greene, C. Hanson, A. Low, D. McEwan, R.B. MacFarlane, C. Swanson, and J.G. Williams. 2004. Population structure of threatened and endangered Chinook salmon ESUs in California's Central Valley basin. NOAA Technical Memorandum NOAA-TM-NMFS-SWFSC-370, 66p.

Maslin, P., J. Kindopp, M. Lennox, and C. Storm. 1999. Intermittent streams as rearing habitat for Sacramento River Chinook Salmon (Oncorhynchus tshawytscha): 1999 update [online]. Unpublished report prepared by Paul Maslin, Biology Department, California State University, Chico, CA. Available online at: http://www.csuchico.edu/~pmaslin/rsrch/Salmon99/abstrct.html.

Myers, J.M., R.G. Kope, G.J. Bryant, D. Teel, L.J. Lierheimer, T.C. Wainwright, W.S. Grant, F.W. Waknitz, K. Neely, S.T. Lindley, and R.S. Waples. 1998. Status Review of Chinook Salmon from Washington, Idaho, Oregon, and California. NOAA Technical Memorandum NMFS-NWFSC-35. February. Available online at: http://www.nwfsc.noaa.gov/publications/techmemos/tm35/index.htm

National Marine Fisheries Service (NMFS). 1993. Biological Opinion for the Operation of the Federal Central Valley Project and the California State Water Project. February 12, 1993.

National Marine Fisheries Service (NMFS). 1997. Proposed Recovery Plan for the Sacramento River winter-run Chinook Salmon. National Marine Fisheries Service, Southwest Regional Office, Long Beach, CA.

National Marine Fisheries Service (NMFS). 1999. Central Valley Chinook Salmon Distributions. Prepared by Sommarstrom, S., A. Eller, and V. Costi for the National Marine Fisheries Service, Southwest Regional Office, Long Beach, CA. Available online at: http://swr.nmfs.noaa.gov/hcd/cvcsd.htm.

National Marine Fisheries Service (NMFS). 2003. Preliminary Conclusions Regarding the Updated Status of Listed ESUs of West Coast Salmon and Steelhead: Draft report. West Coast Salmon Biological Review Team: Northwest Fisheries Science Center, Seattle, WA and Southwest Fisheries Science Center, Santa Cruz, CA. Available online at: http://www.nwfsc.noaa.gov/cbd/trt/brt/brtrpt.html.

National Marine Fisheries Service (NMFS). 2004b. Biological Opinion on long-term Central Valley Project and State Water Project Operations Criteria and Plan. Southwest Region. October 2004.

Pacific Fishery Management Council (PFMC). 1997. Pacific Coast Salmon Plan. Portland, OR.

Pacific Fishery Management Council (PFMC). 2000. Amended Sections of the Pacific Coast Salmon Plan: Fishery Management Plan for Commercial and Recreational Salmon Fisheries off the Coasts of Washington, Oregon, and California as Revised by Amendment 14. Available online at: http://www.pcouncil.org/salmon/salfmp/a14.html .

Pacific Fisheries Management Council (PFMC). 2003. Review of 2002 ocean salmon fisheries. Portland, OR. Available online at: www.pcouncil.org/salmon/salsafe.html

Pacific Fisheries Management Council (PFMC). 2006. Review of 2005 ocean salmon fisheries. Portland, OR. Available online at: www.pcouncil.org/salmon/salsafe.html

Snider, B. and R. Titus. 2000a. Timing, Composition, and Abundance of Juvenile Anadromous Salmonid Emigration in the Sacramento River Near Knights Landing October 1996-September 1997. CDFG, Habitat Conservation Division Stream Evaluation Program, Technical Report No. 00-04.

Snider, B. and R. Titus. 2000b. Timing, Composition, and Abundance of Juvenile Anadromous Salmonid Emigration in the Sacramento River Near Knights Landing October 1997-September 1998. CDFG, Habitat Conservation Division Stream Evaluation Program, Technical Report No. 00-05.

Stevens, D. 1989. When do winter-run Chinook salmon smolts migrate through the Sacramento-San Joaquin Delta? Unpublished Memorandum. Prepared for California Department of Fish and Game, Bay-Delta Project. Stockton, CA.

U.S. Bureau of Reclamation (USBR). 1983. Central Valley fish and wildlife management study: predation of anadromous fish in the Sacramento River, California. Special Report. Sacramento, CA.

U.S. Bureau of Reclamation (USBR). 1992. Biological Assessment for USBR. 1992 Central Valley Project Operations. Mid-Pacific Region. Sacramento, CA.

U.S. Fish and Wildlife Service (USFWS). 1987. An Analysis of the Effectiveness of the Mitigation Plan for Shasta and Keswick Dams, Division of Ecological Services, Sacramento CA.

U.S. Fish and Wildlife Service (USFWS). 1995. Draft Anadromous Fish Restoration Plan, A Plan to Increase Natural Production of Anadromous Fish in the Central Valley of California. Prepared for the Secretary of Interior under authority of the CVPIA. With assistance from the Anadromous Fish Restoration Core Group.

Vogel, D.A. and K.R. Marine. 1991. Guide to upper Sacramento River Chinook salmon life history. U.S. Bureau of Reclamation Central Valley Project. CH2M Hill, Redding, CA.

Ward, M.B. and W.M. Kier. 1999. Maximizing compatibility between Coleman National Fish Hatchery operations, management of lower Battle Creek, and Chinook salmon and steelhead restoration. Prepared by Kier Associates for Battle Creek Working Group. Available online at: http://www.battle-creek.net/docs/ward_battlecrk_compatibility_1999.pdf

3.2.1.3 Central Valley Spring-Run Chinook Salmon (Oncorhynchus tshawytscha)

Legal Status. The Central Valley spring-run Chinook salmon ESU includes all naturally spawned populations of spring-run Chinook salmon in the Sacramento River and its tributaries in California, including the Feather River. The ESU was listed as threatened on September 16, 1999 (64 FR 50394). The listing was revisited in 2004, when NMFS reconsidered the listing following litigation regarding inclusion of hatchery stocks within salmonid ESUs (69 FR 33102). On June 28, 2005, after reviewing the best available scientific and commercial information, NMFS issued its final decision to retain the status of Central Valley spring-run Chinook salmon as threatened (70 FR 37160). This decision also included the Feather River Hatchery spring-run Chinook salmon population as part of the Central Valley spring-run Chinook salmon ESU. Designated critical habitat for Central Valley spring-run Chinook salmon ESU includes 1,158 miles of stream habitat in the Sacramento River basin and 254 square miles of estuary habitat in the San Francisco-San Pablo-Suisun Bay complex (70 FR 52488, September 2, 2005, Figure 2).

Historical and Current Distribution and Status. Historically, the Central Valley spring-run Chinook salmon was one of the most abundant and widely distributed salmon races in the rivers and creeks of the Central Valley, including the middle and upper reaches of the San Joaquin, American, Yuba, Feather, Sacramento, McCloud, and Pit Rivers (NMFS 1999b, NMFS 2002). Gold mining and agricultural diversions caused the first major declines in spring-run Chinook populations (Moyle *et al.* 1995). Further extirpations followed construction of major water storage and flood control reservoirs on the Sacramento and San Joaquin Rivers and their major tributaries in the 1940s and 1950s (Moyle *et al.* 1995; NMFS 1998). Spring-run Chinook salmon have been completely extirpated in the San Joaquin drainage. The only populations of spring-run salmon are currently restricted to accessible reaches in the upper Sacramento River mainstem, Antelope Creek, Battle Creek, Beegum Creek, Big Chico Creek, Butte Creek, Clear Creek, Deer Creek, Feather River, Mill Creek, and Yuba River (CDFG 1998; CALFED 2000a; NMFS 2002, 2003). In the 1980s, these populations reached low abundance levels (e.g., 5-year mean population sizes of 67-243 spawners), compared to historic peak abundance of 700,000 spawners (NMFS 2003). New abundance data suggest that these populations have started increasing since the 1990s, perhaps as the result of habitat improvements, reduced ocean fisheries, and a favorable terrestrial climate (NMFS 2003).

Distribution in the CALFED Solution Area and EWA Action Area. Spring-run Chinook salmon are found in the Suisun Marsh/North San Francisco Bay, Sacramento-San Joaquin Delta, Sacramento River, Feather River/Sutter Basin, Butte Basin, and North Sacramento Valley Ecological Zones (CALFED 2000a).

Life History and Habitat Requirements. Spring-run Chinook enter the freshwater environment as sexually immature adults from January through July; peak migration is during April-May (Moyle 2002: CDFG 1998 and NMFS 2004b) (Figure 3-7). The adults typically mature in cool, deep pools during the summer and spawn from late-August through October, peaking in mid-September (Moyle 2002). Most juvenile spring-run Chinook rear for about a full year in the upper Sacramento from Redding to Red Bluff and in the upper reaches of the tributaries. Spring-run Chinook salmon fry emerge from the gravel from November through March and spend 3 to 15 months (Figure 3-7) in freshwater habitats prior to emigrating to the ocean (NMFS 2004b). Most spring-run juveniles emigrate as smolts, although some portion of an annual year-class may emigrate as fry. Emigration timing varies among the tributaries of origin, and can occur during the period extending from November through May (NMFS 2004b). In the Feather River, data on juvenile spring-run emigration timing and abundance have been collected sporadically since 1955 and suggests that November and December may be key months for spring-run emigration (Painter et al. 1977). The bulk of emigration in Butte Creek occurs from December to January, with some emigration continuing through May (CDFG 1998). Some juveniles continue to rear in Butte Creek through the summer and emigrate as yearlings from October to February, with peak yearling emigration occurring in November and December (CDFG 1998).

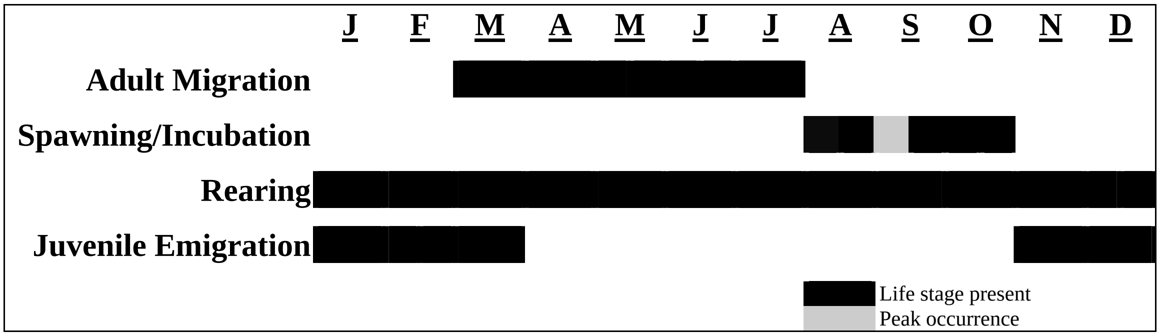

Figure 3-7. General Periodicity of Central Valley Spring-run Chinook Life Stages

The few persistent spring-run Chinook salmon populations in the EWA area of analysis are limited to Mill, Deer, and Butte Creeks in the Sacramento River system (CDFG 1998). The upper Sacramento, Yuba, and Feather Rivers reportedly support small, less persistent spring-run Chinook salmon populations (Figure 3-8).

Reasons for Decline. Factors related to the decline of spring-run Chinook salmon include loss of habitat in river reaches blocked by dams; water development and management activities that affect water quality, timing, and quality; entrainment in water diversions; land uses that degrade aquatic and riparian habitats; over harvesting through commercial fisheries; climatic fluctuations; predation and disease; and genetic threats from the Feather River Hatchery spring-run Chinook salmon program (CDFG 1998; CALFED 2000a; NMFS 2002, 2003). The human-caused factor that has had the greatest effect on the abundance of spring-run Chinook salmon runs is loss of habitat primarily in the rivers upstream from the Delta. Major dams (e.g., Shasta, Oroville, and Friant dams) have blocked upstream access to most Chinook salmon habitat in Central Valley rivers and streams, and smaller dams with ineffective ladders also impair passage of adult spring-run (CDFG 1998). Estimates suggest that up to 95 percent of spring-run salmon spawning and rearing habitat has been lost in the Central Valley (NMFS 2003). Water diversions and reservoir operations affect streamflow, which influences the quantity, quality, and distribution of Chinook salmon spawning and rearing habitat. Water diversions also reduce survival of emigrating juvenile salmonids through direct entrainment losses in unscreened or inadequately screened diversions. The Feather River Hatchery spring-run Chinook program is a threat to genetic integrity of the remaining wild spring-run Chinook populations through possible hybridization introgression with fall stock and high rates of straying (NMFS 2003).

Designated Critical Habitat or Essential Fish Habitat. Critical habitat for the spring-run Chinook salmon was first designated on February 16, 2000. On April 30, 2002, the U.S. District Court for the District of Columbia approved a

Figure 3-8. Distribution of Spring-run Chinook Salmon in the Central Valley

NMFS consent decree withdrawing the February 2000 critical habitat designation for this and 18 other ESUs (NMFS 2002). However, in September, 2005, critical habitat was once again designated and effective January 2, 2006 (NMFS 2005b). Essential fish habitat has been identified in the Pacific Coast Salmon Plan (PFMC 1997, 2000).

Critical habitat for spring-run Chinook salmon includes those areas possessing the PCEs essential to the conservation of this species. The final rule for the determination of critical habitat for spring-run Chinook salmon provides details on these constituent elements. Specific PCEs include:

> "1. Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development. These features are essential to conservation because without them the species cannot successfully spawn and produce offspring.
>
> 2. Freshwater rearing sites with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks. These features are essential to conservation because without them juveniles cannot access and use the areas needed to forage, grow, and develop behaviors (*e.g.*, predator avoidance, competition) that help ensure their survival.
>
> 3. Freshwater migration corridors free of obstruction with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival. These features are essential to conservation because without them juveniles cannot use the variety of habitats that allow them to avoid high flows, avoid predators, successfully compete, begin the behavioral and physiological changes needed for life in the ocean, and reach the ocean in a timely manner. Similarly, these features are essential for adults because they allow fish in a nonfeeding condition to successfully swim upstream, avoid predators, and reach spawning areas on limited energy stores.
>
> 4. Estuarine areas free of obstruction with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater; natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation. These features are essential to conservation because without them juveniles

> cannot reach the ocean in a timely manner and use the variety of habitats that allow them to avoid predators, compete successfully, and complete the behavioral and physiological changes needed for life in the ocean. Similarly, these features are essential to the conservation of adults because they provide a final source of abundant forage that will provide the energy stores needed to make the physiological transition to fresh water, migrate upstream, avoid predators, and develop to maturity upon reaching spawning areas.
>
> 5. Nearshore marine areas free of obstruction with water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels. As in the case with freshwater migration corridors and estuarine areas, nearshore marine features are essential to conservation because without them juveniles cannot successfully transition from natal streams to offshore marine areas.
>
> 6. Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation. These features are essential for conservation because without them juveniles cannot forage and grow to adulthood. However, for the reasons stated previously in this document, it is difficult to identify specific areas containing this PCE as well as human activities that may affect the PCE condition in those areas. Therefore, we have not designated any specific areas based on this PCE but instead have identified it because it is essential to the species' conservation and specific offshore areas may be identified in the future (in which case any designation would be subject to separate rulemaking)" (70FR52488).

Conservation Efforts. Agencies implementing the CVPIA and CALFED actions are working to improve the quality of anadromous fish habitat, improving fish passage, and contributing to population recovery (CDFG 2002; CALFED 2000b). Recently initiated conservation actions include habitat improvements (e.g., removal of several small dams and increases in summer flows) and reduced ocean fisheries (NMFS 2003). CDFG (1998) presents suggestions for future management of spring-run Chinook salmon.

Recovery Plan and Recovery Guidance. Measures for recovery of spring-run Chinook populations are presented in the Anadromous Fish Recovery Plan (AFRP 2001), Delta Native Fishes Recovery Plan (USFWS 1996), CDFG status reports (1998, 2001, 2002), and an interim biological opinion of the NMFS (2002). CALFED (2000b) will also provide support to NMFS in recovery efforts following the Viable Salmonid Population (VSP) framework (McElhany *et al.* 2000), which will target restoring four key Chinook salmon population characteristics: 1) abundance; 2) productivity; 3) spatial distribution; and 4) diversity. Final revised protective regulations were published in 2005 (NMFS 2005b).

In addition, an NOAA Fishery TRT for spring-run Chinook will be developing an updated, long-range plan based on the historical structure of spring-run populations within the ESU (Lindley et al. 2004). Independent populations were largely separated by the influence of hydrology. A return of the population to the historical structure is strongly altered by the habitat modification to the Central Valley system, primarily due to impassible barriers in lower reaches.

Research and Monitoring Gaps. Current research for spring-run Chinook is focusing on intensive studies of Butte Creek spring-run Chinook and genetic clarification of Feather River Hatchery fish (NMFS 2003). Myers *et al.* (1998) also point out that additional genetic information would help elucidate the status of remnant spring-run populations in Butte, Deer, and Mill Creeks and their relationship to spring-run fish from the mainstem Sacramento and Feather Rivers. Studying emigration timing, migration pathways, and juvenile abundance will help to plan habitat restoration projects (CDFG 2000). Additional areas for research include extent and effect of diseases, hatcheries as conservation, effects of mixed-stock fisheries, assessment of relative roles of different mortality factors, experimental assessment of the effects of river operations, efficacy of various habitat improvements, stock identification for management, and constant fractional marking (CDFG 1998, NMFS 2003).

Central Valley Spring-run Chinook Salmon Citations. Anadromous Fish Restoration Program (AFRP). 2001. Final Restoration Plan for the Anadromous Fish Restoration Program. U.S. Fish and Wildlife Service and Anadromous Fish Restoration Program Core Group, CA. Available online at: http://www.delta.dfg.ca.gov/afrp/restplan_final.asp.

CALFED Bay-Delta Program. 2000a. Programmatic Record of Decision. Sacramento, CA.

CALFED. 2000b. Multi-Species Conservation Strategy; Final Programmatic EIS/EIR Technical Appendix. Available online at: http://calfed.ca.gov/Programs/EcosystemRestoration/EcosystemMultiSpeciesConservationStrategy.shtml

California Department of Fish and Game (CDFG). 1998. Report to the Fish and Game Commission: A Status Review of the Spring-Run Chinook Salmon (Oncorhyncus tshawytscha) in the Sacramento River Drainage. Candidate Species Status Report 98-01. June.

California Department of Fish and Game (CDFG). 2000. The status of rare, threatened, and endangered animals and plants of California. Habitat Conservation Planning Branch.

California Department of Fish and Game (CDFG). 2001. Spring-run Chinook Salmon: Annual Report. Unpublished report prepared for the Fish and Game Commission by the California Department of Fish and Game, Sacramento, CA.

California Department of Fish and Game (CDFG). 2002. Sacramento River Spring-run Chinook Salmon: Annual Report, 2001. Unpublished report prepared for the Fish and Game Commission by the California Department of Fish and Game, Sacramento, CA.

Lindley, S.T., R. Schick, B.P. May, J.J. Anderson, S. Greene, C. Hanson, A. Low, D. McEwan, R.B. MacFarlane, C. Swanson, and J.G. Williams. 2004. Population structure of threatened and endangered Chinook salmon ESUs in California's Central Valley basin. NOAA Technical Memorandum NOAA-TM-NMFS-SWFSC-370, 66p.

McElhany, P., M.H. Ruckelshaus, M.J. Ford, T.C. Wainwright, and E.P. Bjorkstedt. 2000. Viable salmonid populations and the recovery of evolutionarily significant units. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS-NWFSC-42, 156 p.

Moyle, P. B. 2002. Inland fishes of California: revised and expanded. University of California Press, Berkeley, CA. 502 pp.

Moyle, P. B., R. M. Yoshiyama, J. E. Williams, and E. D. Wikramanayake. 1995. Fish species of special concern in California. Second edition. Prepared for California Resources Agency and California Department of Fish and Game, Inland Fisheries Division. Rancho Cordova, CA.

Myers, J.M., R.G. Kope, G.J. Bryant, D. Teel, L.J. Lierheimer, T.C. Wainwright, W.S. Grant, F.W. Waknitz, K. Neely, S.T. Lindley, and R.S. Waples. 1998. Status Review of Chinook Salmon from Washington, Idaho, Oregon, and California. NOAA Technical Memorandum NMFS-NWFSC-35. February. Available online at: http://www.nwfsc.noaa.gov/publications/techmemos/tm35/index.htm.

National Marine Fisheries Service (NMFS). 1998. Endangered and threatened species: proposed endangered status for two Chinook salmon ESU and proposed threatened status for five Chinook salmon ESUs; proposed redefinition, threatened status, and revision of critical habitat for one Chinook salmon ESU; proposed designation of Chinook salmon critical habitat in California, Oregon, Washington, and Idaho. Federal Register 63 (45): 11481-11520.

National Marine Fisheries Service (NMFS). 1999b. Central Valley Chinook Salmon Distributions. Prepared by Sommarstrom, S., A. Eller, and V. Costi for the National Marine Fisheries Service, Southwest Regional Office, Long Beach, CA. Available online at: http://swr.nmfs.noaa.gov/hcd/cvcsd.htm.

National Marine Fisheries Service (NMFS). 2002. Biological Opinion for the Interim Operations of the Central Valley Project and State Water Project Between April 1, 2002 and March 31, 2004. National Marine Fisheries Service, Southwest Regional Office, Long Beach, CA. Available online at: http://swr.nmfs.noaa.gov/sac/myweb8/webpages/biol_opinions.htm#2000.

National Marine Fisheries Service (NMFS). 2003. Preliminary Conclusions Regarding the Updated Status of Listed ESUs of West Coast Salmon and Steelhead: Draft report. West Coast Salmon Biological Review Team: Northwest Fisheries Science Center, Seattle, WA and Southwest Fisheries Science Center, Santa Cruz, CA. Available online at: http://www.nwfsc.noaa.gov/trt/brt/brtrpt.cfm?CFID=29815583&CFTOKEN=22128098&jsessionid=6430861296c43f3c5117

National Marine Fisheries Service (NMFS). 2004b. Biological Opinion on long-term Central Valley Project and State Water Project Operations Criteria and Plan. Southwest Region. October 2004.

National Marine Fisheries Service (NMFS). 2005b. Endangered and threatened species: designation of critical habitat for seven evolutionarily significant units of Pacific salmon and steelhead in California. Federal Register 70 (123): 52488-52627.

Pacific Fishery Management Council (PFMC). 1997. Pacific Coast Salmon Plan. Portland, OR.

Pacific Fishery Management Council (PFMC). 2000. Amended Sections of the Pacific Coast Salmon Plan: Fishery Management Plan for Commercial and Recreational Salmon Fisheries off the Coasts of Washington, Oregon, and California as Revised by Amendment 14. Available online at: http://www.pcouncil.org/salmon/salfmp/a14html.

Painter, R.E., L.H. Wixom, and S.N. Taylor. 1977. An evaluation of fish populations and fisheries in the post-Oroville project Feather River. Sacramento. CDFG-Anadromous Fisheries Branch.

U.S. Fish and Wildlife Service (USFWS). 1996. Sacramento/San Joaquin Delta Native Fishes Recovery Plan. U.S. Fish and Wildlife Service, Portland, OR.

3.2.2 Central Valley Steelhead (*Oncorhynchus mykiss*)

Legal Status. The Central Valley steelhead distinct population segment (DPS) was listed as threatened on March 19, 1998, and includes all naturally spawned populations of steelhead in the Sacramento and San Joaquin Rivers and their tributaries, including the Sacramento-San Joaquin Delta (NMFS1998). Steelhead from San Francisco and San Pablo Bays and their tributaries are excluded from this listing. On June 14, 2004, NMFS proposed that Central Valley steelhead remain listed as threatened (NMFS 2004a). On June 28, 2005, after reviewing the best available scientific and commercial information, NMFS issued its final decision to retain the status of Central Valley steelhead as threatened (NMFS 2005a). This decision included the Coleman NFH and Feather River Hatchery steelhead populations. Critical habitat was designated for the Central Valley steelhead DPS on September 2, 2005 (NMFS 2005b), and includes 2,308 miles of stream habitat in the Central Valley and an additional 254 square miles of estuary habitat in the San Francisco-San Pablo-Suisun Bay complex.

Historical and Current Distribution and Status. Historically, the Central Valley ESU steelhead was well distributed throughout the Sacramento and San Joaquin River systems, from the upper Sacramento/Pit River systems south to the Kings and possibly Kern River systems in wet years (Yoshiyama *et al.* 1996, NMFS 2003). Because adults need to over-summer in deep pools in mid to high elevation tributaries, summer steelhead populations were probably eliminated with the construction of large-scale dams during the 1940s, 1950s, and 1960s.

The existing Central Valley steelhead ESU includes steelhead in all river reaches accessible to the Sacramento and San Joaquin Rivers and their tributaries in California (NMFS 1998). Central Valley steelhead populations are found in the Sacramento River and its tributaries, including the Feather, Yuba, and American Rivers, and many small tributaries, such as Mill, Deer, west side tributaries (including Clear, Cottonwood, Putah, Cache, Stony, Thomes, Alamo, and Ulatis Creeks), and Butte Creeks. The Cosumnes and Mokelumne Rivers also support steelhead.

In the San Joaquin River basin, the best available information suggests that the current range of steelhead is limited to reaches below major dams on the Stanislaus, Tuolumne, and Merced Rivers and to the mainstem San Joaquin River downstream from its confluence with the Merced River. Excluded are areas of the San Joaquin River upstream from the Merced River confluence and areas above specific dams identified or above longstanding, naturally impassable barriers (natural waterfalls in existence for at least several hundred years) (NMFS 2000). Also included are river reaches and estuarine areas of the Sacramento-San Joaquin Delta, all waters from Chipps Island westward to Carquinez Bridge, including Honker Bay, Grizzly Bay, Suisun Bay, and Carquinez Strait, all waters of San Pablo Bay westward from the Carquinez Bridge, and all waters of San Francisco Bay (north of the San Francisco/Oakland Bay Bridge) from San Pablo Bay to the Golden Gate Bridge.

Currently, steelhead distribution is primarily limited by dams that block access to upstream reaches of main rivers and their tributary streams. NMFS (2003) estimated that more than 95 percent of historic spawning habitat is now inaccessible. Current abundance information suggests that Central Valley steelhead populations have declined drastically from an estimated one to two million spawners before 1850 to 40,000 spawners in the 1960s and to 3,628 spawners in the entire Central Valley (NMFS 2003). NMFS (2003) concluded that wild steelhead populations in the Central Valley ESU area are continuing to decline and that they are currently "likely to become endangered" or "in danger of extinction" (NMFS 2003).

Distribution in the CALFED Solution Area and EWA Action Area. Central Valley steelhead are found in the Suisun Marsh/North San Francisco Bay, Sacramento-San Joaquin Delta, Yolo Basin, Sacramento River, North Sacramento Valley, west side tributaries (including Clear, Cottonwood, Putah, Cache, Stony, Thomes, Alamo, and Ulatis Creeks), Butte Basin, Feather River/Sutter Basin**,** American River Basin, Eastside Delta Tributaries, and East San Joaquin Basin Ecological Zones.

Life History and Habitat Requirements. Detailed, in-depth descriptions of the life history and habitat requirements of steelhead can be found in McEwan and Jackson (1996) and Moyle (2002). Adult steelhead typically immigrate into Central Valley streams from July to March; peak migration occurs during September. Spawning typically occurs from November to May, but may occur from November through April (Moyle 2002) (Figure 3-9).

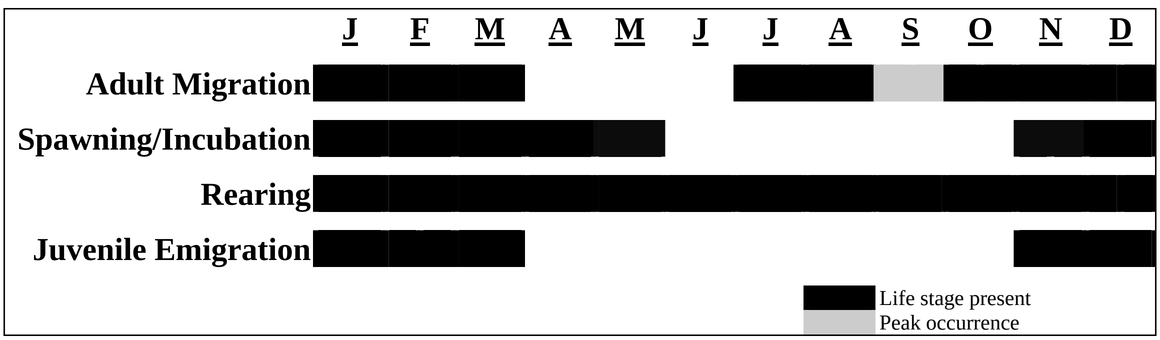

Figure 3-9. General Periodicity of Central Valley Steelhead Life Stages

Central Valley steelhead occur in most accessible stream reaches throughout the Sacramento and San Joaquin river systems (McEwan and Jackson 1996) (Figure 3-10).

Steelhead juveniles rear in Central Valley streams for one to two years, depending upon location. Optimal temperatures for fry and juvenile rearing is reported to range from 55°F to 65°F (NMFS 2004b), although steelhead have been observed to grow to smolt size where summer-fall temperatures exceed 65°F. Steelhead can begin emigrating in the late fall, but the primary period of steelhead emigration occurs from November through May (Snider and Titus 2000a, b and NMFS 2004b).

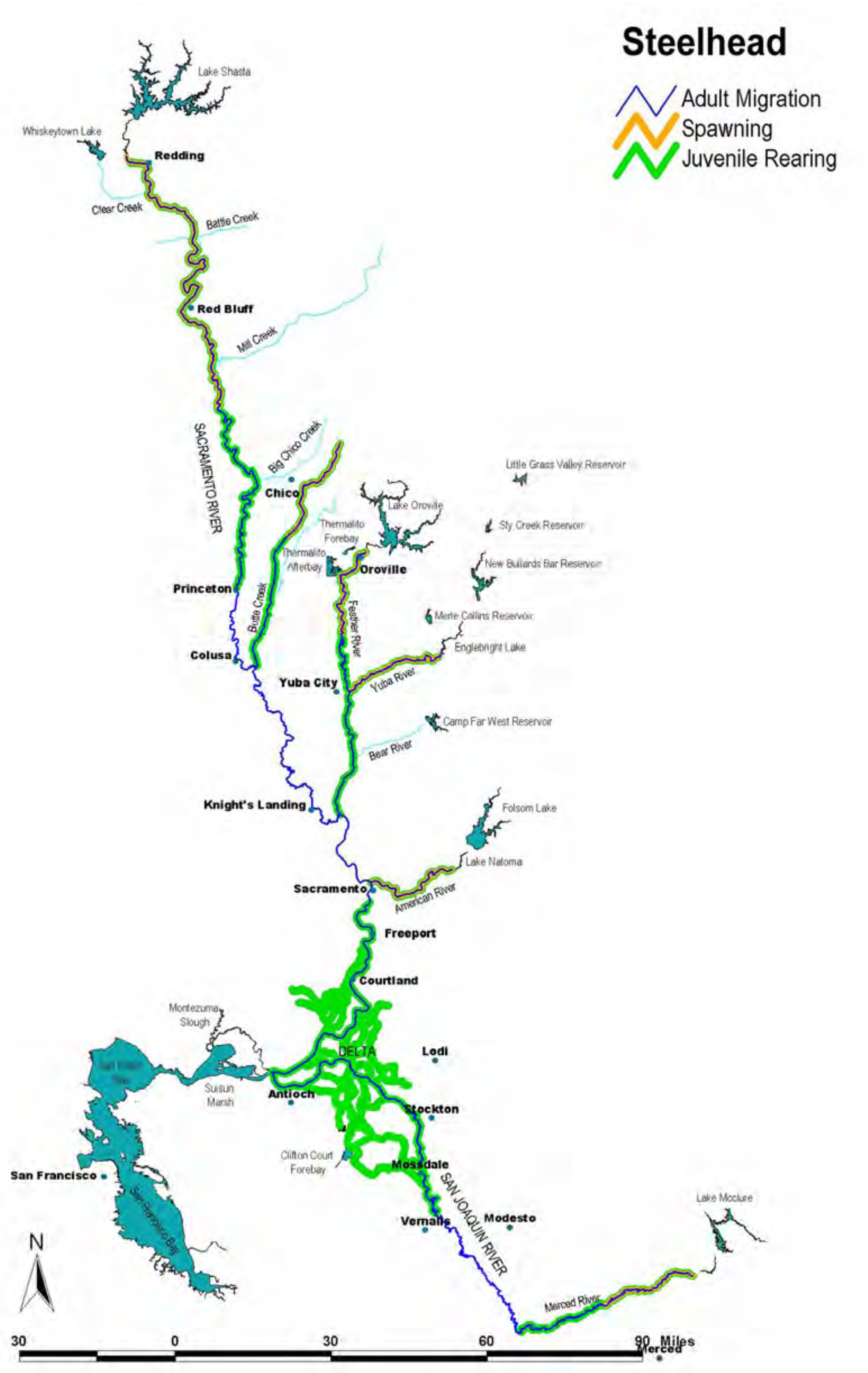

Figure 3-10. Distribution of Steelhead in theCentral Valley

Reasons for Decline. Factors related to the decline of Central Valley steelhead include loss of habitat in river reaches blocked by dams, degradation of habitat conditions (e.g., water temperature), entrainment in water diversions, and possible introgression from hatchery fish (NMFS 2002a, 2003). Loss of habitat has the greatest effect on steelhead abundance. Major dams are the primary barriers to steelhead access to Central Valley rivers and streams. Dams at low elevations on all major tributaries block access to an estimated 95 percent of historical spawning habitat in the Central Valley (McEwan 2001). Below dams, remnant steelhead populations are affected by varying flow conditions and high summer and fall water temperature. Unscreened agricultural, municipal, and industrial diversions in the Delta and rivers cause entrainment losses of emigrating juvenile steelhead (NMFS 2002a). Steelhead populations have declined from 20,000 fish in 1969 to less than 3,000 fish in 1993 (NMFS 2003).

Over 90 percent of the adult steelhead in the Central Valley are produced in hatcheries (Reynolds *et al.* 1990). Hatchery-produced fish may substantially affect the genetic integrity of wild populations. Adult and juvenile steelhead are harvested by sport anglers within the Central Valley watershed, mostly on the American and Feather Rivers (with large steelhead hatcheries) (NMFS 2003). There is no commercial or sport fishery for steelhead in the ocean and, for unknown reasons, steelhead are rarely taken by commercial or sport salmon trollers (Skinner 1962).

Designated Critical Habitat and Essential Fish Habitat. Critical habitat for the Central Valley steelhead ESU was designated on September 2, 2005 (70 FR 52488 52627), effective January 2, 2006 (NMFS 2005b). The Central Valley steelhead critical habitat consists of 2,308 miles of streams and 254 miles of estuary which are included in areas within the Sacramento, Delta, and Lower Mokelumne watersheds. Critical habitat designations are restricted to anadromous and resident forms of the Central Valley steelhead. The co-occurring range was addressed due to uncertainties regarding co-occurrence and the location of natural barriers.

Critical habitat for spring-run Chinook salmon includes those areas possessing the PCEs essential to the conservation of this species. The final rule for the determination of critical habitat for spring-run Chinook salmon provides details on these constituent elements. Additional information can be found under Section 3.2.1.3 Spring-Run Chinook Salmon.

Conservation Efforts. Agencies implementing the CVPIA actions are working to improve the quality of anadromous fish habitat, improve fish passage, and contribute to population recovery of anadromous salmonids (USFWS 2001). CALFED (2000a) has identified specific measures for steelhead recovery in the Ecosystem Restoration Program Plan, yet this plan is still in its initial stages of implementation. Recent, more restrictive, sport fishing regulations, such as those on the Yuba River, are intended to reduce adult steelhead take and incidental mortality.

Recovery Plan and Recovery Guidance. The NMFS has formed a Central Valley Recovery Team to identify recovery requirements and prepare a recovery plan for steelhead. The Battle Creek Salmon and Steelhead Restoration Project has prepared a restoration plan to improve habitat and water flows along Battle Creek (Kier Associates 1998). CALFED has funded a Central Valley steelhead monitoring plan, but at this time, has not funded implementation of the plan. CALFED (2000b) recovery criteria will follow the VSP framework (McElhany *et al.* 2000) developed by NMFS.

In addition, NMFS created the Central Valley TRT, to study conservation and recovery planning for the Central Valley steelhead and other Species of Concern. The TRT and NMFS have issued BOs and recovery reports (NMFS 2002a, Lindley et al. 2004, 2006) regarding activities in the Delta, including water level and temperature fluctuations, barriers, and water pollution, which may impact steelhead. The current and historical structure of steelhead populations were specifically addressed by the TRT because the population structure is considered instrumental in guiding conservation and restoration activities. Recoveries of historical populations from disturbances within the ESU are important in understanding how the ESU will be affected by disturbances now and in the future. NMFS made recommendations using adaptive management groups to minimize the impacts to steelhead based on the project description and continuance of current actions, and to predict the success of reintroductions into restored systems.

In the TRT's most recent report (Lindley et al. 2006), the Central Valley steelhead ESU historically contained areas and populations of biologically significant genetic diversity. Four major subdivisions of habitat areas were identified with the Central Valley steelhead ESU including the Sacramento River basin, Suisun Bay tributaries, San Joaquin tributaries draining the Sierra Nevada, and low-elevation streams draining to Buena Vista and Tulare basins. Patches of suitable habitat were primarily separated by habitat unsuitable due to high summer temperatures on the Central Valley flow. Dams block 80 percent of the historical habitat areas and block access for 38 percent of historical steelhead populations to historical spawning habitat, which is the primary threat to diversity loss. The TRT recommended that the next step is preserving sources of natural production of steelhead including currently producing natural areas and tailwater and above-barrier populations in the San Joaquin basin should the barriers to reproduction be removed.

Research and Monitoring Gaps. NMFS (2003) noted that there are no ongoing population assessments for this species. The effect of catch-and-release mortality on wild populations and effect of trout fisheries on juvenile steelhead should be investigated (NMFS 2003). In addition, ecological conditions in the Sacramento and San Joaquin Rivers differ, and there is a potential for genetic differences among the different populations of these large river basins (NMFS 1997). There is also considerable uncertainty about the relationship between anadromous and non-anadromous *Oncorhynchus mykiss* forms, including the relationship with multiple subspecies of resident trout. It is likely that the abundant manmade barriers have greatly altered historical patterns of migration and anadromy (NMFS 2003). A comprehensive analysis of ecological and genetic information may help elucidate these complex issues (NMFS 1997). Steelhead have also been described spawning and rearing in seasonal habitats such as intermittent streams and streams that do not contain suitable year round habitat (McEwan 2001). McEwan (2001) suggests that further research should be done to determine the extent to which steelhead use seasonal habitats.

Central Valley Steelhead Citations. CALFED. 2000a. Ecosystem Restoration Program Plan. Volume 1-Ecosystem attributes of the San Francisco Bay Delta watershed. Available online at: http://calfed.ca.gov/Programs/EcosystemRestoration/EcosystemRestorationPlans.shtml.

CALFED. 2000b. Multi-Species Conservation Strategy; Final Programmatic EIS/EIR Technical Appendix. Available online at: http://calfed.ca.gov/Programs/EcosystemRestoration/EcosystemMultiSpeciesConservationStrategy.shtml

Kier Associates. 1998. Battle Creek Salmon and Steelhead Restoration Plan. Prepared with Battle Creek Work Group Biological Team, California.

Lindley, S. T., R. S. Schick, A. Agrawal, M. Goslin, T. E. Pearson, E. Mora, J. J. Anderson, B. May, S. Greene, C. Hanson, A. Low, D. McEwan, R. B. MacFarlane, C. Swanson, and J. G. Williams. 2006. Historical population structure of Central Valley steelhead and its alteration by dams. S. Francisco Estuary Watershed Sci. 4(1):article 3. 21 p

Lindley, S.T., R. Schick, B.P. May, J.J. Anderson, S. Greene, C. Hanson, A. Low, D. McEwan, R.B. MacFarlane, C. Swanson, and J.G. Williams. 2004. Population structure of threatened and endangered Chinook salmon ESUs in California's Central Valley basin. NOAA Technical Memorandum NOAA-TM-NMFS-SWFSC-370, 66p.

McElhany, P., M.H. Ruckelshaus, M.J. Ford, T.C. Wainwright, and E.P. Bjorkstedt. 2000. Viable salmonid populations and the recovery of evolutionarily significant units. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS-NWFSC-42, 156 p.

McEwan, D.R. 2001. Central Valley steelhead. Pages 1-44 in R.L. Brown, ed. Contributions to the biology of Central Valley salmonids. CDFG Fish Bulletin 179.

McEwan, D., and T.A. Jackson. 1996. Steelhead restoration and management plan for California. CDFG. February 1996.

Moyle, P. B. 2002. Inland fishes of California: revised and expanded. University of California Press, Berkeley, CA. 502 pp.

National Marine Fisheries Service (NMFS). 1997. Status Review Update for West Coast Steelhead from Washington, Idaho, Oregon, and California: Draft report. West Coast Salmon Biological Review Team: Northwest Fisheries Science Center, Seattle, WA and Southwest Fisheries Science Center, Santa Cruz, CA. Available online at: http://swr.nmfs.noaa.gov/psd/steelhead/sru970707.pdf.

National Marine Fisheries Service (NMFS). 1998. Endangered and threatened species; threatened status for two ESUs of steelhead in Washington, Oregon, and California. Federal Register 63(53): 13347-13371.

National Marine Fisheries Service (NMFS). 2000. Designated critical habitat: critical habitat for 19 evolutionarily significant units of salmon and steelhead in Washington, Oregon, Idaho, and California. Federal Register 65(32): 7764-7787.

National Marine Fisheries Service (NMFS). 2002a. Biological Opinion for the Interim Operations of the Central Valley Project and State Water Project Between April 1, 2002 and March 31, 2004. National Marine Fisheries Service, Southwest Regional Office, Long Beach, CA. Available online at: http://swr.nmfs.noaa.gov/sac/myweb8/webpages/biol_opinions.htm#2000.

National Marine Fisheries Service (NMFS). 2003. Preliminary Conclusions Regarding the Updated Status of Listed ESUs of West Coast Salmon and Steelhead: Draft report. West Coast Salmon Biological Review Team: Northwest Fisheries Science Center, Seattle, WA and Southwest Fisheries Science Center, Santa Cruz, CA. Available online at: http://www.nwfsc.noaa.gov/trt/brt/brtrpt.cfm?CFID=29815583&CFTOKEN=22128098&jsessionid=6430861296c43f3c5117.

National Marine Fisheries Service (NMFS). 2004a. Endangered and Threatened Species; Proposed Listing Determinations for 27 ESUs of West Coast Salmonids. Federal Register 69(113): 33102.

National Marine Fisheries Service (NMFS). 2004b. Biological Opinion on long-term Central Valley Project and State Water Project Operations Criteria and Plan. Southwest Region. October 2004.

National Marine Fisheries Service (NMFS). 2005a. Endangered and Threatened Species: Extension of Public Comment Period on Proposed Listing Determination for the Southern Distinct Population Segment of North American Green Sturgeon. 70 FR 17386

National Marine Fisheries Service (NMFS). 2005b. ESA critical habitat designation regulations for California Central Valley steelhead and California

Central Valley spring run Chinook.. September 2, 2005. Federal Register 70: 52488 - 52627. Also available online at: http://www.nwr.noaa.gov/Publications/FR-Notices/2005/upload/70FR52604.pdf and http://www.nwr.noaa.gov/Publications/FR-Notices/2005/upload/70FR52590.pdf

Reynolds, F. L., R. L. Reavis, and J. Schuler. 1990. Sacramento and San Joaquin River chinook salmon and steelhead restoration and enhancement plan. California Department of Fish and Game. Sacramento, CA.

Skinner, J. E. 1962. An historical view of the fish and wildlife resources of the San Francisco Bay area. (Game Water Projects Branch Report No. 1.) California Department of Fish and Game. Sacramento, CA.

Snider, B. and R. Titus. 2000a. Timing, Composition, and Abundance of Juvenile Anadromous Salmonid Emigration in the Sacramento River Near Knights Landing October 1996-September 1997. CDFG, Habitat Conservation Division Stream Evaluation Program, Technical Report No. 00-04.

Snider, B. and R. Titus. 2000b. Timing, Composition, and Abundance of Juvenile Anadromous Salmonid Emigration in the Sacramento River Near Knights Landing October 1997-September 1998. CDFG, Habitat Conservation Division Stream Evaluation Program, Technical Report No. 00-05.

U.S. Fish and Wildlife Service (USFWS). 2001. Final restoration plan for the Anadromous Fish Restoration Program. Prepared for the Secretary of the Interior under authority of the Central Valley Project Improvement Act.

Yoshiyama, R.M., E.R. Gerstung, F.W. Fisher, and P. B. Moyle. 1996. Historical and present distribution of Chinook salmon in the Central Valley drainage of California. Sierra Nevada Ecosystem Project: final report to Congress.

3.2.3 Delta Smelt *(Hypomesus Transpacificus)*

Legal Status. The U.S. Fish and Wildlife Service (USFWS) listed the delta smelt as threatened effective April 5, 1993, based upon its dramatically-reduced abundance, threats to its habitat, and the inadequacy of regulatory mechanisms then in effect (USFWS 1993). The delta smelt was listed as threatened by California on December 9, 1993. The Sacramento-San Joaquin Delta Native Fishes Recovery Plan was completed in 1995 (USFWS 1996). On March 31, 2004, the USFWS completed a five-year status review for the delta smelt, which concluded that delta smelt abundance remained relatively low, compared to historical levels, and that many of the threats to the species identified at the time of listing still existed, precluding de-listing of the species (USFWS 2004). In February 2007, a consortium of conservation groups petitioned the California Fish and Game Commission to make an emergency listing changing its status to

Endangered under the California ESA. The Commission has accepted the petition and will rule on it within one year.

Historical and Current Distribution and Status. The delta smelt is endemic to the Sacramento-San Joaquin Delta, including Suisun Bay, but are generally most abundant in the western Delta and eastern Suisun Bay (Honker Bay) (CALFED 2000). Distribution varies seasonally with freshwater outflow. Generally, the species inhabits areas where inflowing fresh water from the Delta system meets salt water from the Pacific Ocean via San Francisco Bay. This area meets specific requirements for freshwater inflow, salinity, water temperature, and shallow open water habitat. Their spawning distribution varies from year to year within the Delta. The species is endemic to the Sacramento-San Joaquin Estuary, and its population abundance varies substantially from year to year. Historically, the delta smelt was one of the most abundant pelagic species caught in the estuary during trawl surveys (Stevens and Miller 1983). Beginning in the early 1980's, populations severely declined, possibly a result of variation in temperature and outflow and incidental take (Bennett 2005). Abundance has been uncharacteristically low since 1982, in large part because of the extended drought of 1987-92 and possibly to extremely wet years in 1983 and 1986 (Moyle *et al.* 1989). Population abundance has fluctuated from increases in some years to uncharacteristic decreases in other years as reported in 1998 (IEP 1998), but in recent years (i.e., 2002 to 2005), a drastic decline has been noted. Populations in the Delta dropped more than 80 percent in three years. In 2004, the USFWS conducted a five-year review for the status of the delta smelt and determined that the conditions for listing the species still existed. The USFWS determined that the current population was below its "effective population size", which suggests that the population may be at risk for genetic drift and inbreeding. By 2005, smelt populations were at the lowest levels recorded with 2 percent of the adult population remaining since its listing in 1993. The Recovery Plan for the delta smelt set a target abundance criterion of 239 (USFWS 1996) based on CDFG surveys, which has not been met since 2001 when the recovery index was 314. Since then, the recovery index has drastically declined to a record low of 4 in 2005. The estimated current population is 25,000 individuals (Bennett 2005), although the reliability of these types of population estimates remains unknown. The USFWS determined that there is little evidence to suggest that populations are increasing over pre-decline levels (USFWS 2004).

Distribution in the CALFED Solution Area and EWA Action Area. Delta smelt are confined primarily to the Delta and Suisun Marsh/San Francisco Bay Ecological Zones. They appear to move upstream from Suisun Bay into the Delta in winter and spring to spawn. After early rearing in the Delta, they tend to move downstream to low-salinity habitats in the western Delta (particularly in drier years) and Suisun Bay (in both wet and dry years). Small populations also occur in the Napa River estuary and Suisun Marsh (CALFED 2000).

Life History and Habitat Requirements. During the late winter and spring (December through April), delta smelt migrate upstream from the brackish-water estuarine areas to spawn (Figure 3-11). They spawn in shallow fresh or slightly brackish waters in tidally influenced backwater sloughs and channel edgewaters with suitable temperatures from 45 to 59°F (DWR and Reclamation 2005) from February through July. Larvae hatch from 10 to 14 days (Wang 1986) and are planktonic (float with water currents) as they are transported and dispersed downstream into the low-salinity areas within the western delta and Suisun Bay (Moyle 2002).

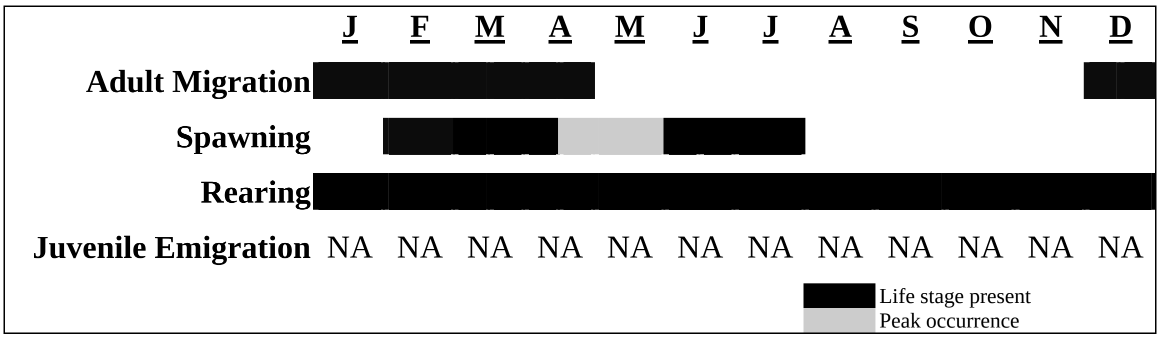

Figure 3-11. General Periodicity of Delta Smelt Life Stages

Delta smelt grow rapidly, with the majority of smelt living only one year. Most adult smelt die after spawning in the early spring. Delta smelt inhabit open surface waters and shoal areas within the western Delta and Suisun Bay for the majority of their one-year life span (USFWS 1994). Their abundance and distribution fluctuates substantially within and among years due to the short life span. Delta smelt abundance is reduced during unusually dry years with exceptionally low outflows (e.g., 1987 through 1991) and unusually wet years with exceptionally high outflows (e.g., 1982 and 1986). Other factors thought to affect the abundance and distribution in the Bay-Delta include entrainment, effects of non-native species on the zooplankton community, and pollution. Results of recent CDFG summer tow-net surveys, 20 mm larval surveys, and the fall mid-water trawl surveys indicate that delta smelt abundance and geographic distribution has not shown any significant signs of recovery (USFWS 2004). Delta smelt abundance has not recovered to its pre-decline (prior to 1982) levels (USFWS 2004).The availability of rearing habitat for delta smelt is closely tied to the locations of the low salinity zone and the 2 ppt isohaline marker known as X2. In general, adult abundance tends to be highest when X2 is located in Suisun Bay in the spring (Bennett 2005). However, this trend is complicated by a switch in the relationship of X2 to habitat quality after the decline of the delta smelt began in the early 1980's. Kimmerer (2002) reported that prior to 1982, smelt abundance was higher when X2 was further east. After 1982, this pattern was reversed. This trend reversal is thought to be due to the decline in habitat quality in the central Delta over time (Bennett 2005).

In 2004, concern arose over the apparent simultaneous decline of delta smelt and striped bass. It was theorized that the two species may share common threats to their populations in the Delta. These species, among others, became the focus of Pelagic Organism Decline (POD) interagency investigations. The investigations of the POD work team into the decline of delta smelt have focused on food web changes due to exotic species, toxic effects, and water management changes as major population stressors (IEP 2005).

In 2005, the POD work team studied delta smelt abundance using both the Summer Townet and Fall Midwater Trawl surveys. The surveys indicated that the higher outflow conditions in 2005: 1) failed to improve fish abundance; 2) showed no evidence of a recent decrease in the amount of “physical habitat” for delta smelt; 3) showed no evidence of a recent major decline in growth rate; and 4) otolith analyses indicated that in 1999, delta smelt spawned throughout the upper estuary recruited to the adult populations, whereas in 2004, only fish spawned in the Delta were recruited (Armor et al 2005).

Delta smelt are a euryhaline fish, native to the Sacramento-San Joaquin estuary. Delta smelt are typically found within Suisun Bay and the lower reaches of the Sacramento and San Joaquin Rivers, although they are occasionally collected within the Carquinez Strait and San Pablo Bay (Figure 3-12). Delta smelt have been found in the Sacramento River at the confluence of the American River (USFWS 1996; Moyle 2002) and as far upstream of the confluence with the Feather River (observed with USFWS Beach Seine Surveys). This species also occurs in the San Joaquin River, downstream of Vernalis (EA Engineering, Science, and Technology 1999). Critical habitat for delta smelt is defined by the USFWS (1994) as:

> *“Areas and all water and all submerged lands below ordinary high water and the entire water column bounded by and contained in Suisun Bay (including the contiguous Grizzly and Honker Bays); the length of Goodyear, Suisun, Cutoff, First Mallard (Spring Branch), and Montezuma Sloughs; and the existing contiguous waters contained within the Delta.”*

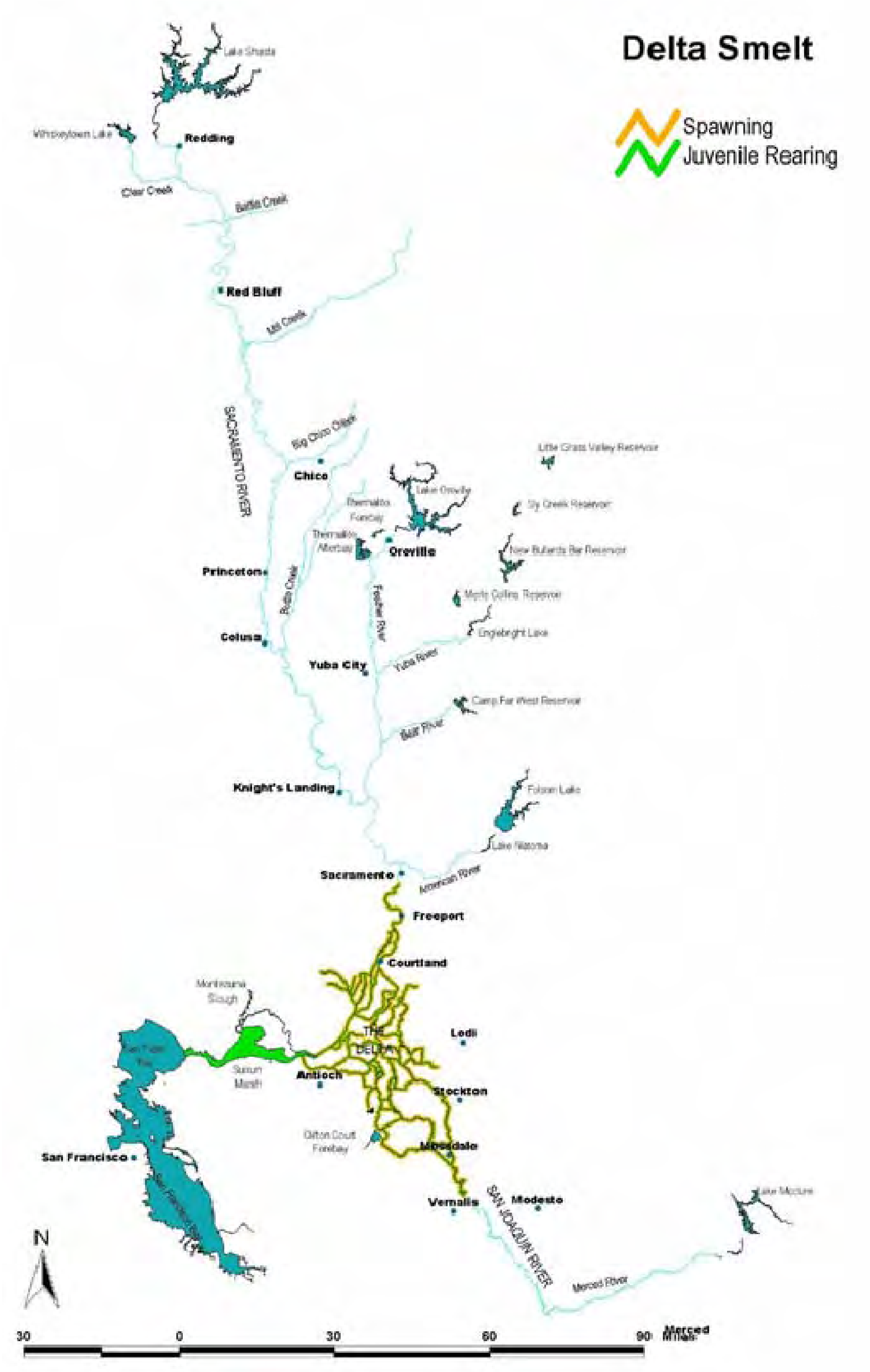

Figure 3-12. Distribution of Delta Smelt in theCentral Valley

Reasons for Decline. Delta smelt are considered environmentally sensitive because they live only 1 year, have a limited diet, have a low fecundity for a fish with planktonic larvae, are poor swimmers, are easily stressed, and reside primarily in the interface between saltwater and freshwater (CDFG 2000a). The delta smelt has declined nearly 90 percent over the last 20 years. Factors that contribute to low abundance relative to historical conditions include change in flow patterns; entrainment in diversions; incidental take; contaminants; and species interactions, particularly competition and predation associated with establishment of non-native species (Stevens *et al.* 1990, Herbold *et al.* 1992; USFWS 1993).

Population abundance is primarily threatened by large freshwater exports from the Sacramento River and San Joaquin River diversions for agriculture and urban use (USFWS 1993). These exports alter natural abiotic variability of the Delta, such as turbidity and salinity, which may affect the abundance of delta smelt (Nobriga *et al*. 2005). At times, the exports reverse the flow of the San Joaquin River, which impairs upstream migrating adults and prevents downstream transport of larvae and juveniles. Since 1983, the proportion of water exported from the Delta during October through March has increased (Moyle *et al.* 1992). Federal and State water diversion projects in the southern Delta export mostly Sacramento River water with some San Joaquin River water (USFWS 1993). Approximately 1,800 other diversions also export water from the system (Herren and Kawasaki 2001). During periods of high export pumping and low to moderate river outflows, reaches of the San Joaquin River reverse direction and flow to the pumping plants located in the southern Delta (USFWS 1993). Seasonal water exports have increased as much as 48 percent since the 1990's with the four greatest years for exports occurring since 2000. Demands on the water supply are only expected to increase in the near future with proposed diversions for several projects (USFWS 2004). Diversions of water from the Delta may be linked with several issues affecting smelt populations, including disruptions in migration, mortality from entrainment, and disruption of habitat.

A relationship has been found between the number of juvenile delta smelt salvaged at the State and Federal pumps and both the percent of inflow diverted and total Delta outflow (CDWR and USBR 1994). When total diversion rates are high relative to Delta outflow and the lower San Joaquin River and other channels have a net upstream (i.e., reverse or negative) flow, transport of larval and juvenile fish to the downstream brackish areas where rearing takes place is impaired and upstream-migrating adults become disoriented. Delta smelt larvae require net positive riverine flows and estuarine outflows of sufficient magnitude in order to be carried downstream into the upper end of the mixing zone of the estuary instead of upstream to the pumping plants (USFWS 1993).

All size classes of delta smelt suffer near total loss when they are entrained by the pumping plants and diversions in the south Delta (USFWS 1993). Very few delta smelt are effectively salvaged at the State and Federal pumping plant screens, and the few that are transported into water project reservoirs or canals fail to reproduce. The majority of diversions from the delta are not screened, and are likely to cause significant mortality (USFWS 2004). Annually, from 11 to 46 percent of juveniles may be killed by State and Federal operations (Kimmerer, pers. comm. as cited in CDFG 2003). Additional mortality may occur when migrating individuals are directed toward pumping facilities where both entrainment in the equipment and through predation by opportunistic predators, such as striped bass or threadfin shad, contribute to total mortality rates.

The smelt's embryonic, larval, and post-larval mortality rates also become higher as reduced western Delta flows allow increases in the salinity level and relocation of the mixing zone (USFWS 1993), which are critical habitat for the delta smelt. During periods of drought and increased water diversions, the mixing zone and associated smelt populations shifted farther upstream in the Delta. Prior to 1984, the mixing zone was usually located in Suisun Bay during October through March, while from April through September, the mixing zone usually was found upstream in the channels of the rivers (USFWS 1993). From 1984 to 1993, with the exception of the record flood outflows of 1986, the mixing zone had been located primarily in the river channels during the entire year because of increased water exports and diversions (USFWS 1993). When located upstream, the mixing zone becomes confined to the deep river channels; becomes smaller in total surface area; contains very few shoal areas of suitable spawning substrates; may have swifter, more turbulent water currents; and lacks high zooplankton productivity (USFWS 1993). Delta smelt reproduction is likely affected because the mixing zone is located in the main channels of the Delta, east of Suisun Bay (Moyle *et al.* 1992). In 1982, the delta smelt population declined significantly because of the shifted location of the mixing zone to the less favorable narrow, deep, and less productive channels in the lower rivers (USFWS 1993).

Long periods of drought may exacerbate impacts to the delta smelt linked to diversions from the Delta. The delta smelt have proven to be especially vulnerable during periods of long drought. Deleterious effects of the 1987-92 droughts would have been exacerbated if additional alterations in hydrology caused by reductions of freshwater inflows to the Delta altered the timing and/or duration of water exports (USFWS 1993). A reduction in the amount of fresh water entering the system due to extended drought may have synergistic effects with salinity, water temperature, and flow dynamics, all of which may impact delta smelt populations.

Agricultural chemicals and residues, chemicals from urban runoff, and heavy metal contaminants released from industry and mining also threaten delta smelt (USFWS 2004). Although effects of contaminants have not been specifically described for delta smelt, pesticides have been found in the Sacramento River in recent years at concentrations potentially harmful to fish larvae (Herbold *et al.* 1992). Nichols *et al.* (1986) found that all major rivers in the delta smelt's historic range had been exposed to large volumes of agricultural and industrial chemicals that are applied in the California Central Valley watersheds. Toxicology studies of rice field irrigation drain water of the Colusa Basin Drainage Canal documented significant toxicity of drain water to striped bass embryos and larvae, medaka larvae, and the major food organism of the striped bass larvae and juveniles, the opossum shrimp (*Neomysis mercedis*) (USFWS 1993). Recent bioassays by the Central Valley Regional Water Quality Control Board indicate that water in the Sacramento River is periodically toxic to larvae of the fathead minnow, a standard U.S. Environmental Protection Agency (USEPA) test organism (Stevens *et al.* 1990). Delta smelt could also be affected by run-off. Although the effects of heavy metal contaminating compounds on delta smelt larvae and their food resources are not well known, the compounds could potentially adversely affect delta smelt survival (USFWS 1993).

Other factors have also been identified that may be partially responsible for the delta smelt's decline; however, there is a general lack of research to support definitive conclusions. Factors such as disease, competition, by-catch, introduction of nonnative species, or predation have been suggested as causes of delta smelt decline (Moyle 2002). The introduced striped bass may have caused an increase in predation on all size classes of the delta smelt (USFWS 1993).

Competition during mating and for food resources have been studied (Armor *et al*. 2005, Bennett 2005, Teh 2005, USFWS 2004). Interactions with related species during mating may be leading to hybridization of the population (Moyle 2002), although displacement of the population is not likely occurring. Hybrids are likely sterile, but the attempts at interbreeding "cause the loss of viable gametes," further reducing the ability of this species to recover (Moyle 2002). In addition, the smelt may be competing with nonnative species for food resources. Nonnative species may be introduced through several modes, but a primary port of introduction may be from the discharge of ballast water into San Francisco Bay, which is not currently prohibited (USFWS 2004). Competition for food may be particularly important for the survival of delta smelt larvae. Abundance of rotifers and phytoplankton has declined in recent years (Obrebski *et al.* 1992). Rotifers are small and may be important to the diet of larval delta smelt (CDWR and USBR 1994) and other fish larvae (Hunter 1981). Nonnative inland silversides may compete for similar prey such as copepods and cladocerans, in addition to being predators on eggs and larvae (Bennett 1995, 2005). Silversides may occupy the shallow water habitat in dense schools, which is the preferred habitat for the smelt. An Asian clam (*Potamocorbula amurensis*), discovered in Suisun Bay in 1986, could affect the phytoplankton dynamics in the estuary by decreasing phytoplankton biomass and by directly consuming the delta smelt's primary food, *Eurytemora affinis* copepod nauplii (USFWS 1993). Three nonnative species of euryhaline copepods (*Sinocalanus doerrii*, *Pseudodiaptomus forbesi*, and *Pseudodiaptomus marinus*) became established in the Delta between 1978 and 1987 (Carlton *et al.* 1990), while *Eurytemora affinis* populations, the native euryhaline copepod, have declined since 1980. These introduced copepod species are more efficient at avoiding the predation of larval delta smelt and exhibit a different swimming behavior that makes them less attractive to feeding delta smelt larvae. Because of reduced food availability or feeding efficiency, weakened delta smelt larvae are more vulnerable to starvation or predation (USFWS 1993).

Designated Critical Habitat. Pursuant to the ESA, critical habitat was designated for the delta smelt effective January 18, 1995 (59 FR 65256 65279, USFWS 1994). Designated critical habitat includes all water and all submerged lands below ordinary high water and the entire water column bounded by and contained in Suisun Bay (including the contiguous Grizzly and Honker Bays), Goodyear, Suisun, Cutoff, First Mallard (Spring Branch) and Montezuma Sloughs, and the Sacramento/San Joaquin River Delta, as defined in Section 12220 of the California Water Code of 1969 (a complex of bays, dead-end sloughs, channels typically less than 4 meters deep, marshlands, etc.) as follows: bounded by a line beginning at the Carquinez Bridge, which crosses the Carquinez Strait; thence, northeasterly along the western and northern shoreline of Suisun Bay, including Goodyear, Suisun, Cutoff, First Mallard (Spring Branch), and Montezuma Sloughs; thence, upstream to the intersection of Montezuma Slough with the western boundary of the Delta as delineated in Section 12220 of the State of California's Water Code of 1969; thence, following the boundary and including all contiguous water bodies contained within the statutory definition of the Delta, to its intersection with the San Joaquin River at its confluence with Suisun Bay; thence, westerly along the south shore of Suisun Bay to the Carquinez Bridge (USFWS 1994).

Critical habitat for the delta smelt includes those areas possessing the primary constituent elements essential to the conservation of the delta smelt. These primary constituent elements are the physical habitat, water, riverflow, and salinity concentrations required to maintain delta smelt habitat for 1) spawning; 2) larval and juvenile transport; 3) rearing; and 4) adult migration (USFWS 1994). The use of critical habitat depends on the life history stage.

The final rule for the determination of critical habitat for the delta smelt provides details on these constituent elements (USFWS 1994). The primary constituent elements are organized by habitat conditions required for each life stage. The specific geographic areas and seasons identified for each habitat condition represent the maximum possible range of each of these conditions. Depending on the water-year type (i.e., wet, above normal, below normal, dry, critically dry), each of the habitat conditions specified below requires fluctuation (within-year and between-year) in the placement of the 2 ppt isohaline (a line drawn to connect all points of equal salinity) around three historical reference points. These three historical reference points are the Sacramento-San Joaquin River confluence, the upstream limit of Suisun Bay at Chipps Island, and in the middle of Suisun Bay at Roe Island. The actual number of days that the 2 ppt isohaline is maintained at the three points varies according to water-year type. Additionally, the number of days at each reference point must simulate a level of water project development equivalent to that which historically existed in 1968. Hydrologic conditions in 1968 were such that delta smelt were abundant and anadromous and resident fisheries were relatively healthy (USFWS 1994).

Suitable habitat conditions must be maintained for recovery of the delta smelt. The naturally occurring variability found in healthy estuarine ecosystems must be preserved for the following reasons 1) temporal and spatial variability of the 2 ppt isohaline will be the most effective deterrent to further invasion of newly introduced species and continued competition by those that are already established; 2) placement of the 2 ppt isohaline in Suisun Bay will produce the high phytoplankton and zooplankton densities that characterize most healthy estuarine ecosystems; and 3) variability is needed to simulate natural processes and historical conditions (USFWS 1994).

The primary constituent elements in the Final Rule for the delta smelt (USFWS 1994) are defined as follows:

Spawning Habitat: Delta smelt adults seek shallow, fresh, or slightly brackish backwater sloughs and edge-waters for spawning. To ensure egg hatching and larval viability, spawning areas also must provide suitable water quality (low concentrations of pollutants) and substrates for egg attachment (e.g., submerged tree roots and branches and emergent vegetation). Specific areas that have been identified as important delta smelt spawning habitat include Barker, Lindsey, Cache, Prospect, Georgiana, Beaver, Hog, and Sycamore Sloughs; the Sacramento River in the Delta; and tributaries of northern Suisun Bay. The spawning season may start as early as December and extend until July (USFWS 1994).

Larval and Juvenile Transport: To ensure that delta smelt larvae are transported from the area where they are hatched to shallow, productive rearing or nursery habitat, the Sacramento and San Joaquin Rivers and their tributary channels must be protected from physical disturbance (e.g., sand and gravel mining, diking, dredging, and levee or bank protection and maintenance) and flow disruption (e.g., water diversions that result in entrainment and in-channel barriers or tidal gates). Adequate riverflow is necessary to transport larvae from upstream spawning areas to rearing habitat in Suisun Bay. Additionally, riverflow must be adequate to prevent interception of larval transport by the State and Federal water projects and smaller agricultural diversions in the Delta. To ensure that suitable rearing habitat is available in Suisun Bay, the 2 ppt isohaline must be located westward from the Sacramento-San Joaquin River confluence during the period when larvae or juveniles are being transported, according to the historical salinity conditions which vary according to water-year type. Reverse flows that maintain larvae upstream in deep-channel regions of low productivity and expose them to entrainment interfere with these transport requirements. Suitable water quality must be provided so that maturation is not impaired by pollutant concentrations. The specific geographic area important for larval transport is confined to waters contained within the legal boundary of 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 on when peak spawning occurs and on the water-year type. In the biological opinion for the delta smelt (USFWS 1995), USFWS identified where additional flows might be required in the July-August period to prevent delta smelt that were present in the south and central Delta from being entrained in the State and Federal Project pumps and to avoid jeopardy to the species. The biological opinion on the long-term CVP-SWP operations (USFWS 1995) identifies situations where additional flows may be required after the February through June period identified by EPA for its water quality standards to protect delta smelt in the south and central Delta.

Rearing Habitat: Maintenance of the 2 ppt isohaline, according to the historical salinity conditions described above and suitable water quality (low concentrations of pollutants) within the estuary, is necessary to provide delta smelt larvae and juveniles a shallow, protective, food-rich environment in which to mature to adulthood. This 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. An area extending eastward from Carquinez Strait, 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. Three Mile Slough represents the approximate location of the most upstream extent of tidal excursion when the historical salinity conditions described above are implemented. Protection of rearing habitat conditions may be required from the beginning of February through the summer.

Adult Migration: Adult delta smelt must be provided unrestricted access to suitable spawning habitat in a period that may extend from December to July. Adequate flow and suitable water quality may need to be maintained to attract migrating adults in the Sacramento and San Joaquin River channels and their associated tributaries, including Cache and Montezuma Sloughs and their tributaries. These areas also should be protected from physical disturbance and flow disruption during migratory periods.

Conservation Efforts. The delta smelt will benefit from efforts by agencies implementing the CVPIA and CALFED actions to restore ecological health and improve water quality of the Delta (CALFED 2000). In addition, USFWS recommended in the 2006 OCAP that: 1) restoration measures in the Delta Fishes and Recovery Plan (USFWS 1996) be developed and implemented; 2) population estimates and pumping impacts to the population be improved; 3) survival and the impact of predation at salvage facilities be improved; and 4) new methods for determining incidental take be identified.

Recovery Plan and Recovery Guidance. USFWS (1996) developed a Delta Native Fishes Recovery Plan to manage the estuary for improved native fish habitat and reduce the decline of native fish populations, including the delta smelt. Delta smelt will be considered restored when its population dynamics and distribution pattern within the estuary are similar to those that existed in the 1967-81 period (USFWS 1996). Distribution criteria include catches: 1) in all zones 2 of 5 consecutive years; 2) in at least two zones in 1 of the remaining 3 years; and 3) in at least one zone, for the remaining 2 years. Abundance criteria are delta smelt numbers or catch; this catch must equal or exceed 239 for 2 out of 5 years and not fall below 84 for more than 2 years in a row (USFWS 1996).

Research or Monitoring Gaps. The California Department of Fish and Game initiated a monitoring and research program in 1992 to investigate all aspects of delta smelt biology (CDFG 2000a). The results of this program are used to make informed water management decisions. The CALFED EWA Science Advisors recommend further research into artificial propagation as essential to recovery of delta smelt, as is further research on the collection, handling, transport, and release aspects of the fish salvage operation of the SWP and CVP's Delta fish protection facilities (CALFED 2002). The Interagency Ecological Program (IEP) Fish Team has identified several areas of emphasis for delta smelt, including habitat, behavior, and population impacts. Topics given high priority include: 1) evaluating the quality of habitat in estuary areas; 2) conducting horizontal and vertical distribution studies; and 3) identifying impacts of predation by inland silversides and other species (IEP 2003).

Delta Smelt Citations. Armor, C.R., B. Baxter, R. Bennett, M. Chotkowski, P. Coulston, D. Denton, B. Herbold, K. Larsen, M. Nobriga, K. Rose, T. Sommer, and M. Stacey. 2005. Interagency Ecological Programs Synthesis of 2005 Work to Evaluate the Pelagic Organism Decline in the Upper San Feancisco Estuary, California Bay-Delta Authority, Sacramento, CA. December. Available online at: http://science.calwater.ca.gov/pod/pod_synthesis.shtml.

Bennett, W.A. 1995. Potential Effects of Exotic Inland Silversides on Delta Smelt. Interagency Ecological Studies Program for the Sacramento-San Joaquin Estuary Newsletter, Winter 1995.

Bennett, W.A. 2005. Critcal assessment of the delta smelt population in the San Francico Estuary, California. San Francisco Estuary and Watershed Science 3(2):1-71.

CALFED Bay-Delta Program. 2000. Programmatic Record of Decision. Sacramento, CA.

CALFED. 2002. Delta smelt and CALFED’s environmental water account: a summary of the 2002 delta smelt workshop. CALFED Science Program. Available online at http://science.calwater.ca.gov/pdf/ewa/EWA_workshop_smelt_summary_100102.pdf

CDFG. 2000a. The status of rare, threatened, and endangered animals and plants of California: delta smelt. Habitat Conservation Planning Branch. Available at: http://www.dfg.ca.gov/hcpb/species/t_e_spp/ann_te_rpt.shtml

CDFG. 2003. Special Animals, January 2003 [online]. California Department of Fish and Game, Wildlife and Habitat Branch, California Natural Diversity Database, CA. Available at: http://www.dfg.ca.gov/whdab/spanimals.pdf.

California Department of Water Resources (CDWR) and U.S. Bureau of Reclamation (USBR). 1994. Biological Assessment. *Effects of the Central Valley Project and State Water Project on delta smelt*. Prepared by the California Department of Water Resources and U.S. Bureau of Reclamation for the U.S. Fish and Wildlife Service. October 1994. 134 pp.

California Department of Water Resources (DWR) and the United States Bureau of Reclamation (Reclamation). 2005. South Delta Improvement Program (SDIP) Draft Environmental Impact Statement/ Environmental Impact Report (DEIS/EIR). October 2005.

Carlton, J.T., J.K. Thompson, L.E. Schemel, and F.H. Nichols. 1990. *Remarkable invasion of San Francisco Bay (California, USA) by the asian clam Potamocorbula amurensis*. I. Introduction and dispersal. Marine Ecology Progress Series 66:81-94.

EA Engineering, Science, and Technology. 1999. Meeting Flow Objectives for the San Joaquin River Agreement 1999 – 2010 Environmental Impact Statement and Environmental Impact Report Final Contents. Also available online at: http://www.sjrg.org/EIR/contents.htm

Herbold, B., A. D. Jassby, and P. B. Moyle. 1992. *Status and trends report on aquatic resources in the San Francisco estuary*. San Francisco Estuary Project, U.S. Environmental Protection Agency. Oakland, CA.

Herren, J. R., and S. S. Kawasaki. 2001. Inventory of water diversions in four geographic areas in California's Central Valley. Pages 343–355 *in* R. L. Brown, editor. Contributions to the biology of Central Valley salmonids. Volume 2. California Department of Fish and Game, Fish Bulletin 179, Sacramento, California.

Hunter, J. R. 1981. *Feeding ecology and predation of marine fish larvae*. Pages 34-77 in R. Lasker (ed.), Marine fish larvae. University of Washington Press. Seattle, WA.

Interagency Ecological Program (IEP). 1998. Interagency Ecological Program Web page: IEP.water.ca.gov.

Interagency Ecological Program (IEP). 2003. *Areas of emphasis for delta smelt research*. Available online at: http://www.iep.ca.gov/resident_fish/dswksp.html

IEP. 2005. Interagency Ecological Program Synthesis of 2005 work to evaluate the Pelagic Organism Decline (POD) in the upper San Francisco Estuary.

Kimmerer, W. 2002. Physical, Biological, and Management Reponses to Variable Freshwater Flow into the San Francisco Estuary. Estuaries 25:1275-1290.

Moyle, P. B. 2002. *Inland fishes of California: revised and expanded*. University of California Press, Berkeley, CA. 502 pp.

Moyle, P.B. and B. Herbold. 1989. *Status of the delta smelt, Hypomesus transpacificus*. Unpublished final report prepared for U.S. Fish and Wildlife Service, Sacramento Field Office, Habitat Conservation Division, Sacramento, California. 42 pp.

Moyle, P.B., B. Herbold, D.E. Stevens, and L.W. Miller. 1992. *Life history and status of delta smelt in the Sacramento-San Joaquin Estuary, California*. Transactions of the American Fisheries Society. 121:67-77.

Nichols, F.H., J.E. Cloern, S.N. Luoma, and D.H. Peterson 1986. The modification of an estuary. Science 231:567-573.

Nobriga, M.L., F. Feyrer, R.D. Baxter, and M. Chotkowski. 2005. Fish community ecology in an altered river delta: Spatial patterns in species composition, life history strategies, and biomass. Estuaries 28 (5): 776-785.

Obrebski, S., J. J. Orsi, and W. J. Kimmerer. 1992. *Long-term trends in zooplankton distribution and abundance in the Sacramento-San Joaquin estuary in California*. (FS/BIO-IATR/92-32, Technical Report 32.) California Department of Water Resources. Sacramento, CA. Prepared for Interagency Ecological Studies Program for the Sacramento-San Joaquin Estuary. Stockton, CA.

Stevens, D.E. and L.W. Miller. 1983. Effects of river flow on abundance of young Chinook salmon, American shad, longfin smelt, and Delta smelt in the Sacramento-San Joaquin river system. N. Am. J. Fish Manage 3:425-437.

Stevens, D. E., L. W. Miller, and B. C. Bolster. 1990. *Report to the Fish and Game Commission: a status review of the delta smelt (Hypomesus transpacificus) in California*. (Candidate Species Status Report 90-2.) California Department of Fish and Game. Stockton, CA.

Teh, S.J. 2005. Histopathological evaluation of starvation and/or toxic effects on pelagic fishes. In: Interagency Ecological Programs Synthesis of 2005 Work to Evaluate the Pelagic Organism Decline in the Upper San Feancisco Estuary, California Bay-Delta Authority, Sacramento, CA. December. Available at: http://science.calwater.ca.gov/pdf/workshops/POD/CDFG_POD_Histopathology_progress_report.pdf.

U.S. Fish and Wildlife Service (USFWS). 1993. *Endangered and Threatened Wildlife and Plants: Determination of Threatened Status for the Delta Smelt*. Federal Register 58 (42): 12854-12864.

U.S. Fish and Wildlife Service (USFWS). 1994. *Endangered and Threatened Wildlife and Plants: Critical Habitat Determination for the Delta Smelt*. Federal Register 59(242): 65256-65279.

U.S. Fish and Wildlife Service (USFWS). 1995. *U.S. Fish and Wildlife Service. 1995. Biological Assessment: OCAP Opinion regulating CVP and SWP operations*. U.S. Fish and Wildlife Service, Ecological Services, Sacramento Field Office.

U.S. Fish and Wildlife Service (USFWS). 1996. *Sacramento/San Joaquin Delta Native Fishes Recovery Plan*. U.S. Fish and Wildlife Service, Portland, OR.

U.S. Fish and Wildlife Service (USFWS). 2004. 5-Year Review, Hypomesus transpacificus (delta smelt). U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, Sacramento, California. Available online at: http://www.fws.gov/sacramento/es/documents/DS%205-yr%20rev%203-31-04.pdf

Wang, J.C.S. 1986. *Fishes of the Sacramento-San Joaquin estuary and adjacent waters, California: A guide to the early life histories*. Interagency Ecological Study Program for the Sacramento-San Joaquin Estuary, Tech. Rept. 9.

3.2.4 Green Sturgeon (*Acipsenser medirostis*)

Legal Status. NMFS published a final rule on April 7, 2006 listing the Southern DPS, which occur in the Estuary and in the Sacramento River and some of its tributaries, as threatened (71 FR 17757), which took effect June 6, 2006. This listing occurred subsequent to several status reviews, described below. NMFS conducted a status review of green sturgeon in 2002 (Adams et al., 2002). Upon completion of this review, NMFS determined that the green sturgeon is comprised of two DPSs that qualify as species under the ESA, but that neither warranted listing as threatened nor endangered (68 FR 4433). Uncertainties in the structure and status of both DPSs led NMFS to add them to the Species of Concern List (69 FR 19975). The "not warranted" determination was challenged on April 7, 2003. NMFS produced an updated status review on February 22, 2005 and reaffirmed that the northern green sturgeon DPS only warranted listing on the Species of Concern List, however proposed that the Southern DPS should be listed as threatened under the ESA.

Historical and Current Distribution and Status. The green sturgeon is the most widely distributed member of the sturgeon family Acipenseridae (NOAA 2003). In North America, green sturgeon are found in rivers from British Columbia south to the Sacramento River, California, though their ocean range is from the Bering Sea to Ensenada, Mexico (Moyle 2002).

In California, historical information regarding the distribution and spawning activities of the green sturgeon is limited (NOAA 2005, Beamesderfer et al. 2004). Until recently, within the past fifteen years, little was documented regarding migration patterns and spawning locations of the green sturgeon in California. Currently, in California spawning occurs in the upper Sacramento, Rouge, Eel, and Klamath-Trinity Rivers and less frequently in the Umpqua River (NOAA 2005, Beamesderfer et al. 2004). Reports and documentation that suggests spawning occurs within the Feather and San Joaquin Rivers are unsubstantiated (NOAA 2005).

Green sturgeon in all age ranges are extensively dispersed throughout the Sacramento-San Joaquin River Delta and estuary although recent habitat elevations have concluded that the green sturgeon habitat and distribution has been altered and reduced by dam construction in major spawning areas such as the Sacramento River. Adults have been observed in the Feather River and its tributaries, the Yuba River and the Bear River. There is no evidence that suggests spawning occurs in these areas, however historically, spawning may have occurred prior to large-scale hydropower and irrigation development (Beamesderfer et al. 2004).

In assessing North American green sturgeon status, NMFS determined two distinct population segments (DPSs) exist. The northern DPS ranges from the Eel River northward; the southern DPS includes any coastal or Central Valley populations south of the Eel River, with the only known population being in the Sacramento River, Feather River and this tributaries, the Yuba River and the Bear River (NMFS 2005).

Population estimates for adult green sturgeon in the San Pablo Bay area have ranged from several hundred to 2000, with a high of over 8,000 in 2001 (NMFS 2002). These estimates are based on incidental green sturgeon catch during CDFG's white sturgeon monitoring. However, the validity of the assumptions necessary for this estimation is questionable (Moyle 2002, NMFS 2002). An overall total of 2,608 juvenile sturgeon were collected between 1994 and 2000 in the Upper Sacramento River based on downstream migrant trapping with no apparent annual trend (Beamesderfer et al. 2004).

Distribution in the CALFED Solution Area and EWA Action Area.
Juvenile green sturgeon rear throughout San Francisco and San Pablo Bays, the Sacramento-San Joaquin Delta, and the Sacramento River. During spawning migrations, adult green sturgeon pass through the San Francisco Bay estuary

and the Sacramento-San Joaquin Delta on their way to spawning grounds in the Sacramento River (NMFS 2002, Moyle 2002).

Life History and Habitat Requirements. Green sturgeon are anadromous. Adults tend to be more marine-oriented than the more common white sturgeon. Spawning populations have been identified in the Sacramento River (Adams et al. 2002), and most spawning is believed to occur in the upper Sacramento River as far north as Red Bluff (Moyle et al. 1995) (Figure 3-13). Adults, spawning, and juvenile rearing have recently been documented upstream of RBDD, as far as north as Anderson Cottonwood Irrigation District (ref. FWS rotary screw trap catches at RBDD).

Adults begin their inland migration in late-February (Moyle et al. 1995), and enter the Sacramento River from February to late-July (CDFG 2001a or b) (Figure 3-14). Spawning occurs from March through August, with peak activity believed to occur from April to June (Moyle et al. 1995). Green sturgeon presumably spawn at temperatures ranging from 52°F to 65°F (Insert Jeans reference here). Juvenile green sturgeon spend 1 to 3 years in freshwater prior to emigrating to the ocean (NOAA 2005, 70FR17386). Small numbers of juvenile green sturgeon have been captured and identified each year from 1993 through 1996 in the Sacramento River at the Hamilton City Pumping Plant (RM 206) (Brown 1996). Juvenile green sturgeon are trapped routinely at RBDD and Glenn-Colusa Irrigation District (FWS & DFG).

A green sturgeon sport fishery exists on the lower Feather River and green sturgeon larvae are occasionally captured in salmon outmigrant traps, suggesting the lower Feather River may be a spawning area (Moyle 2002). A sport fishery for green sturgeon also exists on the Sacramento River from Glenn-Colusa Irrigation District to RBDD. Unknown species of sturgeon have been reported from the Yuba River as far upstream as Daguerre Point Dam (LYRDMP 2004).

Figure 3-14. General Periodicity of Central Valley Green Sturgeon Life Stages

Figure 3-15. Distribution of Green Sturgeon in the Central Valley

On June 6, 2006, the Southern DPS (consisting of coastal and Central Valley populations south of Eel River) of green sturgeon were listed as threatened (NMFS 2006, 71 FR 17757).

Reasons for Decline. The NMFS Biological Review Team for green sturgeon has identified several potential threats or risk factors to the southern green sturgeon DPS, including: 1) harvest bycatch concerns; 2) the concentration of spawning in the Sacramento River and the apparent small population size; 3) loss of spawning habitat; 4) lack of adequate population abundance data; 5) potentially lethal water temperatures for larval green sturgeon; 6) entrainment by water projects in the Central Valley; and 7) the adverse effects of toxic materials and exotic species (NMFS 2002).

Designated Critical Habitat or Essential Fish Habitat. Designation of critical habitat is not applicable for green sturgeon.

Conservation Efforts. Agencies implementing the CVPIA and CALFED actions are working to improve the quality of anadromous fish habitat, improving fish passage, and contributing to population recovery (CALFED 2000, AFRP 2001). The opening of the gates at the RBDD primarily for winter-run Chinook salmon passage has provided a substantial increase in access to spawning habitat for green sturgeon (NOAA 2003). Other conservation measures targeted at anadromous salmonids, such as improving river thermal and flow regimes, are likely to improve conditions for green sturgeon as well.

Recovery Plan and Recovery Guidance. AFRP (2001) under authority of CVPIA states that the target production level for green sturgeon in Central Valley rivers is 2,000 fish. CALFED's (2000) goal is to achieve recovery objectives identified for green sturgeon in the recovery plan for the Sacramento-San Joaquin Delta native fishes (USFWS 1996). Green sturgeon will be considered restored when in the Sacramento-San Joaquin Delta once the median population of mature sturgeon (>1.0 m) has reached 1,000 individuals (USFWS 1996).

Research and Monitoring Gaps. NMFS (2002) states there is a critical need to monitor population trends and identify potential risks to green sturgeon. AFRP (2001) identifies locating green sturgeon spawning sites and evaluating the availability, adequacy, and use by adult green sturgeon as a high priority.

Green Sturgeon Citations. Adams, P.B.; C.B. Grimes; J.E. Hightower; S.T. Lindley; M.L. Moser. 2002. Status Review for North American Green Sturgeon, Acipenser medirostris. National Marine Fisheries Service.

Anadromous Fish Restoration Program (AFRP). 2001. *Final Restoration Plan for the Anadromous Fish Restoration Program*. U.S. Fish and Wildlife Service and Anadromous Fish Restoration Program Core Group, CA. Available online at: http://www.delta.dfg.ca.gov/afrp/restplan_final.asp.

Beamesderfer, R., M. Simpson, G. Kopp, J. Inman, A. Fuller, and D. Demko. 2004. Historical and current information on green sturgeon occurrence in the Sacramento and San Joaquin rivers and tributaries. S.P. Cramer & Associates, Inc. 44 p.

Brown, L.R. 1996. Aquatic biology of the San Joaquin-Tulare Basins, California: Analysis of available data through 1992. U.S.G.S. Water Supply Paper 2471. 89 pp.

CALFED. 2000. *Multi-Species Conservation Strategy; Final Programmatic EIS/EIR Technical Appendix*. Available online at: http://calfed.ca.gov/Programs/
EcosystemRestoration/EcosystemMultiSpeciesConservationStrategy.shtml

California Department of Fish and Game (CDFG). 2001a. Central Valley anadromous fish-habitat evaluations October 1999-September 2000. Stream Evaluation Program Technical Report No. 01-3.

California Department of Fish and Game (CDFG). 2001b. California's Living Marine Resources. A Status Report. CDFG Bulletin pp. 465-6.

Lower Yuba River Daguerre Monitoring Program (LYRDMP). 2004. Quarterly Update. March 1, 2004 to September 6, 2004.

Moyle, P.B., R.M. Yoshiyama, J.E. Williams, and E.D. Wikramanayake. 1995. Fish Species of Special Concern in California. Second Edition. Prepared by Department of Wildlife and Fisheries Biology, University of California, Davis. June 1995.

Moyle, P. B. 2002. *Inland fishes of California: revised and expanded*. University of California Press, Berkeley, CA. 502 pp.

NMFS. 2002. *A status review for North American green sturgeon (Acipenser medirostris).* National Marine Fisheries Service, Southwest Fisheries Science Center, Northwest Fisheries Science Center.

NMFS. 2006. Endangered and Threatened Wildlife and Plants: Threatened Status for Southern Distinct Population Segment of North American Green Sturgeon. 71 FR 17757.

NOAA. 2003. *Endangered and threatened wildlife and plants; 12-month finding on a petition to list North American Green Sturgeon as a threatened or endangered species*. Federal Register 68(19): 4433.

NOAA. 2005. *Green Sturgeon (Acipenser medirostris) Status Review Update.* Biological Review Team, Santa Cruz Laboratory.

U.S. Fish and Wildlife Service (USFWS). 1996. *Sacramento-San Joaquin Delta Native Fishes Recovery Plan*. U.S. Fish and Wildlife Service, Portland, Oregon.

3.3 Species Accounts for Birds

Because there are no changes to the existing conditions for these species, and the project description is materially the same in the 2003 ASIP and the Amended ASIP, no additional analysis beyond that conducted in the 2003 ASIP is necessary for this Amended ASIP.

3.4 Species Accounts for Reptiles

Because there are no changes to the existing conditions for these species, and the project description is materially the same in the 2003 ASIP and the Amended ASIP, no additional analysis beyond that conducted in the 2003 ASIP is necessary for this Amended ASIP.

3.5 References

References associated with the species accounts can be found after each species description. The references below are from the introductory text.

Bjornn T.C. and D.W. Reiser. 1991. Habitat Requirements of Salmonids in Streams. Influences of Forest and Rangeland Management on Salmonid Fishes and their Habitats. p. 83-138. American Fisheries Society Special Publication 19.

Healey, M.C. 1991. Pacific Salmon Life Histories. University of British Columbia Press. Vancouver.

Moyle, P.B. 2002. Inland fishes of California: revised and expanded. University of California Press, Berkeley, CA. 502 pp.

Myers, J.M., R.G. Kope, G.J. Bryant, D. Teel, L.J. Lierheimer, T.C. Wainwright, W.S. Grant, F.W. Waknitz, K. Neely, S.T. Lindley, and R.S. Waples. 1998. Status Review of Chinook Salmon from Washington, Idaho, Oregon, and California. NOAA Technical Memorandum NMFS-NWFSC-35. February. Available at: http://www.nwfsc.noaa.gov/pubs/tm/tm35/index.htm

U.S. Fish and Wildlife Service and National Marine Fisheries Service (USFWS & NMFS). 1998. Endangered Species Consultation Handbook: Procedures for conducting consultation and conference activities under Section 7 of the endangered species act. March 1998.

This page is intentionally left blank

Chapter 4
Species Assessment Methods and Impact Analyses

4.1 Introduction

This section describes the methods used to determine potential effects of the EWA Proposed Action on special-status fishery resources within the Action Area. Special-status fish species within the Action Area are comprised of those species that are federally and state-listed species and species that are candidates for federal listing including:

- Fall-run/late-fall-run Chinook salmon[2] (*Oncorhynchus tshawytscha*);
- Winter-run Chinook salmon (*Oncorhynchus tshawytscha*);
- Spring-run Chinook salmon (*Oncorhynchus tshawytscha*);
- Steelhead (*Oncorhynchus mykiss*);
- Delta smelt (*Hypomesus transpacificus*); and,
- Green sturgeon[3] (*Acipenser medirostris*).

Because there are no changes to the existing conditions for terrestrial species, and the project description is materially the same in the 2003 ASIP and the Amended ASIP, no additional analysis beyond that conducted in the 2003 ASIP is necessary for this amendment.

4.2 Fish Species Assessment Methods

4.2.1 Consideration of Scientific Uncertainties in Determining the Evaluation Approach

Scientific uncertainties stem from an incomplete understanding of cause and effects and our ability to measure physical changes and species responses. Tools to analyze potential actions on aquatic life in the Delta are limited by our understanding of the biological and physical mechanisms that affect the species present. Of necessity, the tools available to represent physical conditions in the Delta simplify complex relationships and limit the kinds of conditions that can be represented. Many models and analytical approaches have been advanced over the years and most have been found wanting to some degree. The earlier models represented regressions of observed physical conditions and biological variables, such as the response of striped bass to salinity. Such models have been applied for management of Delta species and found to be poor indicators of potential future conditions (IEP Review Panel 2005).

As understanding of physical conditions, including Delta hydraulics, have improved, flow and water quality models have improved. However, flow models and water quality models dependent upon them represent oversimplifications of more complex processes. Tools for interpretation of flow and water quality model results used to assess the effects of potential actions on aquatic species tend to focus on individual aspects of the physical environment. More detailed and complex modeling tools for biota are being developed, but are too early in the developmental process to provide reliable results. There also is some controversy as to the true importance and representativeness of several of the biological indices, including those derived from historical monitoring programs that have been used to derive empirical relationships and measure population trends (IEP Review Panel 2005).

The current state of knowledge limits the ability to assess the interactions of biological and physical factors at the community and food web level of the Delta. This limitation affects the accuracy of the predicted changes to the physical environment and the potential effects on biological populations. The uncertainties regarding the mechanisms of food web- interactions restrict our understanding of the factors causing adverse changes in Delta biota. This is especially apparent in the literature addressing the ongoing long-term decline of native Delta species and introduced recreational species and the contribution of invasive exotic species toward this decline. The IEP POD Review Panel Report (IEP 2005) states:

Key pieces of basic information appear to be lacking on the habitat requirements and early life stages of pelagic species of interest. For example, there is very little information on where the eggs of delta smelt can be found in the system. Likewise, there are few reliable estimates of vital rates (e.g. stage-specific growth and mortality rates) required to adequately model spatially explicit population dynamics of pelagic species under different scenarios.

The data analyses and dynamic models lack the sophistication to match the complexity of the dynamics in the hydrological and population/community dynamics of the Bay-Delta system.

There are clearly differences of opinion between scientists as to the use of analytical approaches and the data needed for more complete analyses.

Relationships involving key indices such as X2 and Delta outflow are based primarily on single factors or ratios that are empirically derived to indicate favorable or less favorable conditions for fish. These indices allow for the use of physical models to provide indications of the effect of potential actions by the comparison of results derived from hydraulics and water quality, especially salinity. These indices include X2 and Delta outflows. Such indices provide valuable insight into how changes in physical factors may adversely or favorably affect Delta species, but do not provide a comprehensive analysis of the synergistic interactions of variables that are important to understanding community and ecosystem effects.

4.2.2 Assessment Approach

Results of hydrologic modeling (described in EIS/EIR Appendix B) provide monthly information that is used to evaluate the potential effects of EWA operations on conditions that affect fish species inhabiting the Bay-Delta estuary. The following modeling parameters were selected to be part of this analysis:

- Delta outflow;
- Change in location of the 2 parts per thousand (ppt) salinity isohaline (X2); and,
- Entrainment of fish at CVP and SWP Delta facilities.

Potential effects to fish and aquatic habitat were assessed through a comparative analysis of hydrologic conditions. Changes in these hydrologic parameters are indicative of potential effects on fish species and aquatic ecosystems in the Delta. NMFS has determined that there are no species requiring Essential Fish Habitat (EFH) consultation within the Delta under the Magnuson-Stevens Fishery Conservation and Management Act (MSA) related to the EWA Program (NMFS 2004).

4.2.2.1 Delta Outflow

Delta outflow is the amount of water leaving the western Delta and flowing into Suisun Bay. It is related to seasonal runoff and releases from upstream reservoirs reaching the Delta, as well as in-Delta diversions and CVP/SWP exports. Delta outflow is a general indication of habitat conditions in the Delta. Historically, there were relationships between Delta outflow and striped bass and longfin smelt populations (Kimmerer 2002). These relationships have changed over the years as conditions in the Delta have changed, but these former relationships indicate the potential importance of Delta outflow to Delta fishes. Seasonal flows influence the transport of eggs and young organisms through the Delta and into San Francisco Bay. Flows during the months of April, May, and June play an especially important role in determining the reproductive success, survival, and emigration success of many estuarine and migratory species including salmon, striped bass, American shad, delta smelt, longfin smelt, splittail, and others (Stevens and Miller 1983; Stevens et al. 1985; Herbold 1994; Meng and Moyle 1995 as cited in DWR and Reclamation 1996).

Additionally, Delta outflow is a primary driver of other hydrologic parameters within the Delta that affect habitat quality. These parameters include the location of X2 (discussed below) and fall habitat quality[1] (Feyrer et al., in press, see Section 4.1.3.2.1). D-1641 contains Delta outflow compliance criteria (Net Delta Outflow Index[2] (NDOI) under the water quality objectives for fish and wildlife beneficial uses) ranging from 3,000 to 8,000 cfs, depending on month and water year type (Table 4-1, SWRCB 2001). This requirement is based on a 3-day running average, whereas the model uses a monthly time step and is not capable of examining a 3-day period. This does not allow evaluation of compliance with the standard using the modeled results, as the monthly average may not be a good estimator of the average over any 3-day period.

Table 4-1. Delta Outflow Requirements under D-1641[1]

Water Year Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wet	4,500[2]	7,100[3]	7,100[3]	7,100[3]	7,100[3]	7,100[3]	8,000	4,000	3,000	4,000	4,500	4,500
Above Normal	4,500[2]	7,100[3]	7,100[3]	7,100[3]	7,100[3]	7,100[3]	8,000	4,000	3,000	4,000	4,500	4,500
Below Normal	4,500[2]	7,100[3]	7,100[3]	7,100[3]	7,100[3]	7,100[3]	6,500	4,000	3,000	4,000	4,500	4,500
Dry	4,500[2]	7,100[3]	7,100[3]	7,100[3]	7,100[3]	7,100[3]	5,000	3,500	3,000	4,000	4,500	4,500
Critical	4,500[2]	7,100[3]	7,100[3]	7,100[3]	7,100[3]	7,100[3]	4,000	3,000	3,000	3,000	3,500	3,500

Notes:
[1]Based on Net Delta Outflow Index
[2]Increased to 6,000 cfs if the eight rivers index for December exceeds 800 TAF
[3]Calculated as a 3-day running average and dependent on EC at Collinsville and the Eight Rivers Index and the Sacramento River Index in May.

Approach. To evaluate potential effects on Delta fish resources, monthly Delta outflow under the Proposed Action was determined and compared to monthly Delta outflow under Baseline Conditions over the period of record evaluated. Emphasis is given to the months December through July, which are of greatest import to most of the evaluation species (Sommer 2007). Other periods of the year are also evaluated, however, based on emerging theories about factors affecting pelagic species in other seasons (see Section 4.1.3.2.1).

Effects on Delta fishery resources were considered adverse if monthly Delta outflows decreased under the Proposed Action, relative to Baseline Conditions[3], during one or more months of the evaluation period. Significance criteria for this evaluation are provided in Section 4.2.2.1.

[1] Specific mechanisms linking physical habitat quality to the abundance of these species remain unclear and tools for evaluating this hypothesis are still under development.
[2] D-1641 defines NDOI as Delta Inflow minus Delta Consumptive Use minus Delta Exports (Fig 3, SWRCB 2001)
[3] Baseline Conditions refers to both existing conditions and the Future No Action Conditions. Given the short timeframe for this Supplement, these conditions are expected to be equivalent.

4.2.2.2 Location of X2

The location of suitable habitat for delta smelt and other Delta species has been affected by changes in the hydrodynamics of Delta waterways resulting from water diversions that have shifted the position of X2 upstream of the confluence (USFWS 2005). Historically, the location of X2 has varied from San Pablo Bay (River km 50) during high Delta outflow to Rio Vista (River km 100) during low Delta outflow. In recent years, it has typically been located from approximately Honker Bay to Sherman Island (River km 70 to 85). X2 is controlled directly by the volume of Delta outflow, although changes in X2 lag behind changes in outflow. Minor modifications in outflow do not greatly alter the X2 location. The location of X2 downstream of the confluence is closely associated with the natural logarithm of Delta outflow between 1959 and 1988 (USFWS 2005).

X2 is commonly used as an index of the location of the Low Salinity Zone. The Low Salinity Zone is an area of the Estuary characterized by higher levels of particulates, higher abundances of several types of organisms, and maximal turbidity. It is commonly associated with the position of X2, but actually occurs over a broader range of salinities. Lateral circulation within the Estuary or chemical flocculation may play a role in the formation of the turbidity maximum of the Low Salinity Zone.

The Low Salinity Zone is thought to be biologically important to many species. Mixing and circulation in this zone concentrates plankton and other organic material, and increases food biomass and production. Larval fish such as striped bass, delta smelt, and longfin smelt may benefit from enhanced food resources in the low salinity zone. Since about 1987, however, *Corbula*, the introduced Asian clam, populations have had a substantial impact on phytoplankton through grazing and has reduced zooplankton abundance through both predation and competition (Alpine and Cloern 1992; Kimmerer et al. 1994; Kimmerer and Orsi 1996; Orsi and Mecum 1996 as cited in Kimmerer 2002).

Although little to no enhancement of the base of the food chain in the Low Salinity Zone may have occurred during the past decade, this area continues to have relatively high levels of invertebrates and larval fish. Jassby et al. (1994 as cited in DWR and Reclamation 1996) showed that when X2 is in the vicinity of Suisun Bay, several estuarine organisms tend to show increased abundance. However, the mechanism behind this relationship is not clear. The observed correlations may result from a close relationship of X2 to other factors that affect these species.

Previous analyses have shown that delta smelt are usually distributed upstream of X2 (Kimmerer 2002). Ever since a population decline in the early 1980s, upstream placement of X2 during spring has been associated with low delta smelt abundance in DFG surveys (Kimmerer 2002). Prior to 1982, delta smelt abundance was highest when X2 was in or near the Delta. Currently, it is thought that the central and south Delta no longer provide generally suitable habitat for post larval delta smelt due to altered habitat conditions and entrainment losses (USFWS 2005). Additionally, the summer tow net index increased when outflow was between 34,000 and 48,000 cfs, which placed X2 between Chipps and Roe islands, downstream of the confluence (Jassby et al. 1994 as cited in DWR and Reclamation 1996).

When X2 is west of the confluence, delta smelt and other fishes are outside the area of influence of the pumps. Except for three years in the 1983-1994 period (1986, 1993, and 1994), indices of fish abundance from the summer tow net surveys have remained at consistently lower levels than experienced before 1983. These low levels correlate with the 1983 to 1994 mean location of X2 upstream of the confluence (USFWS 2005). Empirical physical evidence shows that when X2 is upstream of the confluence of the Sacramento and San Joaquin rivers, delta smelt are in the area of the San Joaquin River where flow conditions draw larval fish into the South Delta and expose them to other factors that potentially decrease survival (predation, warmer water temperatures and greater risk of entrainment at the SWP and CVP) (Bennett 2005). For delta smelt, the concern is with upstream movement of X2 east of the confluence during the spring and early summer.

The relationship between fish abundance and X2 location is not as solid in wet years. In wet years, delta smelt typically are located well down into Suisun Bay and away from the influence of the pumps. Therefore, X2 does not necessarily regulate delta smelt distribution in all years. In wet years when abundance levels are high, their distribution is much more dispersed and they can be found well west of the X2 location. This change in distribution is believed to be related to the location of primary food resources (USFWS 2005). Food resources are more dispersed and smelt distribution mimics that of their food resources.

Similar physical processes affect other euryahine (tolerating a wide range of salinities) species, such as longfin smelt, outmigrating juvenile Chinook salmon and steelhead, and life stages of other species that move into or through the Delta during the spring and summer. The change in location of X2 relative to the confluence during key life history stages can be used to evaluate the effects of EWA on Delta conditions for Delta species.

X2 is also used as a surrogate for habitat quality in the western Delta and Suisun Bay. As discussed in Section 4.1.3.2, fall habitat quality has been related to fish population trends for several species (Feyrer et al. in press). Based on this, it is hypothesized that changes in habitat quality may be adversely affecting fish. During the fall, movement of X2 is indicative of habitat quality in Suisun Bay. Westward movement of X2 during this time would be considered beneficial for fish, while eastward movement would be considered an adverse change.

The location of X2 during the late winter through spring (February through June) is included as a regulatory requirement in the 1995 Water Quality Control

Plan and D-1641 (SWRCB 2001). Between January and June, the location of X2 is managed to fall within certain geographic boundaries, the most important of which are Collinsville at rkm 81 upstream and Chipps Island at rkm 74, near Antioch.

Depending on the water year type, the location of X2 is managed to be west of these compliance points for certain periods between January and July by managing Delta inflow and exports. Conditions are highly favorable for fish when X2 is downstream (west) of Chipps Island. Conditions are less favorable for fish when X2 is upstream (east) of rkm 81. Habitat improves as X2 moves to the west between these two points. Because the analysis did not include new CALSIM runs, the location of X2 could not be precisely ascertained. The location of X2 was estimated based upon empirical formulae. These formulae and the error inherent in them are described in the EIS/EIR Appendix B. The X2 values presented and discussed below, provide a relative location of X2, rather than a precise location; that is they indicate the direction in which X2 would change, but may not be used to reliably estimate compliance with the regulatory criteria. The SWP and CVP are operated to comply with these criteria.

Approach. The X2 values presented and discussed in this document provide an assessment of the relative location of X2 for each alternative, rather than its precise location. These data are used to indicate the direction in which X2 would change under the Proposed Action, but lack the resolution needed to determine the exact location of X2.

To assess the effects of the Proposed Action on the location of X2 relative to Baseline Conditions, the estimated locations of X2 were compared. The results were evaluated relative to the significance criteria discussed in Section 4.2.2.3.

4.2.2.3 Entrainment at SWP and CVP Facilities

Implementation of the Proposed Action would change the amount and timing of pumping at the SWP and CVP facilities. The amount of water pumped at these facilities affects fish survival within the Delta both directly and indirectly (USFWS 2005). The number of fish lost to entrainment is assumed to be proportional to the numbers of fish salvaged. Recent estimates indicate that salvage numbers may be close to twenty percent of fish affected by entrainment. However, fish smaller than 20 mm at the SWP and smaller than 38 mm at the CVP are not well represented in salvage, and thus are under represented in the salvage density calculations. Additionally, these smaller fish are considered to be sensitive to handling during and after salvage, and may not survive salvage operations, and thus may be counted as salvaged, when in fact they die subsequently. Recent work with delta smelt has indicated better survival during the actual salvage process than previously suspected (J. Morinaka pers. comm. 2007). Survival of adult delta smelt ranges from 80 to 90 percent, while that of juvenile delta smelt ranges from 30 to 60 percent. These survival estimates may be an under-estimate as they include mortality from only the salvage operation. They do not include associated losses prior to entering the salvage facilities or after release. Nor do they include an estimated 10 percent additional loss that occurs during cleaning operations, when the louvers are lifted out of the water (NMFS 2004). In addition to salvage and entrainment at the pumping facilities, exports may also increase losses due to predation along the approaches to the pumps. These predation losses are believed to be substantial, especially for the SWP, but also occur to a lesser extent at the CVP. In addition, there is mortality associated with salvage operations including survival during the collection, handling, trucking and release of salvaged fish. For salmon, these factors have been studied and are accounted for in calculations and are represented as "loss." For other species, including delta smelt, these factors are not well understood and are not accounted for in the model. Potential mortality for these species is represented as "salvage." Predation losses are influenced by operation of the pumps, in that exports can draw vulnerable fish into areas where predator densities are higher. Additionally, increased pumping can draw fish from more favorable to less favorable habitats within the Delta. Therefore, increased salvage numbers are considered to represent an overall adverse effect of an action or project on fish resources.

The magnitude of losses resulting from export operations is a function of the magnitude of monthly water exports from each facility, the relative abundance of fish that are exposed to entrainment near the export facilities, and the vulnerability of species and life stages to entrainment and the associated effects described above. When fish abundance near the export facilities is high, as indicated by salvage, and export flows also are high, fish losses are more likely to be high since the higher abundances place more fish at risk and higher exports increase the risk of entrainment. When export pumping is low or fish densities are low, losses would be expected to be lower as well.

Approach. An approach was developed to evaluate the relative amount of entrainment that might be experienced at the export facilities under alternative export scenarios. This approach is based upon that used in biological assessments for the long-term operations of the Projects (Reclamation 2004) and combines data developed by Reclamation on the number of fish salvaged by month and hydrological condition (wetter or drier conditions) and the amount of water exported via the pumps as simulated for the Proposed Action for both the CVP and SWP facilities. This information was used to develop an index of the relative risk of entrainment for different species and life stages.

Reclamation used historical salvage data for listed species at the SWP and CVP pumps for the period 1993-2004 to calculate salvage density by species and month for wetter and drier hydrological conditions[4]. Salvage densities were calculated by totaling salvage for each species by month for each export facility

[4] The 2004 EIS/EIR used data from 1979-1993. The more recent data used in the Supplement reflects more recent salvage densities based on evolving operations of the Projects and better data collection techniques at the fish salvage facilities.

and dividing by the volume of water pumped during that month. This provided salvage densities by species for each export facility for each month and year of the evaluation. These were then averaged by water year condition to derive average salvage densities by species, month, and hydrological condition; wetter years consisting of wet and above-normal water years, and drier conditions consisting of below normal, dry, and critically dry water years. Salmon were calculated based on a loss index, which accounts for fish rescued through salvage. Other species, which did not exhibit high survival during salvage, were based on the salvage index. This approach was extended to non-listed species using the same techniques for this analysis.

The entrainment index for operational alternatives is calculated by multiplying the volume of water pumped in a month at a facility by the salvage density (or loss) for the appropriate water year condition for each species. The results for the two export facilities are totaled by month and year. Average calculated salvage by year (long-term average) is produced and tabulated for the overall evaluation period and by hydrological condition to facilitate evaluation of the Proposed Action.

The values calculated are considered an index, as this approach will not precisely calculate the number of fish entrained by the facilities or account for associated effects of pumping, such as predation, handling mortality, and negative flows in Old and Middle Rivers that may draw fish from more favorable to less favorable habitats. It also will not account for entrainment of smaller lifestages that are not well represented in the salvage. However, it seems reasonable to assume that the relationship between export rates and these factors would be the same for all alternatives that are likely to be considered.

Underlying assumptions of the analysis include:

- The 1993–2004 species salvage densities are sufficiently representative for this analysis and can be used as a measure of comparison of the Proposed Action to the Baseline Conditions to predict future densities for similar hydrological conditions, wetter and drier years[5].
- Simulation of the Proposed Action over the historic period of record is sufficiently representative of future conditions under the Proposed Action.
- Factors not included in this analysis would not unduly affect the validity of the evaluation of the Proposed Action.

The entrainment indices by species for the Proposed Action, by water year category and for all years combined, were considered in assessing effects. The

[5] Salvage densities vary not only by month, but also with the population of the species being evaluated. During periods when populations are very high, salvage densities would be expected to be higher. Conversely, when populations are very low, salvage densities would also be low. The 1993 to 2004 salvage numbers are used as an index to assess potential effects of the Proposed Action.

net change in the entrainment indices indicates whether the Proposed Action differs in effect from the Baseline Conditions. A difference of more than five percent in the entrainment index was used to assess significance, since there is some uncertainty in the salvage densities that are used with modeled flows as indicators of future operations. Significance criteria for this parameter are outlined in Section 4.2.2.4. Entrainment indices for late-fall-run Chinook and green and white sturgeon were not developed because the number of these fish salvaged was too low to support this type of analysis. Salvage data for lamprey are not species specific; therefore, entrainment of Pacific lamprey could not be evaluated.

4.3 Species-Specific Impact Assessment

4.3.1 Central Valley Fall-run/Late-fall-run Chinook Salmon (*Oncorhynchus tshawytscha*)

4.3.1.1 Status in the Action Area

The following is a summary of the more detailed discussion provided in Chapter 3 of this Amended ASIP. Central Valley fall-run/late-fall-run Chinook salmon historically inhabited the entire Sacramento-San Joaquin watershed. Fish barriers (typically dams) on many streams and rivers currently limit upstream habitat. Adults migrate upstream through the Bay and Delta ecozones from summer through early winter, with the predominant period being September and October. Adults are found in river and tributary ecozones generally from late summer into winter. Most young move out of tributary spawning areas in winter and spring. Young may be found in the river, Delta, and Bay ecozones from winter into early summer. Additional details regarding the status of Central Valley fall-run/late-fall-run Chinook salmon in the EWA Action Area are provided in Section 3.2.1.1, Central Valley Fall-run/Late-fall-run Chinook Salmon.

4.3.1.2 Effect Assessment Methods

Section 4.2 discusses the assessment methods for all anadromous and Delta estuary fish. In the Delta, the Delta outflows and entrainment numbers were analyzed to determine potential effects.

4.3.1.3 Project Effects

The following discussion is a summary of potential effects on fall-run/late-fall-run Chinook salmon related to changes in habitat conditions and entrainment at the SWP and CVP export facilities within the Sacramento-San Joaquin Delta.

Delta Outflow. *The Proposed Action would generally increase Delta outflow from January through September and decrease outflow from October through December.*

Delta outflows under the Proposed Action would closely track the Baseline Delta outflows from March through December, varying by 10 percent or less, and substantially less most of the time (Table 4-2). In January and February, the Proposed Action would result in higher outflows than occur under Baseline Conditions, as EWA fish actions would be undertaken to improve environmental conditions and reduce the potential for entrainment. The increase in outflows would be similar during nearly every year. The greatest percentage increases in outflow occur at the 90 percentile flows. In January, higher percentage increases in outflows occur under all but the wettest conditions (occurring 1 percent of the time or less); in February, substantially higher percentage increases in outflows occur in normal and drier conditions. This indicates that the greatest benefit is provided under normal or drier conditions. Outflow is increased during wetter conditions as well, but these increases do not rise to a threshold of significance. Outflow is increased to a lesser degree in March through September, as well. Outflow would be decreased by amounts that are not likely to cause adverse effects in October through December as the EWA agencies pumped surplus water from the Delta (when available) to reduce debt in San Luis Reservoir. In December, reductions in Delta outflow would be constrained by the conservation measures to effects that are not likely to be adverse and so would not reach the 11 to 20 percent level shown for the 75-99 percentile flows, but would be more similar to those occurring under normal and wetter conditions.

Table 4-2. Percent Change in Delta Outflow under Proposed Action[1]

Percent of Time Greater Than or Equal To		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Low Occurrence High Value ↓	1	-5%	0%	-3%	9%	4%	2%	2%	3%	0%	0%	1%	1%
	10	0%	0%	-9%	14%	5%	2%	3%	4%	0%	1%	2%	1%
	25	-1%	-1%	-5%	22%	7%	3%	4%	3%	0%	2%	2%	0%
Median	50	-1%	-1%	0%	31%	12%	5%	4%	6%	3%	1%	2%	2%
↑ High Occurrence Low Value	75	-5%	-5%	-11%	37%	16%	6%	6%	4%	1%	1%	3%	3%
	90	-7%	-4%	-9%	41%	19%	5%	2%	0%	0%	3%	4%	3%
	99	-4%	-7%	-20%	32%	6%	10%	0%	0%	0%	3%	4%	4%

Notes:
[1]Positive percentages indicate an increase in Delta outflow, while negative percentages indicate a decrease in Delta outflow

Historically, Delta outflow has been linked to populations of some pelagic species (Kimmerer 2002). While these relationships are not apparent in the last several years, these generally higher outflows under the Proposed Action are anticipated to create more favorable habitat conditions for pelagic species. Higher Delta outflow also keeps eggs, larva, and fry further from the pumps and therefore reduces entrainment risk. Finally, higher outflows would be expected to improve the emigration success of salmonids and other species moving downstream through the Delta at this time. The Proposed Action would have a beneficial effect on outflow relative to Baseline Conditions during the most critical periods of the year, January and February. It would result in a reduction in Delta outflow in October through December. However, due in part to the conservation measures included as part of the project, the effect is not likely to be adverse.

Entrainment. *The Proposed Action would result in substantially reduced entrainment indices for most species evaluated, including all listed species.*

Considering all water years (Table 4-3), the Proposed Action would substantially decrease the entrainment index for most species.[6] For most species, the percent change relative to Baseline Conditions is similar in wetter and drier years. For species where a substantial decrease would occur, these decreases usually exceed 10 percent and often approach or exceed 15 percent, indicating a substantial benefit to these species. The decreased entrainment indices for delta smelt, in all time periods and for both wetter and drier years, ranges from 11 to 19 percent, with the greatest benefits occurring in the January through March period, when early spawning individuals would be present. This represents an important benefit relative to Baseline Conditions.

Table 4-3. Simulated Change in Annual Average Entrainment Indices for the Proposed Action Relative to Baseline Conditions for Combined Banks (SWP) and Jones (CVP) Exports

Fish Species	All Years	Wetter Years	Drier Years
Delta smelt	-11%	-11%	-12%
Delta Smelt - Pre-spawning and adults[1]	-18%	-17%	-19%
Delta Smelt - juveniles[2]	-12%	-11%	-12%
Fall-Run Chinook[3]	-17%	-16%	-17%
Late Fall-Run Chinook[3]	-9%	-11%	-6%
Winter-Run Chinook[3]	-13%	-14%	-12%
Spring-Run Chinook[3]	-15%	-15%	-16%
Steelhead[3]	-15%	-15%	-15%

Notes:
[1]January - March
[2]April - June
[3]Entrainment indices based on loss ratios instead of only salvage numbers

[6] As stated in Section 4.2.1.4, entrainment indices for late-fall-run Chinook and green sturgeon were not developed as the number of these fish salvaged was too low to support this type of analysis.

The Proposed Action would have a beneficial effect on entrainment indices relative to Baseline Conditions for all listed species and most native species.

4.3.1.4 Conservation Measures

Conservation measures that would be applied to the EWA actions for each species and NCCP habitat were originally described in the 2003 ASIP. These conservation measures are repeated below.

Conservation Measure Applicable to all Species The EWA Project agencies will coordinate EWA water acquisition and transfer actions with Federal (Reclamation, USFWS and NMFS), State (DWR and CDFG), other CALFED agencies, and regional programs (e.g., the San Francisco Bay Ecosystem Goals Project, the Anadromous Fish Restoration Program, the Senate Bill [SB] 1086 program, the U.S. Army Corps of Engineers' [USACE's] Sacramento and San Joaquin Basin Comprehensive Study, the Riparian Habitat Joint Venture, the CVPIA, the Central Valley Habitat Joint Venture, and the Grassland Bird Conservation Plan) that could affect management of evaluated species. Coordination will avoid conflicts among management objectives and will be facilitated through CALFED's water transfer program.

General Fish Species Conservation Measures

- In implementing the EWA, the EWA agencies will avoid acquisition and transfer of water that will reduce flows essential to maintaining populations of native aquatic species in the source river.

- In implementing the EWA water acquisition and transfers, the EWA agencies will not increase exports during times of the year when anadromous and estuarine fish are most vulnerable to damage or loss at project facilities or when their habitat may be adversely affected.

- In implementing the EWA, the EWA agencies will avoid acquisition and transfer of stored reservoir water quantities that will impair compliance with flow requirements and maintenance of suitable habitat conditions in the source river in subsequent years.

Salmonids – General Conservation Measures - Central Valley Fall/Late-Fall Run Chinook Salmon (C-FESA; SSC-CDFG); Sacramento River Winter Run Chinook Salmon (E-FESA; E-CESA); Central Valley Spring Run Chinook Salmon (T-FESA; CT-CESA); Central Valley Steelhead (T-FESA)

- In implementing the EWA, the EWA agencies will fully adhere to the terms and conditions in all applicable CESA and FESA biological opinions and permits for CVP and SWP operations.

- In implementing the EWA, the EWA agencies will minimize flow fluctuations resulting from the release of EWA assets from project reservoirs to reduce or avoid stranding of juveniles.

- The EWA agencies will consult with the local river management teams regarding management of EWA water on those rivers.

4.3.1.5 Contribution to Recovery

The EWA Program has been developed to contribute to the recovery of at-risk native fish species. The EWA agencies have established operating tools that allow them to meet protection objectives for at-risk fish species within the Sacramento and San Joaquin Rivers and their tributaries and the Delta, including: 1) reducing export pumping, 2) closing the Delta Cross Channel gates beyond closures required under Baseline Conditions, 3) increasing instream flows, and 4) augmenting Delta outflow. The EWA agencies use their acquired assets, in addition to actions specified under Baseline Conditions, and implement actions to protect at-risk fish under various conditions throughout the year. Each tool, its timing, the protection it provides and why, and how each action is undertaken is described in Section 2.4.2, Actions to Protect Fish and Benefit the Environment, of this ASIP.

4.3.2 Sacramento River Winter-run Chinook Salmon (*Oncorhynchus tshawytscha*)

4.3.2.1 Status in the Action Area

The following is a summary of the more detailed discussion provided in Chapter 3, Environmental Baseline – Special-Status Species Accounts and Status in Action Area, of this ASIP. Sacramento River winter-run Chinook salmon occur only in the Sacramento River. Winter-run Chinook salmon primarily spawn in the main-stem Sacramento River between Keswick Dam (RM 302) and Red Bluff Diversion Dam (RM 243). Winter-run Chinook salmon spawn between late-April and mid-August, with peak spawning generally occurring in June. Winter-run Chinook salmon fry rearing in the upper Sacramento River exhibit peak abundance during September, with fry and juvenile emigration past Red Bluff Diversion Dam occurring from August through March (Reclamation 1992). Emigration (downstream migration) of winter-run Chinook salmon juveniles past Red Bluff Diversion Dam is believed to peak during September and October (Hallock and Fisher 1985), with abundance of juveniles in the Delta generally peaking during February, March, or April (Stevens 1989). Additional details regarding the status of Sacramento River winter-run Chinook salmon in the EWA Action Area are provided in Section 3.2.1.2, Sacramento River Winter-run Chinook Salmon.

4.3.2.2 Effect Assessment Methods

Section 4.2 discusses the assessment methods for all anadromous and Delta estuary fish. In the Delta, the Delta outflows and entrainment numbers were analyzed to determine potential effects.

4.3.2.3 Project Effects

The following discussion is a summary of potential effects on winter-run Chinook salmon related to changes in habitat conditions and entrainment at the SWP and CVP export facilities within the Sacramento-San Joaquin Delta.

Delta Outflow. The Proposed Action would result in reduced Delta outflow in December (Table 4-2). This may slow the emigration of winter-run Chinook salmon which may draw this species into closer proximity of the pumps, increasing their risk of entrainment. However, with conservation measures, when considering Delta outflow the Proposed Action may affect but is not likely to adversely affect Sacramento River winter-run Chinook salmon in December.

Entrainment. The Proposed Action, considering all water years, would decrease the entrainment index of Sacramento River winter-run Chinook salmon compared to existing conditions (Table 4-3). Therefore, when considering entrainment the Proposed Action would provide a beneficial effect to Sacramento River winter-run Chinook salmon.

4.3.2.4 Conservation Measures

Conservation measures applicable to adverse effects on Sacramento River winter-run Chinook salmon can be found in Section 4.3.1.4 as part of the fall-run/late-full-run Chinook salmon discussion.

4.3.2.5 Contribution to Recovery

The EWA Program has been developed to contribute to the recovery of at-risk native fish species. The EWA agencies have established operating tools that allow them to meet protection objectives for at-risk fish species within the Sacramento and San Joaquin Rivers and their tributaries and the Delta, including: 1) reducing export pumping, 2) closing the Delta Cross Channel gates beyond closures required under the Baseline Conditions, 3) increasing instream flows, and 4) augmenting Delta outflow. The EWA agencies use their acquired assets, in addition to actions specified under Baseline Conditions, and implement actions to protect at-risk fish under various conditions throughout the year. Each tool, its timing, the protection it provides and why, and how each action is undertaken is described in Section 2.4.2, Actions to Protect Fish and Benefit the Environment, of this ASIP.

The analysis of potential effects on winter-run Chinook salmon provided in Section 4.3.2.3, Project Effects, demonstrates that implementation of the EWA

Proposed Action (including the above conservation measures) will contribute to the recovery of Sacramento River winter-run Chinook salmon.

4.3.3 Central Valley Spring-run Chinook Salmon (*Oncorhynchus tshawytscha*)

4.3.3.1 Status in the Action Area

The following is a summary of the more detailed discussion provided in Chapter 3, Environmental Baseline – Special-Status Species Accounts and Status in Action Area, of this ASIP. Historically, the Central Valley spring-run Chinook salmon was one of the most abundant and widely distributed salmon races. Extirpations followed construction of major water storage and flood control reservoirs on the Sacramento and San Joaquin Rivers and their major tributaries in the 1940s and 1950s (Moyle *et al.* 1995). Spring-run Chinook salmon have been completely extirpated in the San Joaquin drainage. Additional details regarding the status of Central Valley spring-run Chinook salmon in the EWA Action Area are provided in Section 3.2.1.3, Central Valley Spring-run Chinook salmon.

4.3.3.2 Effect Assessment Methods

Section 4.2 discusses the assessment methods for all anadromous and Delta estuary fish. In the Delta, the Delta outflows and entrainment numbers were analyzed to determine potential effects.

4.3.3.3 Project Effects

The following discussion is a summary of potential effects on spring-run Chinook salmon related to changes in habitat conditions and entrainment at the SWP and CVP export facilities within the Sacramento-San Joaquin Delta.

Delta Outflow. The Proposed Action would result in reduced Delta outflow in December (Table 4-2). This may slow the emigration of Central Valley spring-run Chinook salmon which may draw this species into closer proximity of the pumps, increasing their risk of entrainment. However, with conservation measures when considering Delta outflow the Proposed Action may affect but is not likely to adversely affect Central Valley spring-run Chinook salmon in December.

Entrainment. The Proposed Action, considering all water years, would decrease the entrainment index of Central Valley spring -run Chinook salmon compared to existing conditions (Table 4-3). Therefore, when considering entrainment the Proposed Action would provide a beneficial effect to Central Valley spring -run Chinook salmon.

4.3.3.4 Conservation Measures

Conservation measures applicable to adverse effects on Central Valley spring-run Chinook salmon can be found in Section 4.3.1.4 as part of the fall-run/late-full-run Chinook salmon discussion.

4.3.3.5 Contribution to Recovery

The EWA Program has been developed to contribute to the recovery of at-risk native fish species. The EWA agencies have established operating tools that allow them to meet protection objectives for at-risk fish species within the Sacramento and San Joaquin Rivers and their tributaries and the Delta, including: 1) reducing export pumping, 2) closing the Delta Cross Channel gates beyond closures required under the Baseline Conditions, 3) increasing instream flows, and 4) augmenting Delta outflow. The EWA agencies use their acquired assets, in addition to actions specified under the Baseline Conditions, and implement actions to protect at-risk fish under various conditions throughout the year. Each tool, its timing, the protection it provides and why, and how each action is undertaken is described in Section 2.4.2, Actions to Protect Fish and Benefit the Environment, of this ASIP.

The analysis of potential effects on spring-run Chinook salmon provided in Section 4.3.3.3, Project Effects, demonstrates that implementation of the EWA Proposed Action (including the above conservation measures) will contribute to the recovery of Central Valley spring-run Chinook salmon.

4.3.4 Central Valley Steelhead (*Oncorhynchus mykiss*)

4.3.4.1 Status in the Action Area

The following is a summary of the more detailed discussion provided in Chapter 3, Environmental Baseline – Special-Status Species Accounts and Status in Action Area, of this ASIP. Historically, the Central Valley ESU steelhead was well distributed throughout the Sacramento and San Joaquin river systems: from the upper Sacramento/Pit river systems south to the Kings and possibly Kern River systems in wet years (Yoshiyama *et al*. 1996). Currently, steelhead distribution is primarily limited by dams that block access to upstream reaches of main rivers and their tributary streams. The existing Central Valley steelhead ESU includes steelhead in all river reaches accessible to the Sacramento and San Joaquin Rivers and their tributaries in California. Additional details regarding the status of Central Valley steelhead in the EWA Action Area are provided in Section 3.2.2, Central Valley Steelhead.

4.3.4.2 Effect Assessment Methods

Section 4.2 discusses the assessment methods for all anadromous and Delta estuary fish. In the Delta, the Delta outflows and entrainment numbers were analyzed to determine potential effects.

4.3.4.3 Project Effects

The following discussion is a summary of potential effects on steelhead related to changes in habitat conditions and entrainment at the SWP and CVP export facilities within the Sacramento-San Joaquin Delta.

Delta Outflow. The Proposed Action would result in reduced Delta outflow in December (Table 4-2). This may slow the emigration of Central Valley steelhead which may draw this species into closer proximity of the pumps, increasing their risk of entrainment. However, with conservation measures when considering Delta outflow the Proposed Action may affect but is not likely to adversely affect Central Valley steelhead in December.

Entrainment. The Proposed Action, considering all water years, would decrease the entrainment index of Central Valley steelhead compared to existing conditions (Table 4-3). Therefore, when considering entrainment the Proposed Action would provide a beneficial effect to Central Valley steelhead.

4.3.4.4 Conservation Measures

Conservation measures applicable to adverse effects on Central Valley steelhead can be found in Section 4.3.1.4 as part of the fall-run/late-full-run Chinook salmon discussion.

4.3.4.5 Contribution to Recovery

The EWA Program has been developed to contribute to the recovery of at-risk native fish species. The EWA agencies have established operating tools that allow them to meet protection objectives for at-risk fish species within the Sacramento and San Joaquin Rivers and their tributaries and the Delta, including: 1) reducing export pumping, 2) closing the Delta Cross Channel gates beyond closures required under the Baseline Conditions, 3) increasing instream flows, and 4) augmenting Delta outflow. The EWA agencies use their acquired assets, in addition to actions specified under Baseline Conditions, and implement actions to protect at-risk fish under various conditions throughout the year. Each tool, its timing, the protection it provides and why, and how each action is undertaken is described in Section 2.4.2, Actions to Protect Fish and Benefit the Environment, of this ASIP.

The analysis of potential effects on steelhead provided in Section 4.3.4.3, Project Effects, demonstrates that implementation of the EWA Proposed Action (including the above conservation measures) will contribute to the recovery of Central Valley steelhead.

4.3.5 Delta Smelt (*Hypomesus transpacificus*)

4.3.5.1 Status in the Action Area

The following is a summary of the more detailed discussion provided in Chapter 3, Environmental Baseline – Special-Status Species Accounts and Status in Action Area, of this ASIP. Delta smelt are found mainly in the waters of the Delta and Suisun Bay, but are generally most abundant in the western Delta and eastern Suisun Bay (Honker Bay) and commonly use Montezuma Slough. Their spawning distribution varies from year to year within the Delta. The species is endemic to the Sacramento-San Joaquin estuary and its population abundance varies substantially from year to year. Abundance has been uncharacteristically low since 1982, in large part because of the extended drought of 1987-1992 and possibly to extremely wet years in 1983 and 1986 (Moyle *et al.* 1989). Population abundance has fluctuated recently from increases in some years to uncharacteristic decreases in other years (IEP 1998). Additional details regarding the status of delta smelt in the EWA Action Area are provided in Section 3.2.3, Delta Smelt.

4.3.5.2 Effect Assessment Methods

Section 4.2 discusses the assessment methods for all anadromous and Delta estuary fish. In the Delta, the Delta outflows, X2 locations, and entrainment numbers were analyzed to determine potential effects.

4.3.5.3 Project Effects

The following discussion is a summary of potential effects on delta smelt related to changes in habitat conditions and entrainment at the SWP and CVP export facilities within the Sacramento-San Joaquin Delta.

Delta Outflow. The Proposed Action would result in reduced Delta outflow in December (Table 4-2). The significantly lower outflows during December under drier conditions may adversely affect some species, particularly early spawning delta smelt. However, with conservation measures, when considering Delta outflow, the Proposed Action may affect but is not likely to adversely affect delta smelt in December.

Location of X2. The Proposed Action would move the estimated location of X2 westward most of the time in January through September, and eastward from October through December (Table 4-4). January through May would generally see beneficial changes in X2 location and provide a benefit to aquatic ecosystems and the fisheries dependent upon them. The eastward change in November and December would be constrained by Project conservation measures and thus would not be as great as indicated. Shifts in X2 during October through December therefore would not be adverse.

Table 4-4. Difference in Estimated X2 Location (River Kilometer) from Baseline Conditions for the Proposed Action[1]

WY Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Wet	0.4	0.6	0.5	-2.0	-0.7	-0.3	-0.4	-0.6	-0.2	-0.1	-0.1	-0.1
Above Normal	0.2	0.1	0.1	-2.6	-1.0	-0.4	-0.4	-0.5	-0.1	-0.2	-0.3	0.0
Below Normal	0.1	0.2	0.4	-3.0	-1.1	-0.6	-0.5	-0.5	-0.1	-0.2	-0.3	0.0
Dry	0.4	0.5	1.2	-3.4	-1.7	-0.7	-0.5	-0.4	-0.1	-0.2	-0.3	-0.2
Critical	0.3	0.4	1.1	-3.5	-1.5	-0.8	0.0	0.0	0.0	-0.3	-0.4	-0.4
1922-1994 WY Avg	0.3	0.4	0.7	-2.8	-1.2	-0.5	-0.4	-0.4	-0.1	-0.2	-0.3	-0.1

Notes:
[1]Positive values represent an eastward shift and negative values represent a westward shift

The Proposed Action would have a beneficial effect on X2 location relative to Baseline Conditions during January through May. It would have an impact, although not adverse during the remainder of the year. Therefore, when considering changes in the location of X2, the Proposed Action may affect but is not likely to adversely affect delta smelt.

Entrainment. The Proposed Action, considering all water years, would decrease the entrainment index of delta smelt compared to existing conditions (Table 4-3). Therefore, when considering entrainment, the Proposed Action would provide a beneficial effect to delta smelt.

4.3.5.4 Conservation Measures

Conservation measures that would be applied to the EWA actions for each species and NCCP habitat were originally described in the 2003 ASIP. These conservation measures are repeated below.

Conservation Measure Applicable to all Species. The EWA Project agencies will coordinate EWA water acquisition and transfer actions with Federal (Reclamation, USFWS and NOAA Fisheries), State (DWR and CDFG), other CALFED agencies, and regional programs (e.g., the San Francisco Bay Ecosystem Goals Project, the Anadromous Fish Restoration Program, the Senate Bill [SB] 1086 program, the U.S. Army Corps of Engineers' [USACE's] Sacramento and San Joaquin Basin Comprehensive Study, the Riparian Habitat Joint Venture, the CVPIA, the Central Valley Habitat Joint Venture, and the Grassland Bird Conservation Plan) that could affect management of evaluated species. Coordination will avoid conflicts among management objectives and will be facilitated through CALFED's water transfer program.

General Fish Species Conservation Measures

- In implementing the EWA, the EWA agencies will avoid acquisition and transfer of water that will reduce flows essential to maintaining populations of native aquatic species in the source river.
- In implementing the EWA water acquisition and transfers, the EWA agencies will not increase exports during times of the year when anadromous and estuarine fish are most vulnerable to damage or loss at project facilities or when their habitat may be adversely affected.
- In implementing the EWA, the EWA agencies will avoid acquisition and transfer of stored reservoir water quantities that will impair compliance with flow requirements and maintenance of suitable habitat conditions in the source river in subsequent years.

Delta Smelt (T-FESA; T-CESA)

- In implementing the EWA, the EWA agencies will fully adhere to the terms and conditions in all applicable CESA and FESA biological opinions and permits for CVP and SWP operations.
- In implementing the EWA, the Project Agencies will not initiate EWA water exports in July until Management Agencies agree that Delta smelt will not be harmed.

4.3.5.5 Contribution to Recovery

The EWA Program has been developed to contribute to the recovery of at-risk native fish species. The EWA agencies have established operating tools that allow them to meet protection objectives for at-risk fish species within the Sacramento and San Joaquin Rivers and their tributaries and the Delta, including: 1) reducing export pumping, 2) closing the Delta Cross Channel gates beyond closures required under Baseline Conditions, 3) increasing instream flows, and 4) augmenting Delta outflow. The EWA agencies use their acquired assets, in addition to actions specified in the Baseline Conditions, and implement actions to protect at-risk fish under various conditions throughout the year. Each tool, its timing, the protection it provides and why, and how each action is undertaken is described in Section 2.4.2, Actions to Protect Fish and Benefit the Environment, of this ASIP.

The analysis of potential effects on delta smelt provided in Section 4.3.5.3, Project Effects, demonstrates that implementation of the EWA Proposed Action (including the above conservation measures) will contribute to the recovery of delta smelt.

4.3.6 Green Sturgeon (*Acipenser medirostris*)

4.3.6.1 Status in the Action Area

The following is a summary of the more detailed discussion provided in Chapter 3, Environmental Baseline – Special-Status Species Accounts and Status in Action Area, of this ASIP. Green sturgeon is an anadromous species, migrating from the ocean to freshwater to spawn. Adults of this species tend to be more marine-oriented than the more common white sturgeon. Nevertheless, spawning populations have been identified in the Sacramento River, and most spawning is believed to occur in the upper reaches of the Sacramento River as far north as Red Bluff (Moyle *et al.* 1992; 1995). Adults begin their inland migration in late-February (Moyle *et al.* 1995), and enter the Sacramento River between February and late-July (CDFG 2001). Spawning activities occur from March through July, with peak activity believed to occur between April and June (Moyle *et al.* 1995). In the Sacramento River, green sturgeon presumably spawn at temperatures ranging from 46°F to 57°F. Small numbers of juvenile green sturgeon have been captured and identified each year from 1993 through 1996 in the Sacramento River at the Hamilton City Pumping Plant (RM 206). Lower American River fish surveys conducted by the CDFG have not collected green sturgeon. Although a green sturgeon sport fishery exists on the lower Feather River, the extent to which green sturgeon use the Feather River is still to be determined. Green sturgeon larvae are occasionally captured in salmon outmigrant traps, suggesting the lower Feather River may be a spawning area (Moyle 2002). However, NMFS (2002) reports that green sturgeon spawning in the Feather River is unsubstantiated. Additional details regarding the status of green sturgeon in the EWA Action Area are provided in Section 3.2.5, Green Sturgeon.

4.3.6.2 Effect Assessment Methods

Section 4.2 discusses the assessment methods for all anadromous and Delta estuary fish. Delta outflow was analyzed to determine potential effects.

4.3.6.3 Project Effects

The following discussion is a summary of potential effects on green sturgeon related to changes in habitat conditions within the Sacramento-San Joaquin Delta.

Delta Outflow. The Proposed Action would result in reduced Delta outflow in December (Table 4-2). However, these decreased outflows should not affect the green sturgeon. Therefore, when considering Delta outflow the Proposed Action may affect but is not likely to adversely affect green sturgeon.

4.3.6.4 Conservation Measures

Conservation measures that would be applied to the EWA actions for each species and NCCP habitat were originally described in the 2003 ASIP. These conservation measures are repeated below.

Conservation Measure Applicable to all Species The EWA Project agencies will coordinate EWA water acquisition and transfer actions with Federal (Reclamation, USFWS and NOAA Fisheries), State (DWR and CDFG), other CALFED agencies, and regional programs (e.g., the San Francisco Bay Ecosystem Goals Project, the Anadromous Fish Restoration Program, the Senate Bill [SB] 1086 program, the U.S. Army Corps of Engineers' [USACE's] Sacramento and San Joaquin Basin Comprehensive Study, the Riparian Habitat Joint Venture, the CVPIA, the Central Valley Habitat Joint Venture, and the Grassland Bird Conservation Plan) that could affect management of evaluated species. Coordination will avoid conflicts among management objectives and will be facilitated through CALFED's water transfer program.

General Fish Species Conservation Measures

- In implementing the EWA, the EWA agencies will avoid acquisition and transfer of water that will reduce flows essential to maintaining populations of native aquatic species in the source river.
- In implementing the EWA water acquisition and transfers, the EWA agencies will not increase exports during times of the year when anadromous and estuarine fish are most vulnerable to damage or loss at project facilities or when their habitat may be adversely affected.
- In implementing the EWA, the EWA agencies will avoid acquisition and transfer of stored reservoir water quantities that will impair compliance with flow requirements and maintenance of suitable habitat conditions in the source river in subsequent years.

4.3.6.5 Contribution to Recovery

The EWA Program has been developed to contribute to the recovery of at-risk native fish species. The EWA agencies have established operating tools that allow them to meet protection objectives for at-risk fish species within the Sacramento and San Joaquin Rivers and their tributaries and the Delta, including: 1) reducing export pumping, 2) closing the Delta Cross Channel gates beyond closures required under Baseline Conditions, 3) increasing instream flows, and 4) augmenting Delta outflow. The EWA agencies use their acquired assets, in addition to actions specified under Baseline Conditions, and implement actions to protect at-risk fish under various conditions throughout the year. Each tool, its timing, the protection it provides and why, and how each action is undertaken is described in Section 2.4.2, Actions to Protect Fish and Benefit the Environment, of this ASIP.

4.4 Terrestrial Species Assessment Methods and Impact Analysis

Because there are no changes to the existing conditions for these species, and the project description is materially the same in the 2003 ASIP and the amendment, no additional analysis beyond that conducted in the 2003 ASIP is necessary for this amendment.

4.5 References

Bennett, W.A. 2005. Critcal assessment of the delta smelt population in the San Francico Estuary, California. San Francisco Estuary and Watershed Science 3(2):1-71. (September 2005), Article 1. http://repositories.cdlib.org/jmie/sfews/vol3/iss2/art1

California Department of Fish and Game (CDFG). 2001. California's Living Marine Resources. A Status Report. California Department of Fish and Game Bulletin pp. 465-6.

California Department of Water Resources and U.S. Bureau of Reclamation (CDWR and the Reclamation). 1996. Draft EIR/EIS for the Interim South Delta Program (ISDP). Prepared by ENTRIX, Inc. July 1996.

Feyrer, F., M. L. Nobriga, and T. R. Sommer.(In Press) Multi-decadal trends for three declining fish species: habitat patterns and mechanisms in the San Francisco estuary, California, U. S. A.

Hallock, R.J. and F.W. Fisher. 1985. Status of the Winter-run Chinook Salmon (Oncorhynchus tshawytscha) in the Sacramento River. Prepared for the California Department of Fish and Game.

Interagency Ecological Program (IEP). 1998. Interagency Ecological Program Web page: IEP.water.ca.gov.

IEP. 2005. Interagency Ecological Program Synthesis of 2005 work to evaluate the Pelagic Organism Decline (POD) in the upper San Francisco Estuary.

IEP Review Panel, 2005. Review Panel Report: San Francisco Estuary Sacramento-San Joaquin Delta Interagency Ecological Program on Pelagic Organism Decline.

Kimmerer, W. 2002. Physical, Biological, and Management Reponses to Variable Freshwater Flow into the San Francisco Estuary. Estuaries 25:1275-1290.

Moyle, P.B. 2002. Inland fishes of California: revised and expanded. University of California Press, Berkeley, CA. 502 pp.

Moyle, P.B. and B. Herbold. 1989. Status of the delta smelt, Hypomesus transpacificus. Unpublished final report prepared for U.S. Fish and Wildlife Service, Sacramento Field Office, Habitat Conservation Division, Sacramento, California. 42 pp.

Moyle, P.B., B. Herbold, D.E. Stevens, and L.W. Miller. 1992. Life history and status of delta smelt in the Sacramento-San Joaquin estuary, California. Transactions of the American Fisheries Society 121:67-77.

Moyle, P.B., R.M. Yoshiyama, J.E. Williams, and E.D. Wikramanayake. 1995. Fish species of special concern in California. Second edition. Prepared for California Resources Agency and California Department of Fish and Game, Inland Fisheries Division. Rancho Cordova, CA

National Marine Fisheries Service (NMFS). 2002. A status review for North American green sturgeon (Acipenser medirostris). National Marine Fisheries Service, Southwest Fisheries Science Center, Northwest Fisheries Science Center.

NMFS. 2004. Biological Opinion on long-term Central Valley Project and State Water Project Operations Criteria and Plan. Southwest Region. October 2004.

Sommer, T. 2007. The decline of pelagic fishes in the San Francisco Estuary: An update. Presented to the California State Water Resources Control Board March 22, 2007.

State Water Resources Control Board (SWRCB). 2001. REVISED Water Right Decision 1641 In the Matter of: Implementation of Water Quality Objectives for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary. Revised in Accordance with Order WR 2000-02 March 15, 2000.

Stevens, D. 1989. When do winter-run chinook salmon smolts migrate through the Sacramento-San Joaquin Delta? Unpublished Memorandum. Prepared for California Department of Fish and Game, Bay-Delta Project. Stockton, CA.

U.S. Bureau of Reclamation (Reclamation). 1992. Biological Assessment for USBR. 1992 Central Valley Project Operations. Mid-Pacific Region. Sacramento, CA.

Reclamation. 2004. Long-Term Central Valley Project Operations Criteria and Plan Biological Assessment. June 30, 2004.

U.S. Fish and Wildlife Service (USFWS). 2005. Reinitiation of Formal and Early Section 7 Endangered Species Consultation on the Coordination Operations of the Central Valley Project and State Water Project and the Operational Criteria and Plan to Address Potential Critical Habitat Issues. February 16, 2005. Sacramento Fish and Wildlife Office. Available online at:

http://www.fws.gov/sacramento/ea/news_releases/2004%20News%20Releases/Delta_Smelt_OCAP_NR.htm

Yoshiyama, R.M., E.R. Gerstung, F.W. Fisher, and P. B. Moyle. 1996. Historical and present distribution of Chinook salmon in the Central Valley drainage of California. Sierra Nevada Ecosystem Project: final report to Congress.

Personal Communication:

Morinaka, J. 2007 CDFG. Personal communication with L. Wise of ENTRIX, Walnut Creek, CA.

Chapter 7
Monitoring, Adaptive Management, and Other Disclosures

7.1 Monitoring Program

The EWA program involves acquiring assets through stored reservoir water purchase, groundwater substitution, stored groundwater purchase, and crop idling. EWA agencies will manage the assets to maximize benefits to at-risk native fish species, but asset management can change river flows and Delta outflows, and also the amount of wetlands within agricultural and other areas in the Central Valley. The manner in which EWA agencies apply, acquire, and manage assets will be monitored to ensure that EWA fish benefit objectives are being met while minimizing or avoiding adverse effects to other species and their habitats due to EWA actions. The monitoring program will include both compliance and effectiveness monitoring. Data collected and reviewed under EWA monitoring efforts will be used to support adaptive management decisions that could change how some assets are managed should the overall goals of the EWA program related to fish species, habitats, and terrestrial species not be met. EWA agencies will document compliance with FESA, CESA, and NCCP in the BO's and NCCP Determination prior to implementation of the EWA Proposed Action.

The EWA agencies will complete a Monitoring Plan before implementation of EWA water purchases. An EWAT Monitoring Subteam will be responsible for implementation of the Monitoring Plan.

7.1.1 Responsibilities

7.1.1.1 Agency Responsibilities

The responsibilities of each agency may include data collection, analysis, interpretation, findings, and recommendations for changing EWA water asset acquisition and management strategies. The EWA agencies will establish the EWAT Monitoring Subteam who will manage the EWA Monitoring Plan.

EWA agencies will be responsible for including wildlife and habitat conservation measures in the water purchase contracts with willing sellers as outlined in this document so that the sellers would know their responsibilities in the water transfer action.

Monitoring for compliance with the conservation measures will also be the responsibility of the EWA agencies. The EWA agencies will confirm through field visits and aerial photography that the land idled as part of a crop idling/crop shifting contract action is consistent with the purchase contract. EWA agencies will verify in the field that the willing seller is adhering to conservation measures for maintenance of irrigation ditch habitat and adequate return ditch flows. EWA agencies will seek appropriate remedies if water agencies fail to meet their contractual obligations.

7.1.1.2 Water Agency/Willing Seller Responsibilities

Water agencies and/or willing sellers may participate in monitoring efforts related to asset management actions involving their facilities or land within their districts. The EWA Monitoring Plan will address the responsibilities and involvement of these parties related to overall EWA monitoring efforts.

7.1.2 Monitoring Plan Development

The initial steps of the monitoring plan development will be the identification of specific data requirements for effects and compliance determination, the identification of existing data collection programs that can provide the data, and the development of new monitoring efforts for locations where monitoring is not currently occurring.

The monitoring plan will address data collection, analysis, and implementation activities necessary to demonstrate EWA effects on aquatic and terrestrial resources. Upon completion of the assessment of existing programs and the identification of new monitoring efforts, the EWA agencies will complete a Monitoring Plan that will include, at least, the following sections:

- Data requirements and the actions necessary to satisfy those data requirements;
- Data assessment methods;
- Compliance and performance measures;
- Monitoring strategy;
- Implementation process and schedule;
- Responsibilities of the EWA agencies and the water agency/willing seller;
- Reporting requirements; and
- Monitoring Plan review and adaptive management processes.

7.1.3 Monitoring Plan Implementation

The EWAT Monitoring Subteam will be responsible for ensuring that all aspects of the Monitoring Plan are implemented.

The EWAT Monitoring Subteam will review and assess monitoring data as necessary to evaluate EWA action effects. The EWAT Monitoring Subteam will assess each proposed EWA action relative to existing conditions in making recommendations to the EWAT for any change in asset acquisition and management strategies.

7.1.4 EWA Monitoring Program Review

According to the CALFED ROD, “the purpose of the CALFED Science Program is to provide a comprehensive framework and develop new information and scientific interpretations necessary to implement, monitor, and evaluate the success of the CALFED Program (including all program components), and to communicate to managers and the public the state of knowledge of issues critical to achieving CALFED goals”. The Science Program’s evaluation efforts include two levels of independent review: a standing Independent Science Board for the entire CALFED Program, and a variety of Science Panels focused on specific programs.

Historically, the EWA had an EWA Technical Review Panel (Panel), which included distinguished experts representing scientific, economic, engineering, and socioeconomic disciplines. The Panel evaluated the EWA program every two years. The review considered the overall concept of the EWA program, EWA agencies’ actions (uses of water and actions to protect fish), and the technical and biological basis for actions that took place. The original Panel was disbanded after completion of the 2004 annual review, but was re-formed for the first bi-annual review in 2006. The EWA agencies have endeavored to incorporate the Panel’s recommendations, such as a broader range of asset use, into the manner in which they make purchases and take fish actions.

Adaptive management is a key component of the Science and EWA Programs. Adaptive management treats actions as partnerships between scientists and managers by designing those actions as experiments with a level of risk commensurate with the status of those species involved, and bringing science to bear in evaluating the feasibility of those experiments. New information and scientific interpretations would be developed through adaptive management, as the programs progress, and would be used to confirm or modify problem definitions, conceptual models, research, and implementation actions (CALFED 2000).

The Panel prepares a report after reviewing the EWA program each water year. These reports can be found at http://science.calwater.ca.gov/workshop/past_workshops.shtml. Reports have been prepared for review of EWA actions and are summarized below.

In the report for year one (CALFED 2001), the Panel found that the CALFED and EWA programs were successfully able to purchase and use water within the required limits. Additionally, the agency biologists and project operators exhibited a high degree of cooperation and collaboration. However, the Panel noted that: (1) the EWA goals appear to be "weighted" differently between scientists, resource managers, water managers, and stakeholders; (2) there are knowledge gaps that need to be filled in order to base EWA decisions on statistically rigorous and sound science; (3) the CALFED team needs to be strengthened and knowledge gaps filled; and (4) the EWA agencies and CALFED need to maximize the program's flexibility.

As stated in the report for year two (CALFED 2002), the panel found that, even though all of the agencies were to be commended for their efforts, there are several areas that require attention. The EWA program needs to: (1) overcome the growing burden of expectations placed on EWA, (2) better integrate EWA into other CALFED restoration activities, (3) improve scientific analysis and data synthesis, (4) focus on more ecologically appropriate biological performance measures; and (5) allocate sufficient resources to accomplish the EWA program's stated goals. In order to accomplish these tasks the Panel recommends: (1) identification of the causes of entrainment at the pumps; (2) estimation of growth and mortality rates, habitat use, and movement patterns of Chinook salmon; (3) quantitatively synthesize the delta smelt and Chinook salmon life cycles; (4) determine how DCC operations might be optimized to reduce entrainment; and (5) determine if and how EWA water can be used to make reservoir releases that improve salmon spawning habitat (CALFED 2002).

The goal of the Year Three Technical Review (CALFED 2003) of the Environmental Water Account and Science Symposium (October 15-17, 2003) was to provide a synthesis of the scientific information gained and a description of how this information has affected (or could affect) management of environmental water. The Panel noted (1) increased diversification of water resources and the development of models of water acquisition, storage, and debt; (2) evidence of increasing cooperation among agencies and in the design and execution of field experiments; (3) completion of several successful symposia and workshops; (4) further progress on addressing past recommendations; and (5) avoidance of fish and water crises. The Panel was generally impressed with the EWA program's activities in the last year, but found areas in which additional attention and effort are required. Major recommendations included (1) continue the annual reviews of the EWA; (2) review and summarize the accomplishments and lessons learned from past years; (3) better integrate EWA with other CALFED programs; (4) review background regulatory requirements regularly and provide new scientific information that is as adaptive as possible; and (5) explore creative ways to address EWA's many scientific challenges.

The fourth annual review of the EWA by the Panel considered progress made in 2004 and offered recommendations pertinent to Long-Term EWA operations.

The Panel found many positive results in 2004, but noted that the EWA will need to provide sound rationale for its science and water management practices to endure continued scrutiny. To this end, the Panel recommended the following towards improving the EWA implementation process: (1) gaming is a powerful tool, but would be more effective with more biological information, and should explicitly clarify uncertainty; (2) gaming analyses should be well documented and clearly described, and results should undergo peer review; and (3) a small program should be implemented to develop research proposals and initiate collaboration between agency and non-agency scientists. The Panel further recommended that EWA review process improvements, stating: (1) the annual EWA review should be as transparent as possible and include more stakeholder participation; (2) the Panel and Science Program should confer about the agenda prior to the annual EWA review meeting, and there should be more question and answer time to allow stakeholder input and discussion; (3) the Lead Scientist should provide a written response to the Panel's comments; (4) a biennial review of the Long-Term EWA should be established in order to provide time for the EWA to make progress on key issues; and (5) the role and responsibilities of science advisors should be clearly outlined to reduce ambiguity within the EWA science program (CBDA 2005).

The fifth review of the EWA by the Panel considered progress made through 2006. The Panel found many positive results, but noted that "there is substantial scope for improving the relevance and efficacy of the EWA" (EWA Technical Review Panel 2007). To this end, the Panel made a number of recommendations including (1) earmarking research funds to address EWA issues; (2) the development of general EWA performance measures; (3) research results should be used to refine decision support tools and incorporated into EWA actions and management; (4) EWA's affects, both positive and negative should be viewed across multiple species of concern not focused on a single species; (5) the quality of research results needs to be increased by increasing the flexibility of data collection locations, improving statistical rigor, and improving data quality; and (6) gaming should be revisited to optimize the mix of actions using a fish life cycle approach as a cornerstone.

The EWAT Monitoring Subteam will be responsible for assessing suggested changes as provided by the independent review.

7.2 Adaptive Management

The August 28, 2000, CALFED Bay-Delta Program PEIS/EIR and ROD described an EWA as a 4-year program that could be extended by written agreement of the participating agencies. In September 2004, the five EWA agencies signed a Memorandum of Understanding that extended the EWA program until December 2007. The CALFED Science Panel will be one of the entities responsible for continuing the review of the EWA program through

2011. In addition to this review, the CALFED program includes annual conferences and symposia for analyses of population trends and recovery. It is expected that the scientific reviews of EWA actions and effects will provide recommendations for changes both to the EWA and for the ongoing monitoring efforts related to the EWA. Therefore, any decision to continue EWA would also include the recommended changes.

The EWA agencies, in consultation with other CALFED agencies, may need to amend or modify the Monitoring Plan as information is developed on actions, implementation, and biological monitoring and research. The following elements may change during the life of the EWA program:

- The EWA program description incorporating EWA asset acquisition and management actions;
- Implementation status of other CALFED agency actions;
- Species status relative to goals, or other biological information that results from research and monitoring (including new listings and delistings);
- Species found to be affected by CALFED agency actions;
- Exceedance of incidental take allowed in biological opinions; and
- Prescriptions for achieving “R” and “r” species goals.

Changes in these elements may result in reinitiation of consultation on the EWA program. Conservation measures do not necessarily have to be modified when new information becomes available, but USFWS, NMFS, and CDFG, in consultation with the EWA agencies, may do so when necessary and appropriate. If necessary, conservation measures could be amended to include additional avoidance, minimization, and compensation or restoration measures, species or habitat monitoring, or completion of research needed to meet species goals.

7.3 Funding

This document assumes that during the period reviewed (2007-2011), the EWA agencies’ water acquisitions and monitoring plan will be funded by the State and Federal governments; however, funding is contingent upon the appropriation of funds. The initial acquisition of assets for the EWA actions is being made by Federal and State agencies (Reclamation and DWR). In future years it is anticipated that acquisitions of assets may involve participation of third parties.

7.4 Assurances to Landowners

At a minimum, the following assurances will be included in the cooperating landowner commitments:

- Land Use Classification – EWA agencies will cooperate with local entities in addressing EWA crop idling actions or associated water conservation measures that would result in the change of the land use classification of any land where EWA actions may occur.

- Monitoring – Monitoring and site-specific surveys will be carried out in cooperation with the water agency and local landowner.

Additional landowner assurances may be included in each individual cooperating landowner commitment, depending upon site-specific requirements.

7.5 Assessment of Cumulative Effects

The impact analysis performed for the Proposed Action (the Flexible Purchase Alternative) was based on the maximum quantity of water that any agency, including the EWA agencies, could acquire upstream from the Delta via either surface water purchase, crop idling, groundwater substitution, or groundwater purchase. This limitation represents the maximum quantity of water that is likely to be moved through the Delta in any one year. The water acquisition strategy of the EWA agencies is to employ the conservation measures stated in this ASIP and to assess water acquisition efforts of other agencies before committing to water purchases for the current year. Through the use of the conservation measures and water acquisition program assessments, the EWA agencies would avoid any cumulative effect by not making water acquisitions that lead to a significant adverse effect.

The Draft Supplemental EIS/EIR contains descriptions of the other water acquisition programs and CALFED agency actions included in the cumulative effects analysis. The EWA agencies will work together in a collaborative process to review the water acquisition plans for all water transfer programs to ensure that there are no cumulative effects on MSCS covered fish and terrestrial species or their habitats.

7.6 Other Alternatives Evaluated

The CALFED ROD for the PEIS/EIR identified the EWA as one element of the CALFED Bay-Delta Program. The CALFED Program’s primary objective is to restore the Bay-Delta ecosystem and improve water quality and reliability for the state's water users. Developing the alternatives for the CALFED PEIS/EIR involved a lengthy and inclusive public process that identified problems, objectives, actions, strategies, and alternatives, and culminated in a preferred alternative. The process identified 50 categories of actions that would resolve Bay-Delta problems and achieve Program objectives. The categories were drawn from existing literature; participation from CALFED agencies and the Bay Delta Advisory Council; and numerous workshops with stakeholders and the general public. The CALFED ROD for the PEIS/EIR included the EWA as one element in the preferred alternative.

The element of the CALFED ROD that the EWA program is intended to address is the protection and recovery of at-risk native fish species in the Delta through the use of a water acquisition and management strategy that minimizes water cost to the CVP and SWP water contractors. The strategy involves EWA agencies acquiring water (EWA assets) that can be used to replace project water whose deliveries were curtailed when Delta pumping was reduced to protect fish species. Acquiring of water assets also allows EWA agencies to initiate additional beneficial fish actions without interrupting water supplies.

DWR implemented the EWA in 2001 in accordance with the CALFED ROD and Operating Principles. Reclamation joined in with EWA asset acquisitions in 2002. Because the PEIS/EIR did not address EWA actions fully, an EIS/EIR on the EWA actions – tiered from the PEIS/EIR - was deemed necessary. The preparation of the EWA EIS/EIR allows for reevaluation of actions described in the ROD and of other potential alternatives to the actions described in the ROD.

In addition to the No Action/No Project Alternative, the Draft Supplemental EIS/EIR evaluates two action alternatives. The first action alternative is a "strict" interpretation of the ROD that could limit the quantities of water EWA agencies could acquire and the second is a "flexible" interpretation of the ROD that could allow greater acquisition and management quantities and potentially more fish benefits. The "strict" interpretation of the ROD has been termed the "Fixed Purchase Alternative" and the "flexible" interpretation the "Flexible Purchase Alternative". Each alternative employs a different acquisition strategy with the Flexible Purchase Alternative allowing for the purchase of greater quantities of water to address fish protection and recovery needs.

As part of development of the alternative details, other actions were assessed in relation to their ability to meet the purpose and need of the EWA program. The development of alternatives presented in the 2004 EIS/EIR was an iterative and collaborative process involving representatives from Reclamation, DWR, USFWS, NMFS, CDFG, and other CALFED agencies. This interagency team worked together to fully considering a range of possible EWA alternatives. The purpose and need statement contained in the 2004 EIS/EIR formed the basis for the determination and evaluation of alternatives. Because none of the other alternatives could be immediately implemented to address the EWA purpose and need, only the fixed and flexible purchase EWA strategies were subject to detailed effects analyses in the 2004 EIS/EIR. Because the EWA agencies have identified the Flexible Purchase Alternative as the preferred alternative, this ASIP addresses the Flexible Purchase Alternative as the Proposed Action.

7.7 References

CALFED. 2000. Multi-Species Conservation Strategy; Final Programmatic EIS/EIR Technical Appendix. Available online at: http://calfed.ca.gov/Programs/EcosystemRestoration/EcosystemMultiSpeciesConservationStrategy.shtml

CALFED. 2001. First Annual Review of the Environmental Water Account for the CALFED Bay-Delta Program. EWA Review Panel Final Report.

CALFED. 2002. Review of the 2001-02 Environmental Water Account (EWA) Implementation. 2002 EWA Review Panel.

CALFED. 2003. Review of the 2002-03 Environmental Water Account (EWA). Submitted by the 2003 EWA Review Panel. December 8, 2003.

California Bay Delta Authority (CBDA). 2005. Review of the 2003-04 Environmental Water Account (EWA). Submitted by the 2004 EWA Review Panel. January 17, 2005.

Environmental Water Account Technical Review Panel. 2007. Review of the 2006 Environmental Water Account (EWA). January 2007.

This page is intentionally left blank

Chapter 9
Effects Determination Conclusion

9.1 Species

The purpose of this ASIP is to review the proposed Environmental Water Account in sufficient detail to determine to what extent the Proposed Action may affect any threatened, endangered, proposed, or sensitive species within the project area. This section summarizes the environmental setting, analysis, and effects determination presented in Chapters 3 and 4.

9.1.1 Summary of Effects

The Proposed Action may affect but is not likely to adversely affect six listed species or species of special concern through direct and indirect effects. Table 9-1 summarizes the direct and indirect effects analysis.

Table 9-1. Summary of Direct and Indirect Effects Analysis of Special-Status Species within the Action Area

			Effects Analysis			
			Species Effects Determination			Critical Habitat/EFH
Common Name	**Scientific Name**	**Status**	**No Effect**	**May Affect, Not Likely to Adversely Affect**	**May Affect, Likely to Adversely Affect**	**May Affect**
Central Valley Fall/Late-Fall Run Chinook Salmon	*Oncorhynchus tshawytscha*	FC, CSC		X		
Sacramento River Winter Run Chinook Salmon	*Oncorhynchus tshawytscha*	FE, CE		X		
Central Valley Spring-Run Chinook Salmon	*Oncorhynchus tshawytscha*	FT, CT		X		

			Effects Analysis			
			Species Effects Determination			Critical Habitat/EFH
Common Name	**Scientific Name**	**Status**	**No Effect**	**May Affect, Not Likely to Adversely Affect**	**May Affect, Likely to Adversely Affect**	**May Affect**
Central Valley Steelhead	*Oncorhynchus mykiss*	FT		X		
Delta Smelt	*Hypomesus transpacificus*	FT, CT		X		
Green Sturgeon	*Acipsenser medirostis*	FT, CSC		X		

Notes:
FE= Federal Endangered Species
FT = Federal Threatened Species
FC= Federal Candidate Species
FSC = Federal Species of Concern
CSC = California Species of Special Concern
CE = California Endangered Species
CT = California Threatened Species
FP = California Fully Protected Species
CS = California Sensitive Species

9.1.2 Effects Discussion

The Bay-Delta and its tributaries provide habitat for several special-status anadromous and estuarine fish species. Changes in river flows and other Delta indices during certain periods of the year could potentially affect spawning, fry emergence, and juvenile emigration. Delta outflow and X2 location are indicators of fishery habitat quality and availability within the Delta. Therefore, effect indicators such as Delta outflow were used to evaluate if the Proposed Action would have an adverse effect on the species' habitat and range. The paragraphs below summarize the analysis results. A full discussion of effects on species can be found in Chapter 4.

9.1.2.1 Central Valley Fall-run/Late-fall-run Chinook Salmon

Delta Outflow. The Proposed Action would result in reduced Delta outflow from October through December. This may slow the emigration of winter, spring, and late-fall run Chinook salmon and steelhead and may draw these species into closer proximity of the pumps, increasing their risk of entrainment. However, conservation measures (Section 2.5.1.2.) would avoid effects or reduce effects on salmonids to insignificant levels. Therefore, when considering Delta outflow the Proposed Action may affect but is not likely to adversely affect fall-run/late-fall-run Chinook salmon in December.

Entrainment. The Proposed Action, considering all water years, would decrease the entrainment index of fall-run/late-fall-run Chinook salmon compared to existing conditions. Therefore, when considering entrainment the

Proposed Action would provide a beneficial effect to fall-run/late-fall-run Chinook salmon.

9.1.2.2 Sacramento River Winter-run Chinook Salmon

Delta Outflow. The Proposed Action would result in reduced Delta outflow from October through December. This may slow the emigration of winter, spring, and late-fall run Chinook salmon and steelhead and may draw these species into closer proximity of the pumps, increasing their risk of entrainment. However, conservation measures (Section 2.5.1.2.) would avoid effects or reduce effects on salmonids to insignificant levels. Therefore, when considering Delta outflow the Proposed Action may affect but is not likely to adversely affect winter-run Chinook salmon in December.

Entrainment. The Proposed Action, considering all water years, would decrease the entrainment index of Sacramento River winter-run Chinook salmon compared to existing conditions. Therefore, when considering entrainment the Proposed Action would provide a beneficial effect to Sacramento River winter-run Chinook salmon.

9.1.2.3 Central Valley Spring-run Chinook Salmon

Delta Outflow. The Proposed Action would result in reduced Delta outflow from October through December. This may slow the emigration of winter, spring, and late-fall run Chinook salmon and steelhead and may draw these species into closer proximity of the pumps, increasing their risk of entrainment. However, conservation measures (Section 2.5.1.2.) would avoid effects or reduce effects on salmonids to insignificant levels. Therefore, when considering Delta outflow the Proposed Action may affect but is not likely to adversely affect spring-run Chinook salmon in December.

Entrainment. The Proposed Action, considering all water years, would decrease the entrainment index of Central Valley spring -run Chinook salmon compared to existing conditions. Therefore, when considering entrainment the Proposed Action would provide a beneficial effect to Central Valley spring -run Chinook salmon.

9.1.2.4 Central Valley Steelhead

Delta Outflow. The Proposed Action would result in reduced Delta outflow from October through December. This may slow the emigration of winter, spring, and late-fall run Chinook salmon and steelhead and may draw these species into closer proximity of the pumps, increasing their risk of entrainment. However, conservation measures (Section 2.5.1.2.) would avoid effects or reduce effects on salmonids to insignificant levels. Therefore, when considering Delta outflow the Proposed Action may affect but is not likely to adversely affect Central Valley steelhead in December.

Entrainment. The Proposed Action, considering all water years, would decrease the entrainment index of Central Valley steelhead compared to existing conditions. Therefore, when considering entrainment the Proposed Action would provide a beneficial effect to Central Valley steelhead.

9.1.2.5 Delta Smelt

Delta Outflow. The Proposed Action would result in reduced Delta outflow from October through December. The lower outflows during December under drier conditions would have the potential to adversely affect some species, particularly early spawning delta smelt. However, conservation measures (Section 2.5.1.2.) would avoid effects or reduce effects on delta smelt to insignificant levels. Therefore, when considering Delta outflow the Proposed Action may affect but is not likely to adversely affect delta smelt in December.

Location of X2. The Proposed Action would move the estimated location of X2 westward most of the time in January through September, and eastward from October through December. January through May would generally see beneficial changes in X2 location and provide a benefit to aquatic ecosystems and the fisheries dependent upon them. The eastward change in November and December would be constrained by Project conservation measures and thus would result in effects that are insignificant. Therefore, when considering changes in the location of X2, the Proposed Action may affect but is not likely to adversely affect delta smelt.

Entrainment. The Proposed Action, considering all water years, would decrease the entrainment index of delta smelt compared to existing conditions. Therefore, when considering entrainment the Proposed Action would provide a beneficial effect to delta smelt.

9.1.2.6 Green Sturgeon

Delta Outflow. The Proposed Action would result in reduced Delta outflow from October through December. However, these decreased outflows should not affect the green sturgeon. Therefore, when considering Delta outflow the Proposed Action may affect but is not likely to adversely affect green sturgeon.

Appendix D
Monthly Salvage Densities by Facility and Hydrologic Condition

This page is intentionally left blank

Appendix D
Monthly Salvage Densities by Facility and Hydrologic Condition

Species	Month	Banks PP (CVP)		Jones PP (SWP)	
		Drier	Wetter	Drier	Wetter
American shad	January	66.217	155.769	51.050	100.591
	February	12.815	15.002	11.509	17.003
	March	1.278	0.754	2.013	1.760
	April	2.087	0.508	2.513	3.966
	May	0.116	1.353	0.674	11.250
	June	2.747	24.821	54.427	172.671
	July	305.525	416.616	591.363	1226.727
	August	45.305	260.541	247.751	675.350
	September	23.451	83.329	96.828	180.926
	October	297.766	447.819	223.114	143.631
	November	586.966	599.974	428.577	422.088
	December	362.274	304.964	170.359	200.165
Delta smelt	January	1.942	1.973	3.400	5.225
	February	4.232	2.738	2.412	3.598
	March	3.270	2.495	2.895	1.034
	April	4.356	3.188	4.405	0.485
	May	194.417	93.620	464.601	158.075
	June	26.665	25.972	98.232	128.868
	July	0.056	0.443	4.572	7.308
	August	0.000	0.006	0.000	0.021
	September	0.000	0.000	0.000	0.008
	October	0.000	0.000	0.029	0.000
	November	0.331	0.018	0.074	0.000
	December	0.729	0.615	0.809	1.134
Fall-Run Chinook	January	0.217	16.179	0.078	2.217
	February	0.204	39.709	0.144	23.418
	March	3.088	6.495	5.411	6.237
	April	28.177	20.558	115.648	32.412
	May	21.166	86.719	341.990	215.249
	June	1.693	21.717	1.437	47.623
	July	0.010	0.361	0.000	0.849
	August	0.019	0.013	0.053	0.186
	September	0.000	0.069	0.000	0.832
	October	0.030	0.129	0.686	0.020
	November	0.349	0.158	0.163	0.266
	December	0.273	0.231	0.462	0.328
Late Fall-Run Chinook	January	0.244	0.692	0.905	3.456
	February	0.044	0.031	0.000	0.061
	March	0.024	0.000	0.025	0.000
	April	0.000	0.006	0.083	0.000
	May	0.000	0.000	0.000	0.000

Species	Month	Banks PP (CVP)		Jones PP (SWP)	
		Drier	Wetter	Drier	Wetter
Late Fall-Run Chinook (continued)	June	0.000	0.026	0.000	0.000
	July	0.000	0.000	0.000	0.000
	August	0.000	0.000	0.000	0.012
	September	0.000	0.000	0.000	0.012
	October	0.000	0.004	0.021	0.058
	November	0.033	0.073	0.098	0.113
	December	0.431	0.268	1.546	2.009
Longfin smelt	January	0.181	0.067	0.080	0.126
	February	0.041	0.071	0.087	0.026
	March	1.467	0.000	0.014	0.032
	April	76.668	2.294	35.593	75.843
	May	122.842	4.832	375.569	2.619
	June	0.697	0.023	5.159	0.160
	July	0.000	0.000	0.005	0.154
	August	0.000	0.006	0.000	0.029
	September	0.000	0.000	0.000	0.000
	October	0.000	0.000	0.035	0.000
	November	0.000	0.000	0.019	0.000
	December	0.051	0.052	0.005	0.015
Splittail	January	1.099	7.356	2.232	8.388
	February	0.860	3.569	3.586	4.483
	March	2.026	3.039	4.816	4.370
	April	3.810	14.223	13.053	8.352
	May	2.232	517.239	1.281	134.634
	June	18.386	2290.185	2.012	1695.508
	July	1.597	469.071	0.517	377.166
	August	0.094	7.386	0.147	9.871
	September	0.115	1.250	0.191	0.966
	October	0.064	1.015	0.494	0.525
	November	0.052	0.365	0.321	0.267
	December	0.371	0.223	0.572	0.501
Spring-Run Chinook	January	0.027	0.010	0.000	0.009
	February	0.013	0.098	0.000	0.296
	March	3.215	11.740	7.284	14.417
	April	37.086	73.323	107.356	165.226
	May	3.836	33.341	70.417	81.955
	June	0.040	2.170	0.000	8.128
	July	0.000	0.000	0.000	0.000
	August	0.000	0.000	0.000	0.000
	September	0.000	0.000	0.000	0.008
	October	0.000	0.000	0.000	0.021
	November	0.000	0.000	0.000	0.000
	December	0.000	0.000	0.000	0.000
Steelhead	January	2.196	13.789	4.687	11.892
	February	25.137	19.518	20.405	26.899
	March	27.210	13.191	23.730	8.583
	April	9.505	9.929	7.061	6.352
	May	1.084	3.264	5.053	4.011

Species	Month	Banks PP (CVP)		Jones PP (SWP)	
		Drier	Wetter	Drier	Wetter
Steelhead (continued)	June	0.547	0.474	0.193	0.861
	July	0.000	0.389	0.250	0.062
	August	0.000	0.000	0.000	0.005
	September	0.000	0.000	0.000	0.000
	October	0.000	0.000	0.014	0.180
	November	0.072	0.118	0.247	0.102
	December	0.140	0.575	0.415	0.502
Striped bass	January	73.464	169.879	34.605	126.516
	February	96.531	68.928	49.349	76.494
	March	122.550	39.150	21.334	9.747
	April	45.571	16.308	16.801	2.105
	May	1294.124	456.634	1167.479	655.196
	June	7077.945	3682.542	5082.986	5592.310
	July	1332.657	927.370	996.229	2848.086
	August	81.290	95.741	38.047	447.649
	September	33.126	66.193	43.184	41.746
	October	51.000	39.064	353.488	57.314
	November	104.792	36.803	602.186	207.987
	December	63.450	39.311	107.807	137.241
Threadfin shad	January	1159.601	1190.011	158.674	203.743
	February	698.592	897.188	20.016	78.356
	March	98.915	57.499	27.871	6.273
	April	99.917	62.165	27.839	17.647
	May	6.037	37.445	22.331	7.953
	June	1331.153	237.338	721.366	610.175
	July	3512.219	896.057	6181.622	1834.872
	August	1487.731	1639.557	1472.515	2210.744
	September	684.924	1426.432	398.282	528.302
	October	2534.891	1540.661	1139.957	260.667
	November	1331.088	1250.867	717.183	293.446
	December	802.477	868.441	158.674	377.315
Winter-Run Chinook	January	1.092	1.729	5.881	16.931
	February	3.754	0.547	10.983	4.775
	March	3.968	0.795	19.462	4.519
	April	1.573	0.472	2.195	1.497
	May	0.000	0.047	0.254	0.029
	June	0.000	0.004	0.000	0.000
	July	0.000	0.000	0.000	0.000
	August	0.000	0.000	0.000	0.000
	September	0.000	0.000	0.000	0.000
	October	0.000	0.000	0.000	0.000
	November	0.000	0.000	0.000	0.000
	December	3.226	0.317	3.226	2.307