United States Department of the Interior

FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
2800 Cottage Way, Suite W-2605
Sacramento, California 95825-1846
SFWO_mail@fws.gov

In Reply Refer to:
08ESMF00-2014-F-0518-R003

March 31, 2021

Joe Griffin
Chief, Environmental Resources Branch
U.S. Army Corps of Engineers, Sacramento District
1325 J Street
Sacramento, California 95814
s.joe.griffin@usace.army.mil

Subject: Reinitiation of Formal Consultation on the American River Common Features (ARCF) 2016 Project, Sacramento and Yolo Counties, California

Dear Joe Griffin:

This letter is in response to the U.S. Army Corps of Engineers' (Corps) June 17, 2020, request for reinitiation of formal consultation with the U.S. Fish and Wildlife Service (Service) on the proposed American River Common Features (ARCF) 2016 Project (proposed project) in Sacramento and Yolo Counties, California. Your request was received by the Service on June 17, 2020. The Corps has refined some of the project designs and is updating the project description and effects to listed species. Subsequent to the June 17, 2020, letter, the Corps has provided additional changes to the project description. The Service received final major changes to the project description on November 17, with adjustments being made over the last three months. At issue are the proposed project's effects on the federally threatened valley elderberry longhorn beetle (*Democerus californicus dimorphus*), delta smelt (*Hypomesus transpacificus*), giant garter snake (*Thamnophis gigas*), and western yellow-billed cuckoo (*Coccyzus americanus occidentalis*) and delta smelt designated critical habitat. This response is provided under the authority of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act), and in accordance with the implementing regulations pertaining to interagency cooperation (50 CFR 402).

The previous biological opinion (08ESMF00-2014-F-0518-R002 dated May 2, 2019) has been revised and this consultation includes all previous reinitiations and the current changes to the project description and effects that the Corps has included in this current reinitiation.

The federal action on which we are consulting is the Corps' ARCF 2016 Project, which includes levee improvements and bank protection along the Sacramento River, levee improvements along Arcade and Magpie Creeks, widening the Sacramento Weir, and bank protection along the lower American River. Pursuant to 50 CFR 402.12(j), you submitted a biological assessment for our review and requested concurrence with the findings presented therein. These findings conclude that the proposed project may affect, and is likely to adversely affect the valley elderberry longhorn beetle, the delta smelt (smelt) and its critical habitat, the giant garter snake, and the yellow-billed cuckoo. The project is outside of critical habitat designated for the valley elderberry longhorn beetle and critical habitat proposed for the yellow-billed cuckoo.

In considering your request, we based our evaluation on the following:

1) Biological Assessment American River Watershed Common Features;
2) Information to Reinitiate Section 7 Consultation – Sacramento Weir and Sacramento River East Levee Components; and
3) Various e-mails with project modifications provided between June 2020 and March 2021.

The remainder of this document provides our biological opinion on the effects of the proposed project on the valley elderberry longhorn beetle, delta smelt and its critical habitat, giant garter snake, and yellow-billed cuckoo.

Consultation History

September 4, 2013:	The Service commented on the April 2013 draft biological assessment.
April 8, 2014:	The Service commented on the October 2013 draft biological assessment.
June 30, 2014:	The Corps initiated section 7 consultation with the Service.
July 23, 2014:	The Service sent a letter in response to the Corps initiation requesting additional information.
April 3, 2015:	The Corps provided an updated biological assessment with responses to the Service's July 23, 2014, request for additional information.
August 31, 2015:	The Corps provided a revised biological assessment that addressed questions the Service had regarding the project description.
September 11, 2015:	The Service provided the Corps with a biological opinion on the proposed project.
January 25, 2017:	The Corps reinitiated consultation with the Service.
June 8, 2017:	The Service provided an amended biological opinion to the Corps.
April 15, 2019:	The Corps reinitiated consultation with the Service to add geotechnical explorations.
June 17, 2020:	The Corps reinitiated consultation with the Service due to changes in project description and effects to listed species.

June 2020 – March 2021: The Corps provided numerous e-mails and held numerous meetings to discuss changes to the project description and effects to listed species.

BIOLOGICAL OPINION

Description of the Proposed Action

Congress directed the Corps to investigate the feasibility of reducing flood risk to the city of Sacramento and surrounding areas. The Corps completed feasibility studies in 1991 and 1996, recommending a concrete gravity flood detention dam on the north fork of the American River at the Auburn site along with levee improvements downstream of Folsom Dam. Other plans evaluated in the report were Folsom Dam improvements and a stepped release plan for Folsom Dam releases. These additional plans also included levee improvements downstream of Folsom Dam. Congress recognized that levee improvements were “common” to all candidate plans in the report and that there was a Federal interest in participating in these “common features.” Thus, the ARCF Project was authorized in the Water Resources Development Act (WRDA) of 1996 and a decision on Auburn Dam was deferred to a later date. Major construction components of ARCF in the WRDA 1996 authorization included construction of seepage remediation along about 22 miles of American River levees and construction of levee strengthening and raising of 12 miles of Sacramento River levee in Natomas.

The following problems were identified within the Sacramento levee system:

- Seepage and underseepage;
- Levee erosion;
- Levee stability;
- Levee overtopping;
- Access for maintenance and flood fighting;
- Vegetation and encroachments;
- Releases from Folsom Dam;
- Floodplain management; and
- Additional upstream storage from existing reservoirs.

The project is designed to allow for the release of 160,000 cubic feet per second (cfs) from Folsom Dam. The levees along the American River are unable to withstand these maximum flows for extended periods of time without increased risk of erosion and potential failure.

The Corps’ project involves the construction of fix-in-place levee remediation measures to address seepage, stability, erosion, and height concerns identified for the Sacramento River and American River levees, Natomas East Main Drainage Canal (NEMDC), Arcade, and Magpie Creeks. Most height concerns along the Sacramento River will be addressed by a widening of the Sacramento Weir and Bypass to divert more flood flows into the Yolo Bypass, thereby lowering water surface elevations downstream. Due to the urban nature and proximity of existing development within the American River North and South basins the Corps is planning fix in place remediation. This would improve the flood damage reduction system to safely convey flows to a level that maximizes net benefits. Table 1 summarizes the levee problems discussed above and the proposed measure for each waterway.

Table 1. Remediation by Waterway.

Waterway	Seepage Measures	Stability Measures	Erosion Protection Measures	Overtopping Measures
American River[1]	---	---	Bank Protection (31,000 linear feet), Launchable Rock Trench (45,000 linear feet)	---
Sacramento River	Cutoff Wall (50,300 linear feet)	Cutoff Wall (50,300 linear feet)	Bank Protection (43,000 linear feet)	Sacramento Bypass and Weir Widening, Levee Raise (1,500 feet)
NEMDC	Cutoff Wall (6,000 linear feet)	Cutoff Wall	---	Floodwall (15,600 linear feet)
Arcade Creek	Cutoff Wall (22,000 linear feet)	Cutoff Wall	---	Floodwall (22,000 linear feet)
Dry/Robla Creeks	---	---	---	Floodwall (2,500 linear feet)
Magpie Creek	---	---	---	Levee Raise (2,100 linear feet) and Training Levee (1,000 linear feet)

[1]American River seepage, stability, and overtopping measures were addressed in a previous construction project.

Sacramento Area Flood Control Agency (SAFCA), the project's local sponsor, will complete some portions of the Federal project. SAFCA is seeking permission from the Corps pursuant to 33 USC §408 (Section 408) for alteration of the Federal levees along the NEMDC and Arcade Creek.

In addition to the proposed levee improvements measures shown in Table 1, the following measures and policies would be addressed during construction:

- The Corps will apply a semi-quantitative risk assessment methodology to evaluate the placement of on-site mitigation vegetation.

- The non-Federal sponsor, Central Valley Flood Protection Board (CVFPB), will bring the levees into compliance with the Corps' standard levee footprint using a System Wide Implementation Framework (SWIF) process. A SWIF is a plan developed by the levee sponsor(s) and accepted by the Corps to implement system-wide improvements to a levee system (or multiple levee systems within a watershed) to address system-wide issues, including correction of unacceptable inspection items, in a prioritized way to optimize flood risk reduction. The standard levee footprint consists of a 20-foot crown width, 3 to 1 (height to vertical) (3H:1V) waterside slope and 2H:1V landside slope. There may be locations where a 3H:1V waterside slope design is not possible and, when possible. If the 3H:1V waterside slope is not possible, then a minimum 2H:1V waterside slope will be established with revetment.

American River

Levees along the American River require improvements to address erosion. For design and construction purposes, the lower American River is divided into 4 subreaches. The proposed measures for these areas consist of bank protection or launchable rock trenches with a maximum of 31,000 linear feet (LF) of bank protection, and a maximum of 65 acres/45,000 LF of launchable rock trench. These measures are being implemented to prevent undermining of the levee foundation. Typical designs are described below.

<u>Bank Protection</u>
This measure consists of placing rock revetment on the river's bank to prevent erosion and will consist of the following types of repairs.

Bank protection entails installing revetment along the stream bank based on site-specific analysis. When necessary, the eroded portion of the bank will be filled and compacted prior to the rock placement. The sites will be prepared by clearing and stripping of loose material and understory growth prior to construction. Where possible large woody vegetation will be left on-site. Temporary access ramps will be constructed, if needed, using imported borrow material that would be trucked on site.

The placement of rock onto the bank will occur from a land based staging area using long reach excavators and loader. The loader brings rock from a permitted source and stockpiles it near the levee in the construction area. The excavator then moves the rock from the stockpile to the waterside of the levee. A soil filled planting bench could be established on these rock surfaces for revegetation purposes.

The revetment will be placed on the existing bank at a slope varying from 2H:1V to 3H:1V depending on site specific conditions. Rock will be placed at the toe of the repair which is designed to launch at certain high flows to protect against toe erosion.

After revetment placement has been completed, where hydraulic stage impacts have been deemed acceptable and space allows, a soil-filled planting berm will be constructed on the repair site to allow for vegetation to be planted, outside of the vegetation free zone as required by the Corps. This vegetation will be designed on a site-specific basis in coordination with the Service and in such a way as to not impact the hydraulic conveyance of the channel.

Planting benches will provide on-site mitigation for juvenile salmonids contributing to their foraging and refuge habitat. The planting benches will provide adequate soil volume to establish native tree species. Design of the planting benches should include providing a variety of slopes both parallel and perpendicular to the river and a diverse planting pallet including trees, shrubs, and understory plants. Instream woody material in the form of small dead trees with intact roots will be placed at the lower elevations that are frequently inundated. The planting bench will terminate at the launchable toe where rows of willow stakes will be planted to stabilize the planting bench soil. During the initial plant establishment, planting benches will be protected with biodegradable erosion control fabric on the surface. The planting bench will be placed over a minimum two-foot thick layer of clean riprap. The launchable toe will be of sufficient volume to launch the riprap into scours that could develop along the natural river bottom during high flows.

Launchable Rock Trench

This measure includes construction of a launchable rock filled trench, designed to deploy once erosion has removed the bank material beneath it. All launchable rock trenches will be constructed outside of the natural river channel. The vegetation will be removed from the footprint of the trench and the levee slope prior to excavation of the trench. The trench configuration will include a 2H:1V landside slope and 1H:1V waterside slope and will be excavated at the toe of the existing levee. All soil removed during trench excavation will be stockpiled for potential reuse. The bottom of the trench will be constructed close to the summer mean water surface elevation in order to reduce the rock launching distance and amount of rock required.

After excavation, the trench will be filled with revetment that will be imported from an offsite commercial location. After rock placement the trench will be covered with a minimum of 3 feet of the stockpiled soil. Vegetation may be planted over the trench if it is planted outside of the vegetation-free zone. This vegetation will be limited to native grasses and woody vegetation with shallow root systems to ensure they do not limit the functionality of the trench during a flood event.

Cut Bank

This measure consists of excavating the channel banks to create stable slopes that could be planted with riparian vegetation to provide erosion protection along the channel margins and include the following potential activities.

The design is intended to be deformable vegetated bankline, which will allow small amounts of river processes such as erosion and accretion The design will reduce the likelihood of erosion by reducing bank slope, creating planting areas on the lower slope at elevations observed to recruit and sustain natural riparian vegetation to increase slope stability and erosion resistance. Inclusion of launchable buried rock tiebacks will both protect the levee and the bank.

Island Degrading

At a site in subreach 3, the Corps proposes to degrade the island just upstream of the Howe Ave boat launch, for the purpose of hydraulic mitigation. The mid-channel island will be removed, and the material will be used as fill along the riverbank. The bank fill area extends from the existing bank at approximately elevation 30-foot out into the channel to the 3,900 cfs WSE (approximately 18 ft). The proposed design cuts down half of the island to 16 feet and then cuts down to existing ground at a gradual slope. The area at 16-foot elevation provides shallow fish rearing habitat, as it is in the 95% exceedance flow and will not grow vegetation. The area at and around 18 feet is expected to grow vegetation, as this elevation is where natural recruitment is seen elsewhere on the river. The area is not near known active steelhead spawning areas.

Arden Bar

Along the Lower American River an offsite mitigation area is being designed at Arden Pond (River Mile 12). Arden Pond is approximately 29.5 acres in size. Work at Arden Pond includes grading and fill to reconnect the area with the river by constructing a side channel shoal system and adjacent emergent vegetation. Additional description can be found in the *Arden Pond Supplemental Information for NMFS Consultation* document produced by ESA, January 2021.

Sacramento River

Levees along the Sacramento River require improvements to address seepage, stability, and erosion. About 43,000 LF of bank protection and 50,300 LF of cutoff wall or slope stability work is proposed for the Sacramento River. In addition, these levees require a total of one mile of intermittent height improvements in order to convey additional flows that exceed current design levels.

Levee Raising

Where the existing levee does not meet the levee design requirements, as discussed above, slope flattening, crown widening, and/or a minimal amount of levee raise is required. This improvement measure addresses problems with slope stability, geometry, height and levee crest access and maintenance. To begin levee embankment grading, loose material and vegetation understory will be cleared, grubbed, stripped, and where necessary, portions of the existing embankment will be excavated to allow for bench cuts and keyways to tie in additional embankment fill. Excavated and borrow material (from nearby borrow sites) will be stockpiled at staging areas. Haul trucks and front-end loaders will bring borrow materials to the site, which will then be spread evenly and compacted according to levee design plans.

The levee will be raised about 1 to 2 feet resulting in the levee footprint extending out a maximum of 5 feet on the landside from the existing levee. The levee crown patrol road will be re-established at the completion of construction.

Cutoff Walls

To address seepage concerns, a cutoff wall will be constructed through the levee crown. The cutoff wall will be installed by one of three methods: (1) conventional open trench cutoff walls, (2) deep soil mixing (DSM) cutoff walls, and (3) jet grout cutoff walls. The method of cutoff wall selected for each reach will depend on the depth of the cutoff wall needed to address the seepage. The open trench method can be used to install a cutoff wall to a depth of about 85 feet. For cutoff walls of greater depths, the DSM method will be utilized.

Prior to any cutoff wall construction method, the construction site and any staging areas will be cleared, grubbed, and stripped. The levee crown will be degraded up to half the levee height to create a large enough working platform (about 30 feet) and to reduce the risk of hydraulically fracturing the levee embankment from the insertion of slurry fluids. This method of slurry wall installation will also reduce the risk of slurry mixture following seepage paths and leaking into the river or into landside properties.

Open Trench Cutoff Wall

Under the open trench method, a trench about 3 feet wide will be excavated at the top of levee centerline and into the subsurface materials up to 85 feet deep with a long boom excavator. As the trench is excavated, it is filled with low density temporary bentonite water slurry to prevent cave in. The soil from the excavated trench is mixed nearby with hydrated bentonite, and in some applications cement. The soil bentonite mixture is backfilled into the trench, displacing the temporary slurry. Once the slurry was hardened, it will be capped, and the levee embankment will be reconstructed with impervious or semi-impervious soil.

DSM Cutoff Wall

The DSM method involves a crane supported set of two to four mixing augers used to drill through the levee crown and subsurface to a maximum depth of about 130 feet. As the augers are inserted and withdrawn, a cement bentonite grout will be injected through the augers and mixed with the native soils. An overlapping series of mixed columns will be drilled to create a continuous seepage cutoff barrier. A degrade of up to one half the levee height will be required for construction of the DSM wall. For both methods, once the slurry has hardened it will be capped and the levee embankment will be reconstructed with impervious or semi-impervious soil.

Jet Grout Construction

Jet grout construction involves injecting grout into the soil at very high pressures and will be used in areas where there are utilities that cannot be removed such as the regional sewer line and Pacific Gas and Electric (PG&E) natural gas line near the Pioneer Bridge. The grout is a mixture of cement and water that will be mixed in a batch plant located in the staging area and transported through high- pressure hoses to the location of construction. The jet grout process involves drilling straight down into the levee to a depth of up to approximately 130 feet, then injecting grout into the hole through a high-pressure nozzle. As the grout is injected from the bottom to the top of the hole, the high pressure excavates the soil around the nozzle to a radius of 3 to 4 feet, mixing the soil within the levee with grout. The grout injection may be accompanied with air and water to assist the excavation of soil. The nozzle is rotated and lifted at a slow, smooth, constant speed to achieve thorough mixing and consistent quality. The grout then solidifies to create a column of low permeability. Multiple columns constructed together create a wall through the levee that prevents seepage. Soil that is displaced from the injection site will be piped into drying beds or containment cells located in the staging area for later disposal.

Jet grouting activities near Pioneer Bridge may occur 24 hours a day to expedite work which will generate noise and require night lighting.

Municipal Drainage Systems

Several municipal drainage systems, both legacy and operational, have pipes that run through the levee. These facilities require removal and replacement to install the cutoff walls. Temporary waterside access below the ordinary high-water mark of the river is required to remove or replace these structures. A small portion of the concrete apron will be placed as part of the Sump 70 replacement and will likely extend below the OHWM. Temporary access will consist of dewatering the area with the use of a sandbag cofferdam approximately five feet high (1.75 feet above the typical water level) and approximately 120 feet in length. The sandbag cofferdams would be installed, and work completed between July 1 and October 31, which is outside of sensitive fish species migration windows. A portion of the existing revetment would be sawcut and removed. Work to replace individual drainage facilities is estimated to take up to 15 days. There may be up to five areas where in-water work may be needed to remove or replace these pump systems throughout all Sacramento River east levee contracts.

Stability Berms and Blankets

Stability berms and blankets address shallow foundation and/or levee embankment through-seepage. A stability berm or blanket is a prism of compacted soil that acts as a buttress to increase stability factors of safety and, in some cases, includes an inclined filter/drain zone placed on the landside slope of a levee to capture seepage that would otherwise exist on and potentially erode the unprotected levee slope. Typical stability berms are 10-15 feet high (depending on the height of the levee) and 10-25 feet wide and are considered in limited areas that do not have substantial right of way issues. Alternatively, the stability berm can be constructed within the existing levee in areas with constrained access along the landside levee toe. The inset stability berm would be constructed by excavating the landside levee slope, constructing the filter/drain zone, and then rebuilding the levee slope to about the original grade with compact fill.

Relief Wells

Relief wells provide protection against levee underseepage by providing a path for underseepage to exist the ground surface at the landside toe of the levee without creating sand boils or piping levee foundation materials. Relief wells would be constructed near the levee landside toe to provide pressure relief beneath surficial fine-grained soils (clay or silt "blanket"). The wells would be constructed using soil-boring equipment to bore a hold vertically though the fine-grained layer. Pipe casings and filters would be installed to allow the pressurized water to flow to the ground surface in the well casing, thereby relieving the pressures beneath the clay blanket layers.

Toe Drains

The primary purpose of a toe drain is to divert through-levee seepage before it reaches the levee slope, where it could cause erosion and instability, and to filter the discharge in such a way as to reduce velocity and fine soil carrying capacity. A toe drain will typically be used when through-seepage or through-seepage driven landslide slope stability is problematic. Toe drains can be used in several limited reaches where the levee does not have an existing shallow cutoff wall and there is a concern regarding potential seepage breakout on the levee slope or the levee toe. Toe drains will be constructed by excavating into the levee prism and constructing a filtered drain within the waterside toe of the levee embankment.

Bank Protection

Proposed bank protection along the Sacramento River will address erosion concerns. Studies have shown that the Sacramento River levees have a medium to high risk of breach due to erosion. Bank protection will be addressed by standard bank protection with planting berm. The standard bank protection measure for the Sacramento River consists of placing rock protection on the bank to prevent erosion. This measure entails filling the eroded portion of the bank, where necessary, and installing revetment along the waterside levee slope and streambank from streambed to a height determined by site-specific analysis. Large trees on the lower half of the waterside slope will be protected in place to retain shaded riverine aquatic (SRA) habitat. The sites will be prepared by removing vegetation along the levee slopes at either end of the site for construction of a temporary access ramp, if needed. The ramp will then be constructed using imported commercial borrow material that will be trucked on site.

The placement of rock onto the levee slope will occur from atop the levee and/or from the waterside by means of barges. Rock required within the channel, both below and slightly above the water line at the time of placement, will be placed by a crane and/or excavator located on a barge. Construction will require two barges: one barge will carry the crane and/or excavator, while the other barge will hold the stockpile of rock to be placed on the channel slopes. Rock required on the upper portions of the slopes will be placed by an excavator located on top of the levee. Rock placement from atop the levee will require one excavator and one loader for each potential placement site. The loader brings the rock from a permitted source and stockpiles it near the levee in the construction area. The excavator then moves the rock from the stockpile to the waterside of the levee.

The revetment will be placed via the methods discussed above on existing bank at a slope varying from 2V:1H to 3V:1H depending on site specific conditions. After revetment placement has been completed, a small planting berm will be constructed in the rock to allow for some revegetation of the site.

Additional Measures

Additional bank protection measures may be considered and found to be appropriate during the implementation of site-specific designs. Design and analysis of any additional measures will be carried out during the site-specific planning and design phase. Examples of additional measures include, but are not limited to, toe protection, flow modification, cut bank, and alternative design and materials for reduction of riprap. These and other measures, which may be developed in the future, will be designed in coordination with the Service and National Marine Fisheries Service (NMFS) to minimize effects to listed species and their habitat from the proposed action and to ensure that the effects from these actions are covered in the effects of this biological opinion.

Natomas East Main Drain Canal

The east levee of the NEMDC requires 6,000 LF of improvements to address seepage and stability at locations where historic creeks had intersected the current levee alignment. A cutoff wall will be constructed at this location to address the seepage and stability problems. The cutoff wall will be constructed by one of the methods described in the Sacramento River section above. SAFCA is proposing to construct 2,500 LF of cutoff wall beginning just south of the confluence of Arcade Creek and extending south along the NEMDC. The Corps will construct the remaining 3,500 LF of cutoff wall.

Arcade Creek

The Arcade Creek levees require improvements to address seepage, slope stability, and overtopping when the event exceeds the current design. A centerline cutoff wall will be constructed to address seepage along 22,000 LF of the Arcade Creek levees. Levees from Rio Linda Boulevard to Marysville Boulevard will have a cutoff wall constructed at the waterside toe of the levee. Construction of the waterside toe cutoff wall will require constructing a work bench along the toe of the levee. Excavation for the bench will extend deep enough below existing grade to remove organic material and soft, unsuitable foundation soils. Bench excavation will also extend into the existing waterside slope of the levee as needed. Riprap will be placed on the waterside benches after construction of the waterside toe cutoff wall. Some portions of the Arcade Creek north levee will require more substantial excavation and reconstruction of the waterside slope to provide a low permeable seepage levee slope barrier. Bench fill material will be integrated with the slope reconstruction fill to provide an integral seepage barrier with the cutoff wall over the full height of the levee slope. A small section of levee will have a sheet pile cutoff wall at the centerline of the levee, rather than the waterside toe cutoff wall.

There is a ditch adjacent to the north levee at the landside toe which provides a shortened seepage path and could affect the stability of the levee. The ditch will be replaced with a conduit or box culvert and then backfilled. This will lengthen the seepage path and improve the stability of the levee. Additionally, pressure relief wells will be installed along the landside toe of the levee along the north levee west of Norwood Avenue.

Most of the Arcade Creek levees have existing floodwalls, however, there remains a height issue in this reach. A 1 to 4-foot floodwall will allow the levees to pass flood events greater than the current design level. The floodwall will be placed on the waterside hinge point of the levee and will be designed to disturb a minimal amount of waterside slope and levee crown for construction. The waterside slope will be re-established to its existing slope and the levee crown will grade away from the wall and be surfaced with aggregate base.

Magpie Creek Diversion Canal

The Magpie Creek Diversion Canal will consist of levee raising and a training levee. About 2,100 LF of levee raise will occur from Raley Boulevard to 100 feet south of Vinci Avenue Bridge. A new training levee will be constructed on the south side of the Magpie Creek Diversion Canal east of Raley Boulevard for 1,000 LF. An arch culvert will be installed across the canal to allow Raley Boulevard to cross. A new maintenance road will be constructed adjacent to the raised levee and the training levee. Finally, from Vinci Avenue to Dry Creek Road vegetation will be cleared from the channel to allow for better water flow during high water events.

Sacramento Weir and Fish Passage Facility

The Sacramento Weir was completed in 1916. It is the only weir in the Sacramento River Flood Control Project that is manually operated; all others overflow by gravity on their own. It is located along the right bank of the Sacramento River about 4 miles upstream of the Tower Bridge, and about 2 miles upstream from the confluence with the American River. Its primary purpose is to protect the city of Sacramento from excessive flood stages in the Sacramento River channel downstream of the American River. The weir limits flood stages (water surface elevations) in the Sacramento River to project design levels through the Sacramento/West Sacramento area. Downstream of the Sacramento Weir, the design flood capacity of the American River is 5,000 cfs higher than that of the Sacramento River. Flows from the American River channel during a major flood event often exceed the capacity of the Sacramento River downstream of the confluence. When this occurs, floodwaters flow upstream from the mouth of the American River to the Sacramento Weir.

A new 1520-foot fixed-crest passive weir structure will be constructed north of the existing Sacramento Weir. Additionally, a new bridge over the new weir will be constructed along Old River Road, a fish passage structure will be constructed in the new weir structure, a levee embankment will be constructed between the existing weir and the new weir, County Road 12 will be realigned, and the railroad embankment will be removed.

The California Department of Water Resources is implementing the Lower Elkhorn Basin Levee Setback project, which will widen the Sacramento Bypass by degrading the existing north levee of the Sacramento Bypass and constructing a new levee 1,500 feet to the north. This project was analyzed in a separate consultation (Service file # 2018-F-0479) and is not part of this project description.

The widening of the Sacramento Weir will result in stage increases of about 0.1 to 0.15 foot in the Yolo Bypass during the 1/100 and 1/200 annual exceedance probability (AEP) events and up to 0.3 feet during the 1/325 AEP event. These increases will not substantially change the area of the Yolo Bypass that will be inundated or substantially increase inundation depths in the bypass.

Due to operational criteria and system hydrology, the Sacramento Weir has historically not spilled on occasions when the Fremont weir was not already overtopping (i.e., the Fremont Weir always spills before the Sacramento Weir). Thus, under current conditions, the Sacramento Bypass has never been inundated by Sacramento Weir flood flows unless the Yolo Bypass was already inundated by flows over Fremont Weir Due to the volume of water that passed over the Fremont Weir, when the Fremont Weir spills and inundates the Yolo Bypass, some of the flow backs up and inundates the Sacramento Bypass. Additionally, because it takes an extended period of time for Yolo Bypass flows to drain back into the Sacramento River near Rio Vista, inundation in the Sacramento and Yolo Bypasses may persist for weeks or months after the weirs have stopped overtopping.

A change in operations will occur because the widened weir crest will be constructed at a lower elevation than the current weir. The lowered weir crest will result in the widened Sacramento Weir spilling more often, than current conditions. However, when the operation is modeled with the last 50 years of historical data, the proposed project will not substantially increase the frequency or duration of inundation in the Yolo Bypass.

New Weir and Bridge

A new 1,496-foot-long passive weir will be constructed along the right bank (looking downstream) of the Sacramento River, north of the existing weir. The new weir and existing weir will be separated by a levee embankment. The proposed weir would be composed of 60-foot-wide weir bays, separated by 3- to 5-foot-wide piers. A concrete approach slab and weir crest will form the floor between the piers. The weir crest elevation will be at 26 feet.

The new primary weir structure will be constructed behind the existing levee and Old River Road; therefore, only 1 year of in-water work is anticipated for the levee degrade, rock slope placement, and fish exit pool construction.

The existing levee, which will be in front of the new weir, once constructed, will be degraded in the final year of construction to create a graded approach to the new weir. The bank will be sloped back impacting 5.56 acres of riverine habitat and 2 acres of upland habitat which will result in 7.5 acres of riverine habitat once completed. The elevation of the graded approach to the new weir will be excavated down to an elevation of 22 feet. Once grading of the approach is completed, part of the area will be seeded with native perennial herbaceous species to stabilize the approach and protect it from erosion. Based on the proposed elevation of the approach, it is anticipated that this area will likely be inundated on an annual to biennial basis, given the OHWM is 2 feet higher than the proposed approach.

Once the graded approach is completed, areas that cannot be seeded due to erosion risk will have rock slope protection placed. Rock placed above the 10-foot contour will be 20 inches thick, while rock placed below this elevation will be 30 inches thick. A total of 18,358 cubic yards of rock are anticipated to be necessary. Placement of the rock will be achieved using an excavator staged from a barge or on land, and/or by bottom dumping rock from a barge. It may also be necessary to install a vibratory driven sheet-pile cofferdam to dewater the work area for installation of the rock slope protection. Turbidity will be controlled via a cofferdam, installation of a turbidity curtain, or other means and methods approved by the Regional Water Quality Control Board and NMFS.

Fish Passage Structure and Channel

The proposed action’s fish passage design includes the following design elements:

- Hydraulic Control Structure and Fishway Exit Pool
- Fish Ladder
- Fish Passage Channel
- Stilling Basin Drain
- Transition of open channel fish way into Tule Canal.

Like the new weir, most of the fish passage facility will be constructed behind the existing Sacramento River and Tule Canal levees.

A fish passage channel begins at the downstream end of the flow control structure and runs parallel to the north wall of the fish ladder. Downstream, the channel turns to connect to the fish ladder entrance pool, then continues west, aligned with the fish ladder centerline. It may be necessary to install a vibratory driven sheet-pile cofferdam to dewater work area where relatively high groundwater levels may otherwise limit dry conditions for channel grading and shaping. The Bypass Transport Channel will extend to the Tule Canal. As the Bypass Transport Channel approaches the Tule Canal a segment of existing canal will be modified resulting in a change in the depth, shape, and alignment of the existing canal. A small amount of riprap will be placed where the Bypass Transport Channel discharges into the Tule Canal.

Fish monitoring will occur in both the Sacramento River and Tule Canal. Active construction monitoring will consist of deploying a hydro acoustic receiver array and acoustic positioning systems. This technology is currently being utilized throughout the west coast and compliments other ongoing acoustic studies in the area. The array and positioning system will determine the fish's site fidelity and behavioral characteristics within the project area as construction activities are occurring. Pre-construction monitoring is anticipated to occur in the spring of 2020, using the acoustic array. Pre-construction monitoring is occurring to establish baseline conditions within the project/action area.

Fish monitoring will include the placement of up to twenty-five individual 14" diameter steel poles or pilings to be placed in the Sacramento River from RM throughout the ARCF action area in the Sacramento River. Minor pile driving activities are anticipated to occur. The purpose of the poles is for the placement/tethering of multi-functioning fish acoustic monitoring equipment, water quality monitoring equipment and an acoustic doppler current profiler. There will be navigation warning signs placed on top of each station. Monitoring will provide data for majority of the fish studies occurring within the Sacramento River.

Interior Drainage

A drainage ditch will be constructed north of the levee parallel to the proposed County Road 124. The new drainage ditch will include a culvert through the railroad embankment and will discharge to a drainage ditch being constructed through the Department of Water Resources' setback levee project.

Utility Relocation

Many utilities will be avoided; however, some utilities may need to be temporarily removed or relocated prior to construction. Temporary bypass pumping may be required for sanitary sewers. SAFCA and the construction contractors will coordinate with utility owners to manage the utilities in advance of construction. Disturbed utilities will be restored after construction consistent with CVFPB requirements.

Stormwater Pollution Prevention

Temporary erosion/runoff best management control measures would be implemented during construction to minimize stormwater pollution resulting from erosion and sediment migration from the construction, borrow, and staging areas. These temporary control measures may include implementing construction staging in a manner that minimizes the amount of area disturbed at any one time; secondary containment for storage of fuel and oil; and the management of stockpiles and disturbed areas by means of earth berms, diversion ditches, straw wattles, straw bales, silt fences, gravel filters, mulching, revegetation, and temporary covers as appropriate. Erosion and stormwater pollution control measures will be consistent with National Pollutant Discharge Elimination System (NPDES) permit requirements and included in a Stormwater Pollution Prevention Plan (SWPPP).

After completion of construction activities, the temporary facilities (construction trailers and batch plants) will be removed and the site would be restored to pre-project conditions. Site restoration activities for areas disturbed by construction activities, including borrow areas and staging areas, will include a combination of regrading, reseeding, constructing permanent diversion ditches, using straw wattles and bales, and applying straw mulch and other measures deemed appropriate.

Geotechnical Explorations

Geotechnical explorations include activities such as: geotechnical borings, erosion jet tests, geotechnical trenching, and geotechnical potholing. A brief description of each follows below.

<u>Geotechnical Borings</u>
Borings are done to determine the geologic composition of the foundation of various flood features (erosion protection, slurry walls, and Sacramento Weir). Each borehole will be about 4 to 6 inches in diameter and will be drilled to a depth of 50 to 100 feet. Equipment will include a tire-mounted drill rig, a support truck, and three crew trucks. Prior to initiating drilling, the workers will clear surface vegetation within the immediate borehole location (about 12 inches in diameter at each borehole). Woody vegetation will be avoided. Upon completion of each boring, the borehole will be backfilled with cement-bentonite grout. Drilling fluid and cuttings will be disposed of at an offsite location.

Erosion Jet Tests – Soil jet tests are used to classify erosion conditions along the waterside banks of the rivers. Tests will be conducted as close to the bank toe as feasibly possible. All jet tests will occur in the dry but may occur below the ordinary high-water mark. Two to six jet tests will be conducted at each site.

<u>Geotechnical Trenching</u>
This action involves digging trenches about 10 feet deep. The purpose of geotechnical trenching is to validate the composition of the levee embankment or other surface soil conditions. Additionally, trenching is often conducted in a similar manner as part of preconstruction geoarchaeological studies to determine the potential for presence of buried archaeological resources in the project area. Following site characterization, the trenches will be backfilled with soil.

Geotechnical Potholing

Geotechnical potholing is used when the purpose of the study is to determine the locations of pipes or other underground features that have the potential to be damaged by other techniques. The potholing is carried out using a vacuum truck to minimize potential damage to the utilities, and to biological resources. Any excess excavated material will be hauled offsite. All disturbed areas will be returned to their original state upon completion of each pothole.

Borrow Sites, Haul Routes, Mobilization, and Staging Areas

Borrow Sites

It is estimated that a maximum amount of borrow material is shown in Table 2 and will be needed to construct the ARCF Project. Detailed studies of the borrow material needs have not been completed. Actual volumes exported from any single borrow site will be adjusted to match demands for fill. Clean rock will be commercially acquired in order to construct the American and Sacramento River bank protection sites.

Borrow material will be obtained from locations on the project site that will undergo grade changes a part of project implementation, or from permitted offsite locations within 30 miles of the project site. Site selection will include the following criteria: avoidance of threatened and endangered species and their habitat, compatible with current land use patterns, and appropriate soil types. Fill may be borrowed from bank protection sites, when available, for the use of project-related mitigation.

Haul Routes

For construction of the enlarged Sacramento Weir, necessary aggregate base rock material will be obtained from a commercial sand and gravel operation, most likely in the Sacramento area, with majority of the riprap material to be transported by barge from quarries located within about 100 miles of the Sacramento Weir. The primary access to the Sacramento Weir project area will be from Interstate (I) 80 and Highway (Hwy) 50 via Harbor Boulevard and/or Reed Avenue, and then along Old River Road. The primary corridor for construction traffic will include temporary construction access roads, and local county roads.

For sites on the American River, haul routes will travel to the sites from either I-80 to the north or from Hwy 50 to the south and then through the residential neighborhoods utilizing various parkway access sites. Internal transfer dump trucks will utilize the top of the levee, the levee toe road, and bike paths to move material from the staging area where needed.

For the Sacramento River, rock will be acquired from a commercial source in the Bay Area and barged up the Sacramento River to the construction sites (see Table 2 for total barge trips estimated). Rock for the American River sites will be acquired from a commercial source within a 50-mile radius and will be hauled in trucks to the construction sites from either I-80 or Hwy 50 and through residential neighborhoods utilizing various Parkway access sites. Internal transfer dump trucks will utilize the top of the levee, the levee toe road, and bike paths to move material from the staging area to erosion repair sites.

Table 2. Barge Traffic Associated with Erosion Activities.

Activity	Total Number of Trips Modeled	Total Volume of Material Transported
Sacramento Weir and Bypass 2021	28 barge trips	25,000 cubic yards (cy)
Sacramento Weir and Bypass 2023	83 barge trips	75,000 cy
Sacramento River Erosion Contract 1	26 barge trips	23,000 cy
Sacramento River Erosion Contracts 2, 3* and 4	1,101 barge trips	1,000,000 cy

*Volume and trips are per year, there are likely to be 2 years of construction.

Mobilization

Mobilization will take place at each project site. Mobilization may include creation of temporary access roads, if needed; securing the site; and transporting equipment and materials to the site (e.g., clearing and grubbing, and construction of the repair). Access routes to construction sites will be primarily along existing roads, levee crown roads, or unpaved private farm roads. Barges will be used to transport rock to the sites on the Sacramento River. At several sites, a barge crane may be used to transport and stockpile rock and soil to the site.

Staging Areas

Staging areas will be selected so removal of trees and shrubs are minimized. Previously disturbed areas will be preferred. Landside staging areas may frequently be required for stockpiling materials and equipment. Activities that will occur within staging areas will include storing necessary imported materials (e.g., rock, soil); parking, refueling, and servicing of construction equipment; establishing a temporary restroom; and parking construction staff transportation vehicles.

Construction Process, Sequencing, and Equipment

Site Preparation

Vegetation clearing may need to occur for site access and construction purposes. Site preparation may also include the removal of submerged wood and fallen trees within the construction footprint. A turbidity curtain or other Service and NMFS approved minimization measure will be installed prior to any in-water work conducted on the waterside of the levee where there is potential for listed fish. The work limits and staging areas will be fenced (orange construction fencing) to prevent vehicles and equipment from approaching the waterside edge of the existing bank (where applicable), to protect sensitive habitat, and to identify disturbance area limits.

Where necessary, existing vegetation within the work area will be removed during project construction except for trees or shrubs identified and marked for protection prior to construction. Trees within the repair area identified for protection and outside the work limit may require trimming or removal for equipment clearance, excavation, or due to severely undermined tree health. All tree and sensitive plant removal will be documented. The construction site may be cleared of grasses, ground cover, or any other undesirable materials, using mechanized equipment.

Construction Process
Rock or other fill material (eg., sand, soil, cobble) will be placed using a long-arm bucket excavator, barge crane, or other heavy equipment. IWM may be installed, if feasible, near the water surface during time of construction to replace or enhance riverine aquatic habitat to the repair area.

Demobilization, Rehabilitation, and Clean-up

Following construction, all equipment and materials will be removed from the work area and excess materials will be disposed of at appropriate facilities. All areas will be cleaned and cleared of rubbish and left in a safe and suitable condition.

Compensatory Mitigation

A compensatory mitigation proposal is under development by the Corps. It will include success criteria, long-term monitoring, and a reporting schedule.

Elderberry Shrub Transplanting
Sites currently being pursued by the Corps, non-Federal sponsor, and local maintaining agency in coordination with the Sacramento County Parks, include, but are not limited to Rio Americano West and East, Glenn Hall, and Rossmoor. Additional sites are being investigated in anticipation of the full implementation of the proposed project. These sites will be used to transplant elderberry shrubs from erosion protection measures along the lower American River. Table 3 shows the size of the current known elderberry and riparian mitigation sites in the lower American River.

Site Elements
Each site will require temporary access for initial construction and mitigation site establishment activities and permanent access for long-term maintenance. Temporary activities include access to the river or a well for irrigation pump facilities, and a staging area. Site fencing will be determined on a site by site basis. Irrigation will be available for at least the first three years. The elderberry shrubs will be removed using an excavator and transplanted in cluster groups of 3 to 12 shrubs. Maintenance of the sites during the establishment period will include irrigation, removal of non-native vegetation, and mowing.

Erosion Protection On-Site Mitigation
The incorporation of IWM, willow fascines, and plantings is being implemented to replace lost habitat. Entire almond or walnut trees with root balls and canopies may be used as IWM. The IWM will be placed at the waterside edge of the riparian bench and anchored into the quarry stone by the root ball. The fascines are anchored near the winter mean water surface elevation. Plantings will include an appropriate mix of local native riparian trees and shrubs and will occur at appropriate elevations.

Vegetation installation within the sites will be developed in coordination with the Service and NMFS during the design phase. A variety of materials for revegetation and site-enhancement may be used depending on the site-specific conditions. Below is a description of commonly used materials and methods used for revegetation purposes.

The incorporation of IWM functions to replace lost in-stream cover and habitat form construction impacts. Entire trees with root balls and canopies are used as the IWM. The trees shall be anchored into the quarry stone to one half of the tree length. They are placed to be submerged when fish are generally present in the area.

Willow fascines and pole cuttings are also incorporated into the site designs in order to replace lost in-stream cover and habitat due to construction. The fascines are anchored just below the winter mean water surface elevation at 15-foot triangular spacing. Pole cuttings will be planted in rows where the planting bench will terminate at the launchable toe to help stabilize the planting bench soil.

Table 3. Valley Elderberry Longhorn Beetle and Riparian Habitats

Site	Total Site Acreage	Mitigation Acreage	Temporary Work Acreages	Permanent Access Route Acreages	Plantable Acreage
Glenn Hall (RM 4.9 L)	17.28	8.71	1.33	0.83	5.72
Rio American West (RM 10.4 R)	12.88	5.32	1.84	2.24	3.33
Rio American East (RM 11.1 R)	5.67	2.44	0.43	0.52	2.13
Rossmoor West (RM 15.5 L)	43.70	21.61	3.60	0.94	15.88
Rossmoor East (RM 16.4 L)	12.77	6.07	0.86	1.04	4.68

Plant material installation is designed to mitigate for lost riparian habitat post construction. The proposed planting design includes an appropriate mix of local system native riparian trees and shrubs. Plantings will be incorporated into the sites at appropriate elevations to provide successful on-site mitigation.

Large Off-Site Mitigation Sites

The Corps is committed developing a large-scale mitigation site to offset effects to fisheries and riparian habitat along the Sacramento River mainstem. Mitigation on the Sacramento River will be sited between the areas of Verona and Walnut Grove, and preferably south of the I Street Bridge along the Sacramento River to benefit all fish species impacted by the project. Not all mitigation may be able to be done at one site, so the Corps is continuing to pursue habitat creation within the Lower American River in addition to the sites discussed above. The Service and NMFS will be provided the opportunity to serve on the mitigation site technical team to provide input to the site selection and design throughout the design process for the sites. Since these sites are not in design at this time the Corps will reinitiate consultation to address any potential effects not currently covered in this biological opinion.

Operation and Maintenance

Operation and maintenance (O&M) of the levees in the Sacramento area are the responsibility of the local maintaining agencies, including the American River Flood Control District, DWR, and the City of Sacramento. The applicable O&M Manual for the Sacramento area levees is the Standard Operation and Maintenance Manual for the Sacramento Flood Control Project. Typical levee O&M in the Sacramento in the Sacramento area currently includes the following actions:

- Vegetation maintenance up to four times a year by mowing or applying herbicide.
- Control of burrowing rodent activity monthly by baiting with pesticide.
- Slope repair, site-specific and as needed, by re-sloping and compacting.
- Patrol road reconditioning up to once a year by placing, spreading, grading, and compacting aggregate base or substrate.
- Visual inspection at least monthly, by driving on the patrol road on the crown and maintenance roads at the base of the levee.
- Post-construction, groundwater levels will be monitored using the piezometers.

The Corps will work with local maintaining agencies to develop additional maintenance activities necessary for long-term operations and maintenance. This will occur during the preconstruction engineering and design phase of the project. The Corps will evaluate if these maintenance activities will affect any Federally listed species and reinitiate section 7 consultation if there will be adverse effects to listed species. Currently, the Corps only has a project description for activities that will affect valley elderberry longhorn beetle habitat. This is included below.

Following construction, the O&M manual for these reaches will be adjusted to reflect the design deviations and the SWIF plan. Under the adjusted O&M manual, large trees that are protected in place under the design deviation will be allowed to remain on the waterside slopes and additional vegetation will be planted on the planting benches.

Vegetation maintenance includes keeping maintenance roads clear of overhanging branches. Some of the vegetation along the levees includes elderberry shrubs. As part of long-term O&M, elderberry shrubs will be trimmed by the three levee maintenance districts. Table 4 describes the maximum amount of elderberry acreage that will be trimmed each year as a result of O&M. Trimming consists of cutting overhanging branches along the levee slopes on both the landside and waterside. Some shrubs may be located adjacent to the levee with branches hanging over the levee maintenance road. Up to a third of a shrub will be trimmed in a single season. Trimming will occur between November 1 and March 15. Loss of habitat will be offset through the development of a conservation area as described in the conservation measures below. Each year the local maintaining agency will document the amount of valley elderberry longhorn beetle habitat that they have trimmed and report that number to the Corps to ensure compliance with this biological opinion. If the local maintaining agency has a need to exceed the amount of valley elderberry longhorn beetle habitat which needs to be trimmed or affected due to routine maintenance, then they will request the Corps reinitiate consultation on this biological opinion for those actions.

Table 4. O&M by Maintaining Agency

Local Maintaining Agency	Levee Systems Covered	Annual Acreage of Trimmed Elderberry Shrubs*	Total Acreage of Elderberry Shrubs Trimmed over the 50 Year Life of the Project
American River Flood Control District	Lower American River, Arcade Creek, NEMDC	0.5	25
Maintenance Area 9	Sacramento River east levee between Sutterville Road and the Beach Lake Levee	0.2	10
City of Sacramento	Sacramento River East Levee between the confluence of the American River and Sutterville Road	0.1	5

*acreage based on an estimated average shrub of 0.027 acre and no more than 1/3 of a shrub trimmed any given year.

Conservation Measures

Valley Elderberry Longhorn Beetle

- The Corps assumes complete avoidance of the valley elderberry longhorn beetle when a 100-foot (or wider) buffer is established and maintained around elderberry shrubs.

- When work will occur within the 100-foot buffer, a setback of 20 feet from the dripline of each elderberry shrub will be maintained whenever possible.

- During construction activities, all areas to be avoided will be fenced and flagged with as large as a buffer as possible.

- Signs will be erected every 50 feet along the edge of the avoidance area, identifying the area as an environmentally sensitive area.

- A qualified biologist will monitor the work area at appropriate intervals to ensure that all avoidance and minimization measures are implemented. The amount and duration of monitoring will depend on the project and will be coordinated with the Service.

- As feasible, all activities that will occur within 50 meters of an elderberry shrub, will be conducted outside of the flight season of the valley elderberry longhorn beetle (March through July).

- Any damage done to the buffer area will be restored.

- Buffer areas will continue to be protected after construction.

- Erosion control will be implemented, and the affected area will be re-vegetated with appropriate native plants.

- Herbicides will not be used within the dripline of the shrub. Insecticides will not be used within 30 meters (98 feet) of an elderberry shrub. All chemicals will be applied using a backpack sprayer or similar direct application method. Mechanical week removal within the dripline of the shrub will be limited to the season within adults are not active (August through February) and will avoid damaging the elderberry shrubs.

- Dust will be controlled by reducing speed limits to 10 miles per hour on unpaved roads, regularly watering roads, and wetting down soil and rock during grading operations and placement.

- Elderberry shrubs that cannot be avoided and that can be feasibly transplanted without safety concerns or detriment to the surrounding environment will be transplanted to an appropriate riparian area at least 100 feet from construction activities; see the 2017 Framework for further information

- It is estimated that no more than 10 percent of the shrubs will not be transplanted due to water quality or safety of personnel. For shrubs that cannot be transplanted, all stems will be cut at ground level, collected, and distributed among the transplanted shrubs within the valley elderberry longhorn beetle conservation areas.

- Elderberry shrubs will be surveyed prior to construction to ensure that the actual effects match the estimated effects of this biological opinion. If the Corps will affect more valley elderberry longhorn beetle habitat than estimated than they will reinitiate consultation with the Service.

- Elderberry shrubs will be transplanted between November 1 and February 15, when shrubs are dormant.

- The Corps is proposing to compensate for effects to valley elderberry longhorn beetle through creation of compensation sites as described in the Service's 2017 Valley Elderberry Longhorn Beetle Framework and as below. The Corps will compensate at a 3:1 ratio for effects to valley elderberry longhorn beetle habitat. Tables 5 through 8 describe the calculated acreages and compensation.

Table 5. American River Elderberry Shrub Habitat and Compensation

Reach	Acreage/Amount	Compensation Ratio	Compensation Acreage
Subreach 2	2.84 acres elderberry shrubs[1] 8.07 acres associated riparian[2]	3:1	24.21
Subreaches 1, 3, and 4	4.27 acres elderberry shrubs[1] 13.71 acres associated riparian[2]	3:1	41.13

1 – There are about 300 to 400 individual elderberry shrubs
2 – This encompasses the riparian habitat within 25 meters of the elderberry shrubs

Table 6. Sacramento River Bank Stabilization Elderberry Shrub Habitat and Compensation

Acreage	Compensation Ratio	Compensation Acreage
0.12 acre elderberry shrubs[1] 2.69 acres associated riparian[2]	3:1	8.43

1 – There are about 300 to 400 individual elderberry shrubs
2 – This encompasses the riparian habitat within 25 meters of the elderberry shrubs

Table 7. Sacramento River Seepage and Stability Elderberry Shrub Habitat and Compensation

Number of Isolated[1] Elderberry Shrubs	Compensation Ratio	Compensation Credits/Acreage
40	2:1	80/3.31

1 – Given the linear nature of the work and the narrow width of the riparian habitat elderberry shrubs in this portion of the project will be compensated by a 2:1 ratio based on the number of shrubs that will be transplanted.

Table 8. Sacramento Weir Elderberry Shrub Habitat and Compensation

Acreage	Compensation Ratio	Compensation Acreage
0.69 acre elderberry shrubs[1] 2.05 acres associated riparian[2]	3:1	8.22

1 – There are about 300 to 400 individual elderberry shrubs
2 – This encompasses the riparian habitat within 25 meters of the elderberry shrubs

- If possible, elderberry shrubs would be transplanted during their dormant season (November through the first two weeks in February). If transplantation occurs during the growing season, increased mitigation will apply.

- The Corps is developing conservation areas to offset the transplantation, and loss of valley elderberry longhorn beetle habitat. Sites are being developed in the Lower

American River and at the Beach Lakes Conservation Area along Morrison Creek. The Corps will find areas within the lower American River parkway which will either expand existing compensation areas or provide for connectivity between conserved valley elderberry longhorn beetle habitat areas. Sites within the lower American River parkway will be coordinated with Sacramento County Parks and the Service during the design phase of the project. Sites will be designed and developed prior to any effects to valley elderberry longhorn beetle habitat. The Corps will create 19.96 acres of riparian habitat which supports valley elderberry longhorn beetle within the lower American River parkway for the transplantation of elderberry shrubs. In addition, the local sponsors will create an additional 40 acres of land to benefit the valley elderberry longhorn beetle or purchase 40 acres of credits at a Service approved conservation bank to offset the loss of habitat due to trimming of elderberry shrubs along the lower American River, Sacramento River, Dry/Robla Creeks, Arcade Creek, Magpie Creek, and NEMDC. If off-site compensation cannot be identified a portion of the compensation can purchase credits at a valley elderberry longhorn beetle conservation bank.

- Management of these lands will include all measures specified in the Service's Framework (2017) related to weed and litter control, fencing, and the placement of signs.

Giant Garter Snake

- Unless approved otherwise by the Service, construction will be initiated only during the giant garter snakes' active period (May 1–October 1, when they are able to move away from disturbance).

- Construction personnel will be given a Service-approved worker environmental awareness program.

- A survey for giant garter snakes will be conducted within 24 hours prior to construction beginning in potential giant garter snake habitat. Should there be any interruption in work for greater than 2 weeks, a biologist will resurvey the area within 24 hours prior to the restart of construction.

- Giant garter snakes encountered during construction will be allowed to move away from construction activities on their own.

- Movement of heavy equipment to and from the construction site will be restricted to established roadways. Stockpiling of construction materials will be restricted to designated staging areas, which will be located more than 200 feet away from giant garter snake aquatic habitat.

- Giant garter snake habitat within 200 feet of construction activities will be designated as an environmentally sensitive area and delineated with signs or fencing. This area will be avoided by all construction personnel.

- Habitat temporarily affected for one season (the 5.5 acre borrow site along the NEMDC and the 3.1 acres of aquatic and 32.7 acres of upland habitat associated with the fish passage channel located between the south Cross Canal and Tule Canal along the landside of the existing Sacramento Bypass North Levee) will be restored after construction by applying appropriate erosion control techniques and replanting/seeding with appropriate native plants and one year of monitoring. If for any reason the construction season in giant garter snake habitat extends into an additional active season, the Corps will replace the habitat on-site and purchase credits at a ratio of 1:1 at a Service-approved conservation bank in advance of the second construction season in suitable habitat.

- Habitat temporarily affected for more than three or more seasons will be restored and twice as much habitat will be created.

- Habitat permanently affected in the Sacramento Bypass in the form of 0.3 acre of drainage ditches and irrigation canals and 2.3 acres of surrounding upland habitat will be offset through the creation of the Bypass Transport Channel, which will create 6.7 acres of aquatic habitat.

- A biological monitor will be on-site during all ground disturbing activities at borrow site 2.

- Exclusionary fencing will be placed at least 10 days prior to the beginning of ground disturbing activities after May 1, to exclude giant garter snakes from entering areas where upland disturbance (borrow site 2) will occur during the active season (May 1 to October 1). Prior to fencing installation, the fence line will be mowed (with a minimum height of 6 inches) in order to conduct a surface survey of potential burrows. Fencing will be installed with a minimum of 6 inches buried in the ground and a minimum of 24 inches above ground. Fence staking will be installed on the inside of the exclusion area. One-way escape funnels will be installed every 50 to 100 feet and sealed along the fence line to provide an escape for any giant garter snake that may be within the exclusion area. The fencing will enclose the entirety of the site, or additional exclusionary fencing can be extended 200 to 400 feet beyond the proposed entrance area. The fencing will be inspected before the start of each workday and maintained by the contractor until completion of the project. The fencing will be removed only when project activities are completed.

Yellow-Billed Cuckoo

- Prior to construction, a Service-approved biologist shall conduct nesting bird surveys to determine the presence of nesting birds, including the yellow-billed cuckoo. If cuckoos are located the Service will be contacted to establish appropriate buffers. Surveys will be repeated if construction stops for a period of two weeks or longer.

- All vegetation removal shall occur between October 1 and March 1 outside of the cuckoo nesting season.

- Loss of riparian habitat that can serve as migratory stopover habitat for the yellow-billed cuckoo will be offset at a 2:1 ratio.

- Riparian habitat that is removed due to project construction will be mitigated within the American River parkway and at the Beach Stone Lakes compensation site. The Corps intends to expand existing conserved riparian lands within the parkway that could support the yellow-billed cuckoo. The design of replacement riparian areas will be coordinated with the Service to ensure that the habitat benefits both the valley elderberry longhorn beetles and yellow-billed cuckoo.

<u>Delta Smelt</u>

- The Corps is proposing to work outside of the delta smelt work window. In-water construction activities (e.g., placement of rock revetment) will be limited to the work window of July 1 through November 30.

- The Corps will purchase 90 acres of delta smelt credits from a Service-approved conservation bank or through the creation of a mitigation site to compensate for the loss of up to 30 acres of shallow water habitat due to the placement of riprap along the river bed and bank. If the Corps creates a compensation site instead of purchasing credits at a conservation bank, the site will be constructed and planted prior to the end of the construction of the Sacramento River sites.

- The Corps will create on-site mitigation in the form of riparian or wetland benches in the shallow water habitat zone. These sites will be developed in coordination with the Service and NMFS.

- The Corps will develop and implement a compensatory mitigation accounting plan to ensure the tracking of compensatory measures associated with the implementation of the proposed project.

- Erosion control measures (BMPs), including Storm Water Pollution Prevention Program and Water Pollution Control Program, that minimize soil or sediment from entering the river shall be installed, monitored for effectiveness, and maintained throughout construction operations to minimize effects to federally listed fish and their designated critical habitat.

- Screen any water pump intakes, as specified by NMFS and the Service screening specifications. Water pumps will maintain an approach velocity of 0.2 feet per second or less when working in areas that may support delta smelt.

- Minimize the removal of existing vegetation during project-related activities.

- The Corps shall include as part of the project, a Riparian Corridor Improvement Plan with the overall goal of maximizing the ecological function and value of the existing levee system within the Sacramento Metropolitan area.

<u>Additional Conservation Measures</u>

- A qualified biologist will provide training for all contractors, work crews, and any onsite personnel on the status of the valley elderberry longhorn beetle, delta smelt, giant garter snake, and yellow-billed cuckoo, their habitats, the need to follow conservation measures, and the possible penalties for not complying with these requirements.

- The Corps will go through the design deviation process to limit vegetation removal prior to final design and construction phase for any contract.

- The Corps will include as part of the project, a Riparian Corridor Improvement Plan with the overall goal of maximizing the ecological function and value of riparian habitat within the existing levee system in the Sacramento Metropolitan area.

- Engineering designs will be modified to avoid potential direct and indirect effects.

- The Corps will include the Service and NMFS during the design of project components, including mitigation sites. This will include soliciting input and comments on designs and plans.

- The Corps will develop and implement a compensatory mitigation accounting plan to ensure the tracking of compensatory measures. The Corps will continue to coordinate with the Service during all phases of construction, implementation, and monitoring by hosting meetings. Additionally, prior to beginning construction, the Corps will provide a brief project description and describe the acres of listed species habitat effected and the amount of compensation for that contract that is being proposed.

- The Corps will develop, in conjunction with the Service and NMFS, interim management plans for mitigation sites. These will include performance standards that will be met. The Corps, in conjunction with the Service, NMFS, and the future maintainer, will develop long-term management plans for any mitigation that is developed as part of the project. Monitoring will occur for 8 consecutive years or as determined through the long-term management plan planning process. Annual monitoring reports will be submitted to the Service.

- Compensation areas will be protected in perpetuity and have a funding source for maintenance (endowment).

- Site access will be limited to the smallest area possible in order to minimize disturbance. Litter, debris, unused materials, equipment, and supplies will be removed from the project area daily. Such materials or waste will be deposited at an appropriate disposal or storage site.

- Designating a qualified biologist as a point-of-contact for any contractor who might incidentally take a living, or find a dead, injured, or entrapped threatened or endangered species. This representative shall be identified to the employees and contractors during an all employee education program conducted by the Corps. They shall have knowledge of the listed species that are discussed in this biological opinion.

- The Corps will provide an analysis of the launchable toe and buried rock trench, which shall evaluate the likelihood of the toe and trench launching. This analysis will also include the long-term durability of habitat which is established on the planting bench and the rock footprint of the launched buried rock trench. This analysis will be done by December 31, 2021. If long-term durability of the planting benches is diminished and the habitat will not be viable in perpetuity, then the Corps will work with the Service to offset effects to listed species due to this design feature.

- Stockpile all liquid chemicals and supplies at a designated impermeable membrane fuel and refueling station with a 100% containment system.

- Stockpile construction materials such as portable equipment, vehicles, and supplies, at designated construction staging areas and barges, exclusive of any riparian and wetland areas.

- Implement BMPs to prevent slurry from seeping out to the river and require piping systems on the landside of the levee.

- Immediately (within 24 hours) cleanup and report any spills of hazardous materials to the resource agencies. Any such spills, and the success of the efforts to clean them up, shall also be reported in post-construction compliance reports.

Action Area

The action area is defined in 50 CFR § 402.02, as "all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action." For the proposed project, the action area encompasses the Sacramento River from the Sacramento Bypass downstream to River Mile 45, the lower American River from Arden Way to the confluence of the Sacramento River, Arcade Creek from Marysville Boulevard to the confluence of the NEMDC, the NEMDC from the south Dry Creek levee to just south of the NEMDC Arcade Creek confluence, the southern Dry Creek levee between Dry Creek Road and Rose Street, the borrow site along the NEMDC, and any borrow sites. Additionally, we are including a buffer of 300 feet from construction to account for effects to listed species due to dust and noise.

Analytical Framework for the Jeopardy Determination

Section 7(a)(2) of the Act requires that federal agencies ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of listed species. "Jeopardize the continued existence of" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR § 402.02).

The jeopardy analysis in this biological opinion considers the effects of the proposed federal action, and any cumulative effects, on the range wide survival and recovery of the listed species. It relies on four components: (1) the *Status of the Species*, which describes the current range wide condition of the species, the factors responsible for that condition, and its survival and recovery needs; (2) the *Environmental Baseline*, which analyzes the current condition of the species in the action area without the consequences to the listed species caused by the proposed action, the factors responsible for that condition, and the relationship of the action area to the survival and recovery of the species; (3) the *Effects of the Action*, which determines all consequences to listed species that are caused by the proposed federal action; and (4) the *Cumulative Effects*, which evaluates the effects of future, non-federal activities in the action area on the species. The *Effects of the Action* and *Cumulative Effects* are added to the *Environmental Baseline* and in light of the status of the species, the Service formulates its opinion as to whether the proposed action is likely to jeopardize the continued existence of the listed species.

Analytical Framework for the Adverse Modification Determination

Section 7(a)(2) of the Act requires that federal agencies ensure that any action they authorize, fund, or carry out is not likely to destroy or to adversely modify designated critical habitat. A final rule revising the regulatory definition of "destruction or adverse modification" (DAM) was published on August 27, 2019 (84 FR 44976). The final rule became effective on October 28, 2019. The revised definition states:

> "*Destruction or adverse modification* means a direct or indirect alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species."

The DAM analysis in this biological opinion relies on four components: (1) the *Status of Critical Habitat*, which describes the current range wide condition of the critical habitat in terms of the key components (i.e., essential habitat features, primary constituent elements, or physical and biological features) that provide for the conservation of the listed species, the factors responsible for that condition, and the intended value of the critical habitat overall for the conservation/recovery of the listed species; (2) the *Environmental Baseline*, which analyzes the current condition of the critical habitat in the action area without the consequences to designated critical habitat caused by the proposed action, the factors responsible for that condition, and the value of the critical habitat in the action area for the conservation/recovery of the listed species; (3) the *Effects of the Action*, which determines all consequences to designated critical habitat that are caused by the proposed federal action on the key components of critical habitat that provide for the conservation of the listed species, and how those impacts are likely to influence the conservation value of the affected critical habitat; and (4) *Cumulative Effects*, which evaluate the effects of future non-federal activities that are reasonably certain to occur in the action area on the key components of critical habitat that provide for the conservation of the listed species and how those impacts are likely to influence the conservation value of the affected critical habitat. The *Effects of the Action* and *Cumulative Effects* are added to the *Environmental Baseline* and considering the status of critical habitat, the Service formulates its opinion as to whether the action is likely to destroy or adversely modify designated critical habitat. The Service's opinion evaluates whether the action is likely to impair or preclude the capacity of critical habitat in the action area to serve its intended conservation function to an extent that appreciably diminishes the range wide value of critical habitat for the conservation of the listed species. The key to making that finding is understanding the value (i.e., the role) of the critical habitat in the action area for the conservation/recovery of the listed species based on the *Environmental Baseline* analysis.

Status of the Species

Valley Elderberry Longhorn Beetle

For the most recent comprehensive assessment of the species' range wide status please refer to the *Withdrawal of the Proposed Rule to Remove the Valley Elderberry Longhorn Beetle from the Federal List of Endangered and Threatened Wildlife* (Service 2014a). Threats discussed in the final document have continued to act on the species, with the loss of habitat being the most significant effect. While there have been continued losses of beetle habitat throughout the various recovery units, including the Sacramento River and Putah Creek Management Units identified in the *Revised Recovery Plan for the Valley Elderberry Longhorn Beetle (Desmocerus californicus dimorphus)* (VELB Recovery Plan) (Service 2019), to date no project has proposed a level of effect for which the Service has issued a biological opinion of jeopardy for the valley elderberry longhorn beetle. The Service is currently working on a 5-year review for this species.

Delta Smelt

<u>Species Legal Status and Life Cycle Summary</u>
The Service proposed to list the delta smelt as threatened with proposed critical habitat on October 3, 1991 (Service 1991). The Service listed the delta smelt as threatened on March 5, 1993 (Service 1993), and designated critical habitat for the species on December 19, 1994 (Service 1994). The delta smelt was one of eight fish species addressed in the *Recovery Plan for the Sacramento–San Joaquin Delta Native Fishes* (Service 1996). A 5-year status review of the delta smelt was completed on March 31, 2004 (Service 2004). The review concluded that delta

smelt remained a threatened species. A subsequent 5-year status review recommended uplisting delta smelt from threatened to endangered (Service 2010a). A 12-month finding on a petition to reclassify the delta smelt as an endangered species was completed on April 7, 2010 (Service 2010b). After reviewing all available scientific and commercial information, the Service determined that re-classifying the delta smelt from a threatened to an endangered species was warranted but precluded by other higher priority listing actions (Service 2010c). The Service reviews the status and uplisting recommendation for delta smelt during its Candidate Notice of Review (CNOR) process. Each year it has been published, the CNOR has recommended the uplisting from threatened to endangered. Electronic copies of these documents are available at https://ecos.fws.gov/ecp0/profile/speciesProfile?sId=321.

The delta smelt is a small fish of the family Osmeridae. In the wild, very few individuals reach lengths over 3.5 inches (90 mm; Damon *et al.* 2016). At the time of its listing, only the basics of the species' life history were known (Moyle *et al.* 1992). In the intervening 26 years, it has become one of the most studied fishes in the United States. Enough has been learned about the delta smelt to support its propagation in captivity over multiple generations (Lindberg *et al.* 2013), to support the development of complex conceptual models of the species life history (Interagency Ecological Program (IEP) 2015), and mathematical simulation models of its life cycle (Rose *et al.* 2013a). Any synthesis of the now extensive literature on the delta smelt requires drawing conclusions across studies that had disparate objectives, but several syntheses have been compiled from existing information (Moyle *et al.* 1992; Bennett 2005; IEP 2015; Moyle *et al.* 2016). In this biological opinion, the Service relied on these previous syntheses where it remains appropriate to do so. We also relied on source study results and analyses of our own to synthesize across a rapidly growing body of scientific information.

The delta smelt has a fairly simple life history because a large majority of individuals live only one year (Bennett 2005; Moyle *et al.* 2016) and because it is an endemic species (Moyle 2002), comprising only one genetic population (Fisch *et al.* 2011), that completes its full life cycle in the northern reaches of the San Francisco Bay-Delta (Merz *et al.* 2011; Figure 1). The schematic of this simple life cycle developed by Moyle *et al.* (2016) and published again by Moyle *et al.* (2018) is shown in Figure 2. Most spawning occurs from February through May in various places from the Napa River and locations to the east including much of the Sacramento-San Joaquin Delta. Larvae hatch and enter the plankton primarily from March through May, and most individuals have metamorphosed into the juvenile life stage by June or early July. Most of the juvenile fish continue to rear in habitats from Suisun Bay and marsh and locations east principally along the Sacramento River-Cache Slough corridor (recently dubbed the 'North Delta Arc'; Moyle *et al.* 2010). The juvenile fish (or 'sub-adults') begin to develop into maturing adults in the late fall. Thereafter, the population spatial distribution expands with the onset of early winter storms and the first individuals begin to reach sexual maturity by January in some years, but most often in February (Damon *et al.* 2016; Kurobe *et al.* 2016). Delta smelt do not reach sexual maturity until they grow to at least 55 mm in length (~ 2 inches) and 50% of individuals are sexually mature at 60 to 65 mm in length (Rose *et al.* 2013b). In captivity delta smelt can survive to spawn at two years of age (Lindberg *et al.* 2013), but this appears to be rare in the wild (Bennett 2005; Damon *et al.* 2016; Figure 2). The spawning microhabitats of the delta smelt are unknown, but based on adult distribution data (Damon *et al.* 2016; Polansky *et al.* 2018) and the evaluation of otolith microchemistry (Hobbs *et al.* 2007a; Bush 2017), most delta smelt spawn in freshwater to slightly brackish-water habitats under tidal influence. Most individuals die after spawning, but as is typical for annual fishes, when conditions allow, some individuals can spawn more than once during their single spawning season (Damon *et al.* 2016). In a recent study spanning 2 to 3 months, captive males held at a constant water temperature of

12°C (54°F) spawned an average of 2.8 times and females spawned an average of 1.7 times (LaCava *et al.* 2015).

Figure 1. Delta smelt range map. Waterways colored in purple depict the delta smelt distribution described by Merz *et al.* (2011). The Service has used newer information to expand the transient range of delta smelt further up the Napa and Sacramento rivers than indicated by Merz *et al.* (2011). The red polygon depicts the boundary of delta smelt's designated critical habitat. The inset map shows the region known as the North Delta Arc shaded light green.

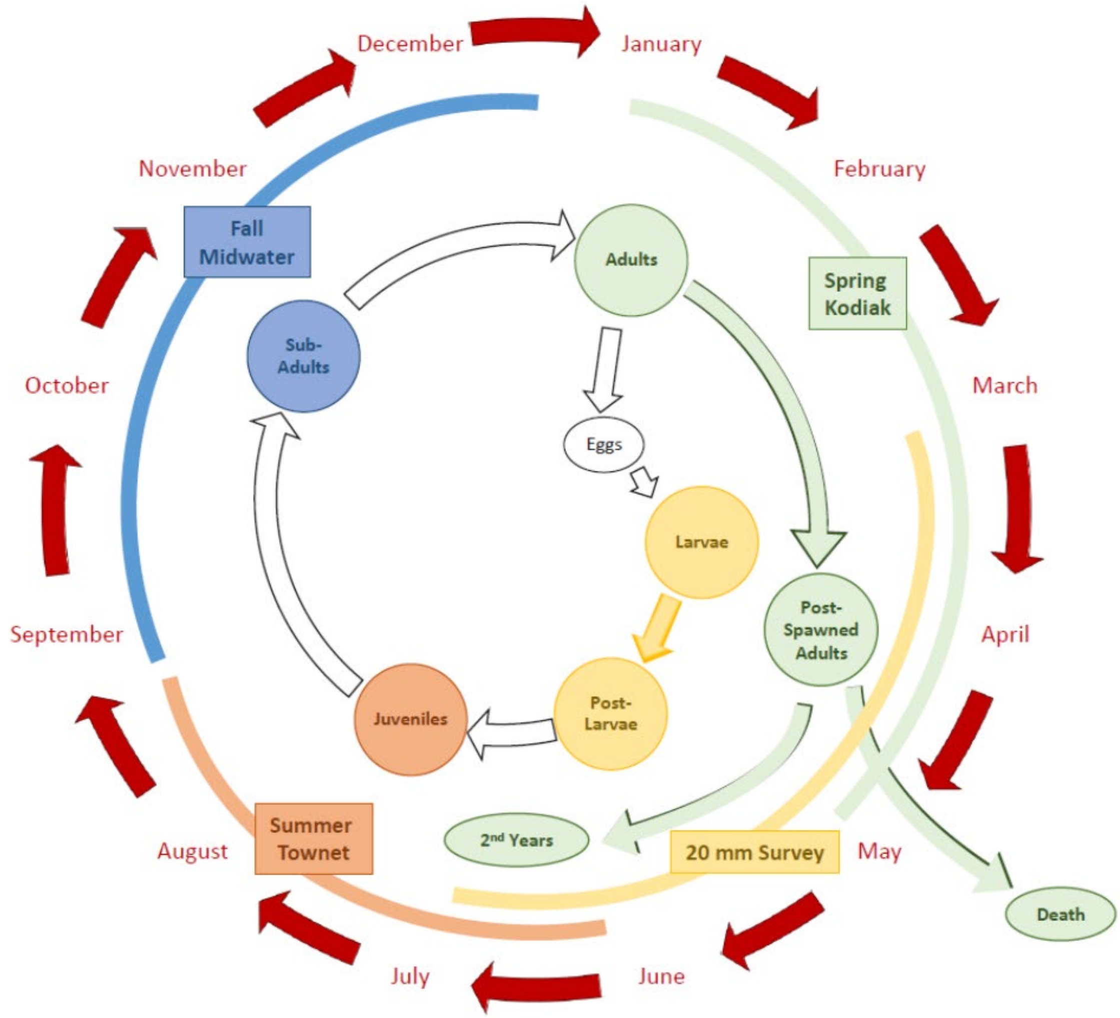

Figure 2. Schematic representation of the delta smelt life cycle. This conceptual model crosswalks delta smelt life stages with calendar months and current monitoring programs (prior to Enhanced Delta Smelt Monitoring) used to evaluate the species' status. Source: Moyle *et al.* 2016

<u>Detailed Review of the Reproductive Biology of Delta Smelt</u>

Delta smelt spawn in the estuary and have one spawning season for each generation, which makes the timing and duration of the spawning season important every year. Delta smelt are believed to spawn in fresh and low-salinity water (Hobbs *et al.* 2007a; Bush 2017). Therefore, freshwater flow affects how much of the estuary is available for delta smelt to spawn (Hobbs *et al.* 2007a). This is one mechanism in which interannual variation in Delta outflow could play a role in the population dynamics of delta smelt. Given the timing of delta smelt reproduction, Delta outflow during February through May would be most important for this mechanism. During this time of year, variation in Delta outflow is largely driven by weather variation and regulated by the California State Water Resources Control Board (SWRCB) Decision-1641 (D-1641).

The locations of delta smelt spawning are thought to be influenced by salinity (Hobbs *et al.* 2007a), but the duration of the spawning season is thought to be driven mainly by water temperature (Bennett 2005; Damon *et al.* 2016), which is largely a function of regional air temperature (Wagner *et al.* 2011). Thus, the spawning season duration does not appear to be a freshwater flow mechanism, but rather, a climate-driven mechanism (Brown *et al.* 2016a). Delta smelt can start spawning when water temperatures reach about 10°C (50°F) and can continue until temperatures reach about 20°C (68°F; Bennett 2005; Damon *et al.* 2016). The ideal spawning condition occurs when water temperatures remain between 10°C and 20°C throughout February through May. Few delta smelt ≤ 55 mm in length are sexually mature and 50% of delta smelt reach sexual maturity at 60 to 65 mm in length (Rose *et al.* 2013b). During January and February, many delta smelt are still smaller than these size thresholds (Damon *et al.* 2016). Thus, if water temperatures rise much above 10°C in January, the "spawning season" can start before many individuals are mature enough to actually spawn. If temperatures continue to warm rapidly toward 20°C in early spring, that can end the spawning season with only a small fraction of 'adult' fish having had an opportunity to spawn, and perhaps only one opportunity to do so. Delta smelt were initially believed to spawn only once before dying (Moyle *et al.* 1992). It has since been confirmed that delta smelt can spawn more than once if water temperatures remain suitable for a long enough time, and if the adults find enough food to support the production of another batch of eggs (Lindberg *et al.* 2013; Damon *et al.* 2016; Kurobe *et al.* 2016). In a recent study spanning 2 to 3 months, captive males held at a constant water temperature of 12°C (54°F) spawned an average of 2.8 times and females spawned an average of 1.7 times (LaCava *et al.* 2015). As a result, the longer water temperatures remain cool, the more fish have time to mature and the more times individual fish can spawn. Most adults disappear from monitoring programs by May, suggesting they have died (Damon *et al.* 2016; Polansky *et al.* 2018).

The reproductive behavior of delta smelt is only known from captive specimens spawned in artificial environments and most of the information has never been published, but is currently being revisited in new research. Spawning likely occurs mainly at night with several males attending a female that broadcasts her eggs onto bottom substrate (Bennett 2005). Although preferred spawning substrate is unknown, spawning habits of delta smelt's closest relative, the Surf smelt (*Hypomesus pretiosus*), are sand or small gravel (Hirose and Kawaguchi 1998; Quinn *et al.* 2012).

The duration of the egg stage is temperature-dependent and averages about 10 days before the embryos hatch into larvae (Bennett 2005). It takes the fish about 30-70 days to reach 20-mm in length (Bennett 2005; Hobbs *et al.* 2007b). Similarly, Rose *et al.* (2013b) estimated that it takes delta smelt an average of slightly over 60 days to reach the juvenile life stage. Metamorphosing "post-larvae" appear in monitoring surveys from April into July of most years. By July, most delta smelt have reached the juvenile life stage. Thus, subtracting 60 days from April and July indicates that most spawning occurs from February-May.

Hatching success is highest at temperatures of 15-16°C (59-61°F) and lower at cooler and warmer temperatures and hatching success nears zero percent as water temperatures exceed 20°C (Bennett 2005). Water temperatures suitable for spawning occur most frequently during the months of February-May, but ripe female delta smelt have been observed as early as January and larvae have been collected as late as July, suggesting that spawning itself may extend into June in years with exceptionally cool spring weather.

<u>Detailed Review of the Habitat Use and Distribution of Delta Smelt</u>

Because the delta smelt only lives in one part of one comprehensively monitored estuary, its general distribution and habitat use are well understood (Moyle et al. 1992; Bennett 2005; Hobbs et al. 2006; 2007b; Feyrer et al. 2007; Nobriga et al. 2008; Kimmerer et al. 2009; Merz et al. 2011; Murphy and Hamilton 2013; Sommer and Mejia 2013; Mahardja et al. 2017a; Simonis and

Merz 2019). The delta smelt has been characterized as a semi-anadromous species (Bennett 2005; Hammock et al. 2017) and Sommer et al. (2011) characterized the species as a partial diadromous migrant, recognizing individual variation in its life-history. However, both terms emphasize a life cycle in which delta smelt spawn in freshwater and volitionally move ‘downstream’ into brackish water habitat, which is only one endpoint among several individual life cycle strategies that have recently been confirmed through the use of otolith microchemical analyses (Bush 2017). In addition, semi-anadromy and partial diadromy are scale-dependent terms which have caused confusion among researchers and managers alike. For instance, some individual delta smelt clearly migrate between fresh and brackish water during their lives (Bush 2017). Other individuals could appear to have done so based on otolith microchemistry but in reality have moved very little and simply experienced annual salinity variation, which can be very high in much of the range of delta smelt (see Hammock et al. 2019). Other individual delta smelt are clearly freshwater and brackish-water resident throughout their lives (Bush 2017). As a result, there are both location-based (e.g., Sacramento River around Decker Island) and conditions-based (low-salinity zone) habitats that delta smelt permanently occupy. There are habitats that some delta smelt occupy seasonally (*e.g.*, for spawning), and there are habitats that a few delta smelt occupy transiently, which we define here as occasional use. Transient habitats include distribution extremes from which delta smelt have occasionally been collected, but were not historically collected every year or even in most years. Thus, the Service suggests the delta smelt may be best characterized as an upper estuary resident species with a population-scale distribution that expands and contracts as freshwater flow seasonally (and interannually) decreases and increases, respectively. This influence of freshwater flow inputs on delta smelt distribution could in turn influence mechanisms that affect the species’ population dynamics when those mechanisms are linked to where the fish reside or how they are distributed in the estuary. We note that water temperature, turbidity, water diversion rates, prey availability, and possibly other factors would also affect these spatial recruitment and survival mechanisms.

Delta smelt have been observed as far west as San Francisco Bay near the City of Berkeley, as far north as Knight’s Landing on the Sacramento River, as far east as Woodbridge on the Mokelumne River and Stockton on the Calaveras River, and as far south as Mossdale on the San Joaquin River (Merz *et al.* 2011; Figure 1). These extremes of the species’ distribution extend beyond the geographic boundaries specified in the critical habitat rule. However, most delta smelt have been collected from locations within the critical habitat boundaries. In other words, observations of delta smelt outside of the critical habitat boundaries reflect transient habitat use rather than permanent or seasonal habitat use. The Napa River is the only location outside of the critical habitat boundaries that may be used often enough to be considered a seasonal habitat rather than a transient one.

The fixed-location habitats that delta smelt permanently occupy span from the Cache Slough complex down into Suisun Bay and Suisun Marsh (Figure 3). The reasons delta smelt are believed to permanently occupy this part of the estuary are the presence of fresh- to low-salinity water year-round that is comparatively turbid and of a tolerable water temperature. These appropriate water quality conditions overlap an underwater landscape featuring variation in depth, tidal current velocities, edge habitats, and food production (Nobriga *et al.* 2008; Feyrer *et al.* 2011; Murphy and Hamilton 2013; Sommer and Mejia 2013; Hammock *et al.* 2015; 2017; 2019; Bever *et al.* 2016; Mahardja *et al.* 2019; Simonis and Merz 2019). Field observations are increasingly being supported by laboratory research that explains how delta smelt respond physiologically and behaviorally to variation in water quality that can vary with changes in climate, freshwater flow and estuarine bathymetry (e.g., Hasenbein *et al.* 2013; 2016b; Komoroske *et al.* 2014; 2016).

The principal variable-location habitat that delta smelt permanently occupy is the low-salinity zone (LSZ) (Moyle *et al.* 1992; Bennett 2005). The LSZ is a dynamic habitat with size and location that respond to changes in tidal and river flows (Jassby *et al.* 1995; Kimmerer *et al.* 2013; MacWilliams *et al.* 2015; 2016; Bever *et al.* 2016). The LSZ generally expands and moves downstream as river flows into the estuary increase, placing low-salinity water over a larger and more diverse set of nominal habitat types than occurs under lower flow conditions. As river flows decrease, the LSZ contracts and moves upstream. This is perhaps the most frequently assumed freshwater flow mechanism in discussions about X2 regulations, but as shown by Kimmerer *et al.* (2009; 2013), it does not appear to be a major explanatory mechanism for most fishes including the delta smelt.

The LSZ often encompasses many of the permanently occupied fixed locations discussed above. It is treated separately here because delta smelt distribution tracks the movement of the LSZ somewhat (Moyle *et al.* 1992; Dege and Brown 2004; Feyrer *et al.* 2007; 2011; Nobriga *et al.* 2008; Sommer *et al.* 2011; Bever *et al.* 2016; Manly *et al.* 2015; Polansky *et al.* 2018; Simonis and Merz 2019). Due to its historical importance as a fish nursery habitat, there is a long research history into the physics and biology of the LSZ. The LSZ is frequently defined as waters with a salinity range of about 0.5 to 6 ppt (Kimmerer 2004). This and similar salinity ranges reported by different authors were chosen based on analyses of historical peaks in chlorophyll concentration and zooplankton abundance. Most delta smelt collected in California Department of Fish and Wildlife's (CDFW) 20-mm Survey and Summer Townet Survey (TNS) have been collected at salinities of near 0 ppt to 2 ppt and most of the (older) delta smelt in the Fall Midwater Trawl (FMWT) have been collected from a salinity range of about 1 to 5 ppt (Kimmerer *et al.* 2013). These fish of different life stages do not tend to be in dramatically different places (Murphy and Hamilton 2013; Figure 3), suggesting that some of the change in occupied salinity with age is due to the seasonal increases in salinity that accompany lower outflow in the summer and fall.

Each year, the distribution of delta smelt seasonally expands when adults disperse in response to winter flow increases that also coincide with seasonal increases in turbidity and decreases in water temperature (Sommer *et al.* 2011; Figure 3). The annual range expansion of adult delta smelt extends up the Sacramento River to about Garcia Bend in the Pocket neighborhood of Sacramento, up the San Joaquin River from Antioch to areas near Stockton, up the lower Mokelumne River system, and west throughout Suisun Bay and the larger sloughs of Suisun Marsh. Some delta smelt seasonally and transiently occupy Old and Middle rivers in the south Delta each year, but face a high risk of entrainment when they do (Kimmerer 2008; Grimaldo *et al.* 2009). The expanded adult distribution initially affects the distribution of the next generation because delta smelt eggs are adhesive and not believed to be highly mobile once they are spawned (Mager *et al.* 2004). Thus, the distribution of larvae reflects a combination of where spawning occurred and freshwater flow when the eggs hatch.

In summary, the delta smelt population spreads out in the winter and then retracts by summer into what is presently a bi-modal spatial distribution with a peak in the LSZ and a separate peak in the Cache Slough complex. Most individuals occur in the LSZ at some point in their life cycle and the use of the Cache Slough complex diminishes in years with warm summers (Bush 2017).

Microhabitat Use: The delta smelt has been historically characterized as a pelagic fish, meaning one with a spatial distribution that is skewed away from shorelines (Moyle *et al.* 1992; Sommer *et al.* 2007). This has led to some confusion among researchers and managers alike – usually perpetuating a strawman argument that delta smelt either occupy deep-water habitats or shallow-water habitats. Then, catch data from shallow habitats get used to refute the pelagic characterization, but catches in shallow-water say nothing more about a pelagic tendency than catches in deep water would say about a nearshore habitat tendency. The long-term monitoring programs used to characterize delta smelt status and trend are offshore sampling programs – meaning pelagic sampling programs, and surface-trawling appears to be particularly effective at capturing delta smelt away from shorelines (Mitchell *et al.* 2017). However, numerous studies have reported collecting delta smelt from nearshore environments using fishing gear like beach seines and fyke nets from locations that often had a water depth less than or equal to 1 meter (just over three feet) (e.g., Matern *et al.* 2002; Nobriga *et al.* 2005; Gewant and Bollens 2012; Mahardja *et al.* 2017b). Further, it has been established that onshore-offshore movements are one behavior option delta smelt and other fishes can use to maintain position or move upstream in a tidal-flow influenced estuary (Bennett *et al.* 2002; Feyrer *et al.* 2013; Bennett and Burau 2015). Captive delta smelt have been shown to avoid in-water structure like submerged aquatic vegetation (SAV) (Ferrari *et al.* 2014). SAV tends to grow where tidal current velocities are low, which is a habitat attribute that has also been associated with wild delta smelt (Hobbs *et al.* 2006; Bever *et al.* 2016). Thus, the proliferation of SAV in areas that might otherwise be attractive to delta smelt represents a significant habitat degradation, not only because it creates structure in the water column, but also because it is associated with higher water transparency (Hestir *et al.* 2016), and a fish fauna that delta smelt does not seem to be able to coexist with (Nobriga *et al.* 2005; Conrad *et al.* 2016). Based on our review, the Service suggests that the characterization of delta smelt as an open-water fish appears to be accurate and does not imply occupation of a particular water column depth. The species does appear to have some affinity for surface waters (Bennett and Burau 2015; Mitchell *et al.* 2017), but like any microhabitat descriptor, this is not intended to reflect the location of all individuals because delta smelt are not limited to surface waters (Feyrer *et al.* 2013).

Although the delta smelt is generally an open-water fish, depth variation of open-water habitats is an important habitat attribute (Moyle *et al.* 1992; Hobbs *et al.* 2006; Bever *et al.* 2016). In the wild, delta smelt are most frequently collected in water that is somewhat shallow (4-15 ft deep) where turbidity is often elevated and tidal currents exist, but are not excessive (Moyle *et al.* 1992; Bever *et al.* 2016). For instance, in Suisun Bay, the deep shipping channels are poor quality habitat because tidal velocity is very high (Hobbs *et al*. 2006; Bever *et al.* 2016), but in the Delta where tidal velocity is slower, offshore habitat in Cache Slough and the Sacramento Deepwater Shipping Channel is used to a greater extent (Feyrer *et al.* 2013; CDFW unpublished data).

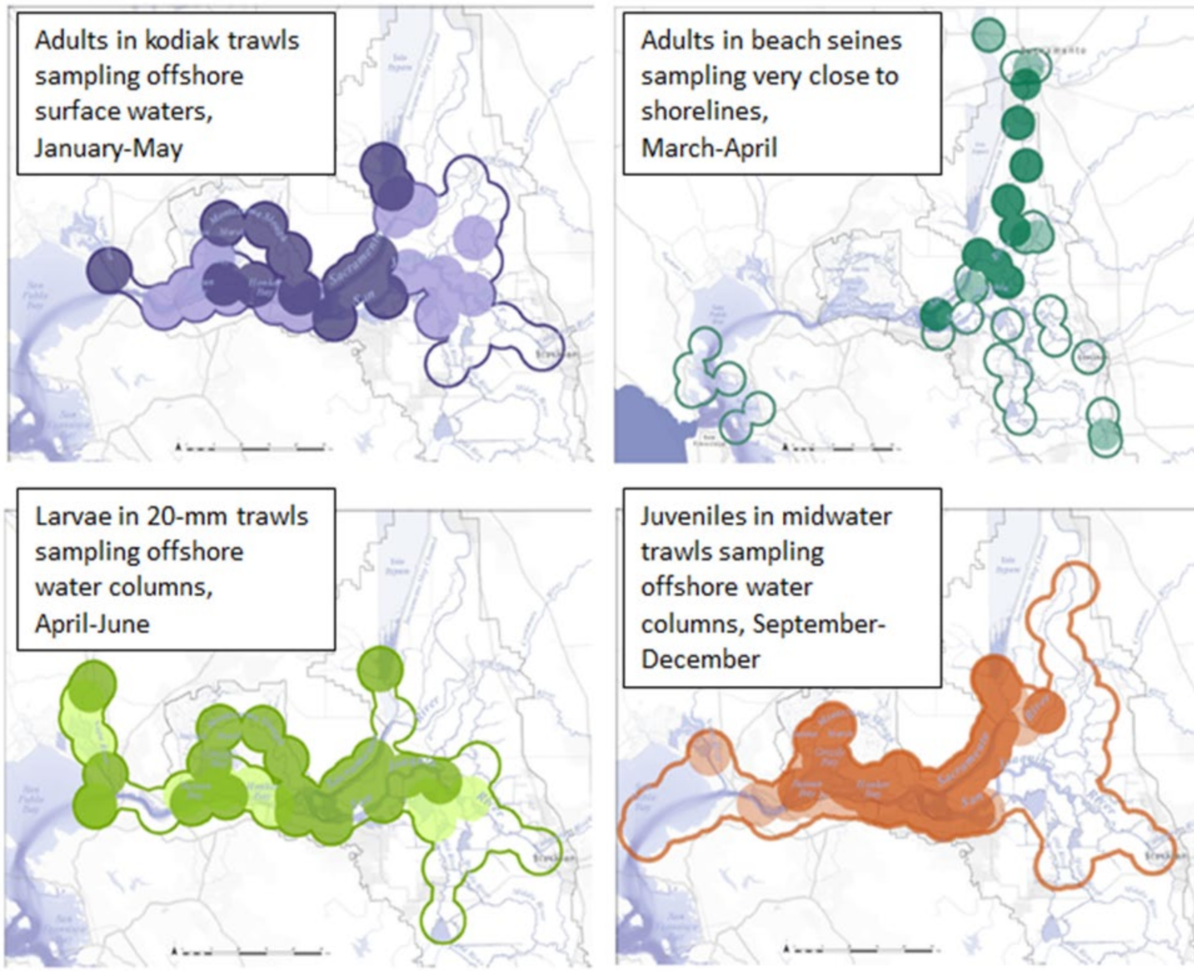

Figure 3. Maps of multi-year average distributions of delta smelt collected in four monitoring programs. The sampling regions covered by each survey are outlined. The areas with dark shading surround sampling stations in which 90 percent of the delta smelt collections occurred, the areas with light shading surround sampling stations in which the next 9 percent of delta smelt collections occurred. Note the lack of sampling sites in Suisun Bay and marsh for the beach seine (upper right panel). Source: Murphy and Hamilton (2013).

<u>Environmental Setting and History of Ecological Change in the Bay-Delta</u>

This section briefly reviews environmental changes that have occurred since 1850; i.e., the California Gold Rush to the present. This section is subdivided into three parts. The first describes the condition that is believed to have existed in 1850. The second covers a period from about 1920 to 1967, which is the year prior to the initiation of State Water Project (SWP) water exports from the Delta. The third sub-section covers 1968, the first year of Central Valley Project (CVP) and SWP dual operations, to the present.

Over the past few years, the scientific information developed to understand pre- and post-water project changes to the estuary's landscape and flow regime has grown substantially. However, as with most scientific endeavors, there are some discrepancies that may affect some conclusions. For instance, Whipple *et al.* (2012) showed the difference between contemporary estimates of unimpaired Delta outflow that were used in the modeling studies reviewed below and measured data from the latter 19^{th} century. These discrepancies can affect the conclusions about the natural hydrograph of the Bay-Delta ecosystem and should be kept in mind when reviewing what follows. The information on ecosystem changes that have accrued through time provides context for the current status of the delta smelt.

The 1850 Bay-Delta estuary: The historical Delta ecosystem was a large tidal marsh at the confluence of two floodplain river systems (Whipple *et al.* 2012; Andrews *et al.* 2017; Gross *et al.* 2018; Figure 4). The Delta itself experienced flooding over spring-neap tidal time scales and seasonal river runoff time scales. This variability in freshwater input to the estuary was likely important to seasonal and interannual variability in the productivity of the ecosystem for the same reasons that smaller-scale tidal marsh plain and floodplain inundation are today. Specifically, these flood cycles deliver organic carbon, but also increase the production of lower trophic levels due to lengthened water residence times and greater shallow, wetted surface areas (Sommer *et al*. 2004; Grosholz and Gallo 2006; Howe and Simenstad 2011; Enright *et al*. 2013). When freshwater flows out of the Delta and into the estuary, it can generate currents that aggregate particulate matter like sediment and phytoplankton (Monismith *et al*. 1996; 2002; MacWilliams *et al*. 2015) – and presumably also did so in the pre-development ecosystem. Prior to the invasion of the overbite clam, these sediment and phytoplankton aggregations, which occurred near the 2 ppt isohaline, demarcated an important fish nursery region (Turner and Chadwick 1972; Jassby *et al*. 1995; Bennett *et al*. 2002).

The estuary's natural hydrograph reached its annual base flows (annual minimum inputs of fresh water) in August or September toward the end of California's dry summers (Figure 5). Freshwater inputs would generally increase during the fall as precipitation in the watershed resumed. Delta outflow reached a broad winter through spring peak fueled first by precipitation followed by additional contributions from melting snow. The annual peak of Delta outflow often spanned January through May before declining back to base flow conditions by the late summer. The year-to-year variation in Delta outflow was considerable, often varying by about an order of magnitude during each month of the year. Water flowing from the Delta mixed into larger open-water habitats in Suisun and San Pablo bays, which themselves were fringed with marshes and tidal creeks. This pre-development ecosystem was shallower than the modern system. As a result, salinity responded more rapidly to changes in freshwater flow than it does now and less freshwater flow was needed to move salinity isohalines than is presently the case (Andrews *et al.* 2017; Gross *et al.* 2018). Like most native fish, the delta smelt evolved its life history to take advantage of this flow regime (Moyle 2002). In particular, its spawning period and early life stages overlap the months in which historical marsh-floodplain inundation and freshwater inputs to the estuary were highest, and water temperatures were cool, but not as cold as they are in the winter before spawning commences (see above for details of what is known about spawning and early life stages of delta smelt).

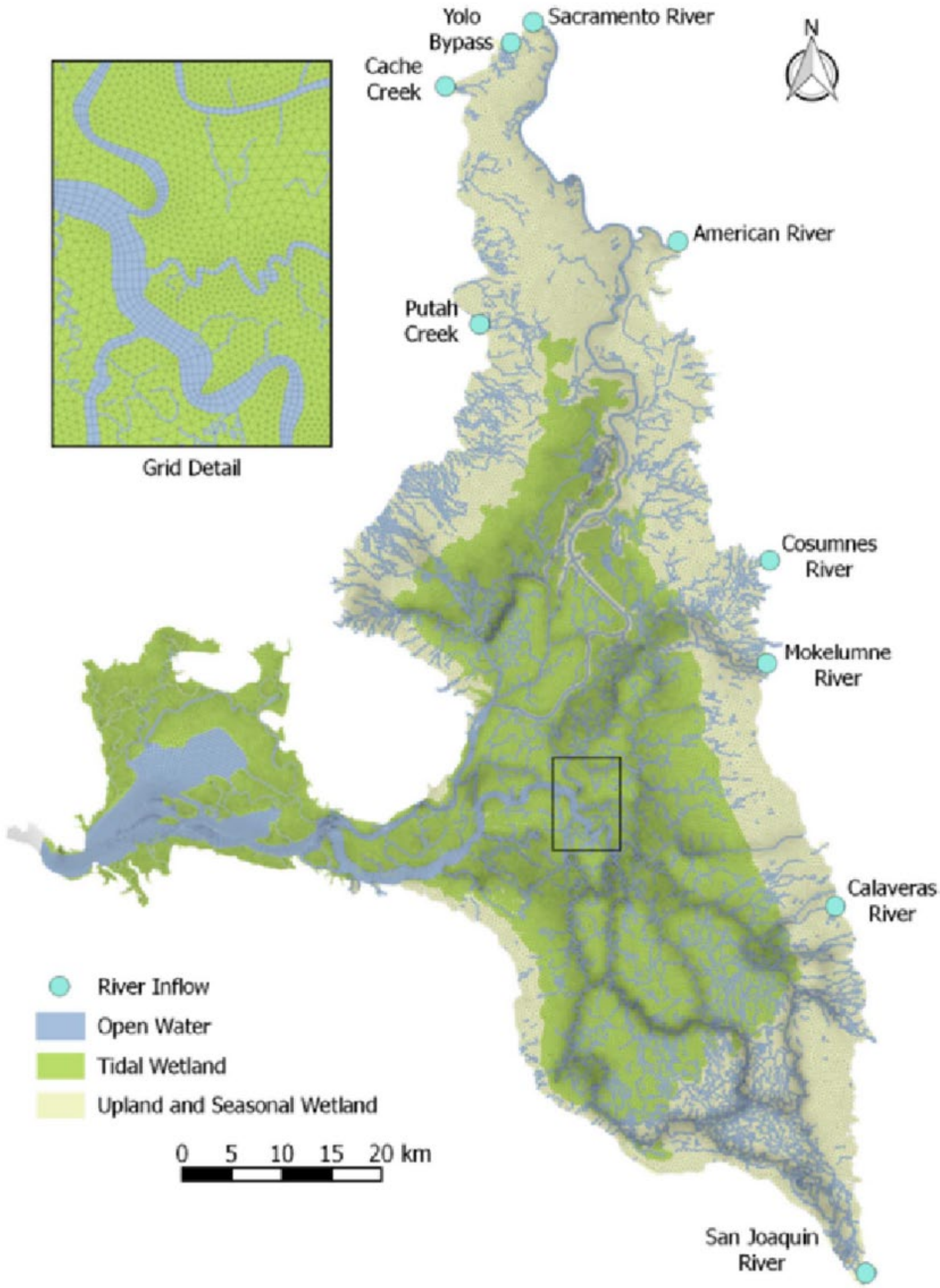

Figure 4. The circa 1850 Delta as depicted in the version of the UnTRIM 3-D hydrodynamic model described by Andrews *et al.* (2017). The model depicts an expansive tidal marsh area of approximately 2,200 square kilometers (km) or 850 square miles. Source: Andrews *et al.* (2017).

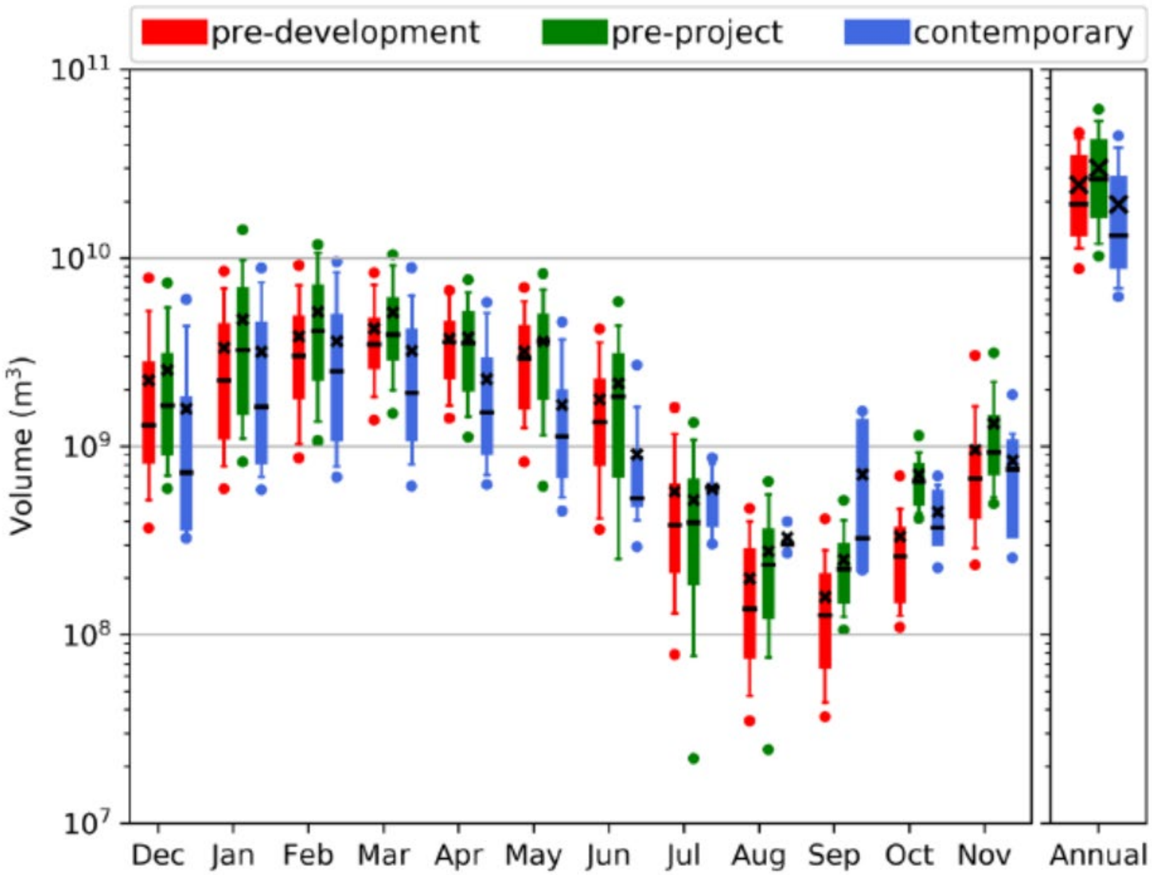

Figure 5. Boxplots of estimated Delta outflow by month for a pre-development Bay-Delta (circa 1850; red boxes), a pre-CVP and SWP Bay-Delta (circa 1920; green boxes), and a contemporary Bay-Delta (blue boxes; precise year not stated by the authors). Source: Gross *et al.* (2018). The inset labeled "Annual" on the x-axis is the boxplot summary of the sum of monthly outflows. Gross *et al.* (2018) attributed the higher outflow in the pre-project era relative to the pre-development era to the levees that had been constructed in the system by 1920.

Many tidal river estuaries form frontal zones where inflowing fresh water begins mixing with seawater (Peterson 2003). In the Bay-Delta, a frontal zone of biological importance is the LSZ (Jassby *et al.* 1995). The LSZ is a mobile and variable habitat region that frequently overlaps the parts of the estuary where many delta smelt reside (as described above). In the Bay-Delta the location and associated function of the LSZ have historically been indexed using a statistic called X2, which is the geographic location of 2 ppt salinity near the bottom of the water column measured as a distance from the Golden Gate Bridge (Jassby *et al.* 1995; MacWilliams *et al.* 2015; Figure 6). When Delta outflow is high, saline water is pushed closer to the Golden Gate, resulting in a smaller distance from the Golden Gate Bridge to X2. Conversely, when Delta outflow is low, salinity intrudes further into the estuary resulting in a larger distance from the Golden Gate Bridge to X2. These changes in how salinity is distributed affect numerous physical and biological processes in the estuary (Jassby *et al.* 1995; Kimmerer 2002a,b; Kimmerer 2004; MacWilliams *et al.* 2015).

X2, rather than another salinity isohaline, was chosen as the low-salinity zone habitat metric because it is a frontal zone or boundary upstream of which, salinity tends to be the same from the surface of the water to the bottom, and downstream of which, salinity varies from top to bottom (Jassby *et al.* 1995). That variability in the vertical distribution of salinity is indicative of currents that help to aggregate sinking particles like sediment and phytoplankton, and as recently modeled, zooplankton (Kimmerer *et al.* 2014a), near X2.

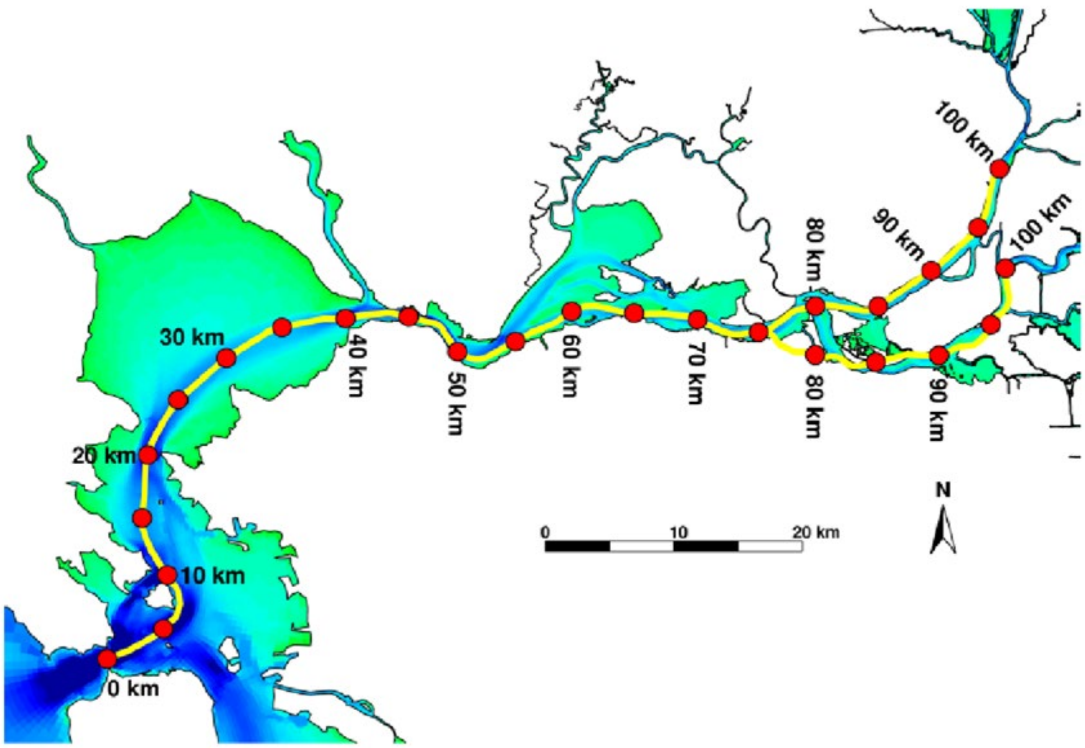

Figure 6. The northern reach of the Bay-Delta as depicted in the UnTRIM 3-D contemporary Bay-Delta model; greener colors represent shallower water and bluer colors represent deeper areas. The yellow lines depict the transect along which the location of X2 is estimated in the model and the associated red circles depict selected km distances from the Golden Gate Bridge along the northern axis of the estuary into the Sacramento and San Joaquin rivers for use in interpreting the variable locations of X2. Source: MacWilliams *et al.* (2015).

Pre-development outflows from the Delta were higher in the winter and spring than they are now while summer and fall outflows may have been lower (Andrews *et al.* 2017; Gross *et al.* 2018; Figure 5). Thus, X2 also varied more within years in the circa 1850 estuary than it now does. In the pre-development estuary, X2 would remain in San Pablo Bay for months at a time in the winter-spring of Above Normal and wetter water year types before retreating landward (upstream) in the summer-fall. In the contemporary estuary, X2 spends nearly all of its wet season time in Suisun Bay (landward or 'upstream' of historical) and dry season time between Collinsville and Rio Vista (~ 80 to 95 km; Figure 6). These contemporary dry season locations of X2 may be seaward or 'downstream' of historical locations (Gross *et al.* 2018).

There are no data on the timing and magnitude of biological productivity in the circa 1850 Bay-Delta, nor are we aware of any information on how delta smelt used the estuary at the time.

However, inferences can be made based on general ecosystem function in the northern hemisphere temperate zone and contemporary information. The input of basal food web materials like nutrients and detritus likely co-varied with the timing, duration, and magnitude of freshwater flows (e.g., Delta inflow; Jassby and Cloern 2000), which would likewise have affected the timing, magnitude, and duration of inundation of the system's expansive floodplains (e.g., Whipple *et al.* 2012; Figure 4). The production of planktonic and epibenthic invertebrates from floodplains, tidal wetlands, and open-water habitats that fuel the production of juvenile fishes that feed in open waters may have generally increased during the spring and peaked during the summer in concert with seasonal variation in water temperature (e.g., Heubach 1969; Orsi and Mecum 1986; Merz *et al.* 2016). The summer months are the warmest months in the Bay-Delta region and thus, they support the highest *average* metabolic rates of invertebrates and fish, which rely on water temperature to control their body temperature and metabolic rates. However, there was likely to have been considerable species-specificity to this generalization (e.g., Ambler *et al.* 1985; Gewant and Bollens 2005) because the Bay-Delta's native biotic community includes numerous cold-water adapted species.

The seasonal timing of delta smelt reproduction (February-May; detailed below) would have more broadly coincided with the general timing of peak freshwater flow into the Bay-Delta (Figure 5). The higher outflow and shallower average depth of the system resulted in frequent occurrence of the LSZ in San Pablo Bay during the wet season. Thus, it is likely that delta smelt reared in San Pablo Bay, taking advantage of its greatly expanded low-salinity habitat area (see MacWilliams *et al*. 2015), to much greater extent prior to development of the system than they are able to now. Lower flows in the summer-fall likely caused delta smelt distribution to seasonally retract back into Suisun Bay/marsh and the Delta; ecosystems which were likely much more productive at the time due to the expansive tidal marshes and greater connection between land and water (Whipple *et al*. 2012). Delta smelt's population-level demand for prey annually peaks at some combination of water temperature and growth of the population's biomass. This timing could be estimated from the model developed by Rose *et al.* (2013a), but we are not aware that such a calculation exists.

1920-1967: By 1920, most of the Delta's tidal wetlands had been reclaimed (Whipple *et al.* 2012; Figure 7). The data provided by Gross *et al.* (2018; Figure 4) suggest that Delta outflow may have been a little higher circa 1920 than it had been circa 1850 due to levee construction. However, this may (Hutton and Roy 2019) or may not be consistent with historical observations (Whipple *et al.* 2012). Regardless, Delta outflow and several other net flow metrics from within the Delta did begin to decline between the early 1920s and 1967 (Hutton *et al.* 2017a; 2019). These changes occurred because of four factors: (1) water storage in the Bay-Delta watershed increased from about 4 million acre feet (MAF) to about 40 MAF because of the construction of dams upstream of the Delta, (2) the CVP began exporting water from the Delta in 1951, (3) non-project water diversions within and upstream of the Delta increased, and (4) shipping channels were dredged through the estuary and into the Sacramento and San Joaquin rivers. These changes facilitated a general water management strategy in California to store water during the wet season and re-distribute it during the dry season to provide a more reliable supply than was available naturally. In addition, the CVP and SWP have had to offset a considerable summertime water deficit to protect the quality of their exported water and to protect water quality for senior water rights holders in the Delta. These uses would be highly impaired without water released from CVP and SWP reservoirs during the summer and fall (Hutton *et al.* 2017b).

During the 1930s to 1960s, the navigation channels were dredged deeper (~12 meters) to accommodate shipping traffic from the Pacific Ocean and San Francisco Bay to ports in Sacramento and Stockton and to increase the capacity of the Delta to convey floodwaters. Channel deepening interacted with the simultaneously increasing water storage to change the Bay-Delta ecosystem into one in which Suisun Bay and the Sacramento-San Joaquin River confluence region became the largest and most depth-varying places in the typical range of the LSZ. Even with these changes, the LSZ remained a highly productive fish nursery habitat for many decades (Stevens and Miller 1983; Moyle *et al.* 1992; Jassby *et al.* 1995).

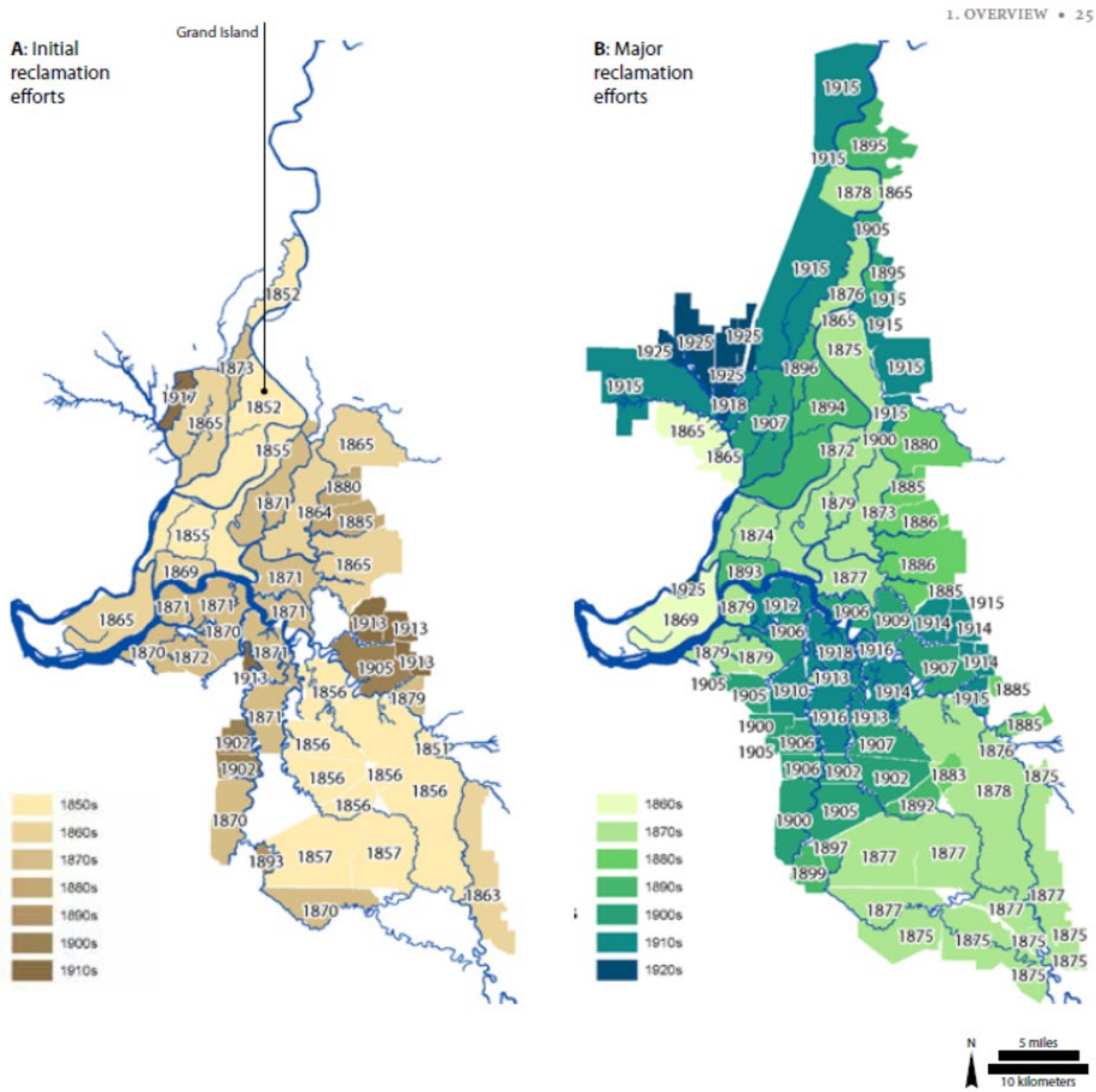

Figure 7. Maps of the Delta showing years of initial land reclamation attempts on the left and major land reclamation efforts on the right. Note that a large majority of the major reclamation efforts were underway by 1915 and the last efforts in the vicinity of Liberty Island began in 1925. Source: Whipple *et al.* (2012).

1968-present: The SWP began exporting water from the Delta in 1968 and its exports generally increased until about 1989 (Figure 8). CVP exports reached present-day levels by the end of the 1970s. During the 1980s water storage capacity in the Bay-Delta watershed reached its present-day level of a little over 50 MAF (Cloern and Jassby 2012; Hutton *et al.* 2017a). Thereafter, combined CVP-SWP exports began to increase in year-to-year variability, which increased the uncertainty about how much water would be supplied south of the Delta annually. This has combined with the increasing human demand for fresh water to result in a conflict between human water demand and environmental water uses, including the maintenance of the hydraulic salinity barrier needed to protect exported water and other in-Delta water users from salinity intrusion (Hutton *et al.* 2017b; Reis *et al.* 2019).

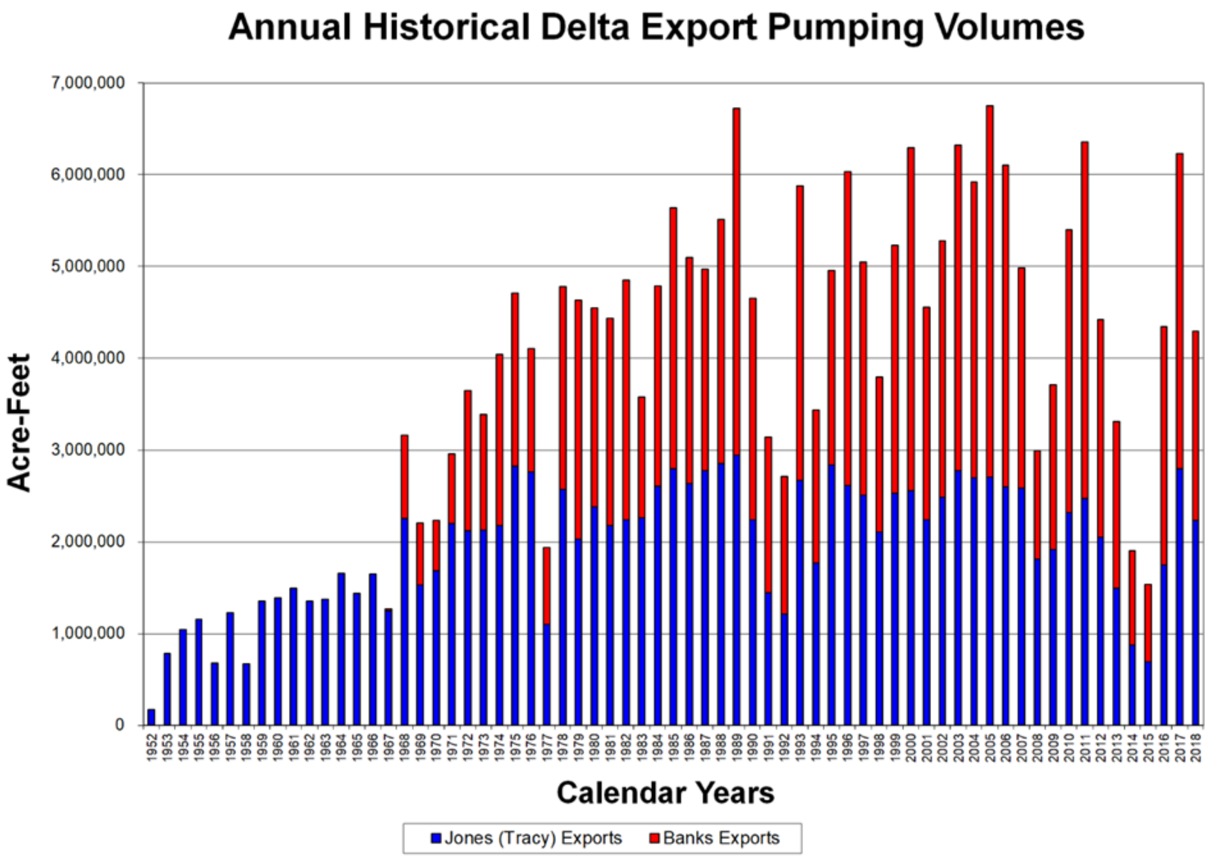

Figure 8. Time series of Central Valley Project and State Water Project exports from the Delta for 1952 through 2018. State Water Project exports began in water year 1968. Source: DAYFLOW data base.

The changes discussed above have continued to lower Delta outflow (Hutton *et al.* 2017a,b; Reis *et al.* 2019; Figures 9 and 10), though D-1641 appears to have halted the trend for years in which the eight river index is lower than 20 MAF (middle panel of Figure 9). In Figure 9, exports were modeled as depletions of water from the system, so the more negative the number on the y-axis of the middle panel, the higher the exports. Thus, the graphic shows that in years when the eight river index is more than 20 MAF, exports continue to increase, but in years when the eight river index is lower than 20 MAF, exports have been trending lower. Both of these trends cause the higher year-to-year variability in water exports shown in Figure 8.

In general, major changes to the flow regime of an aquatic ecosystem are expected to be accompanied by ecological change (Benson 1981; Bunn and Arthington 2002; Poff and Zimmerman 2010; Gillson 2011), and that is what has been observed over time in the Bay and Delta (e.g., Matern *et al.* 2002; Moyle and Bennett 2008; Winder *et al.* 2011; Feyrer *et al.* 2015; Conrad *et al.* 2016). Delta outflow is a driver of many ecological mechanisms in the Bay-Delta and an indicator of several others (Kimmerer 2002a). Thus, the changes to the estuary's freshwater flow regime have likely interacted with the changes to the estuary's landscape, specifically its deeper channels and greatly reduced land-water connections (Andrews *et al.* 2017), to lower the total biological productivity of the estuary. In addition, changes to the freshwater flow regime detailed above appear to have affected the reproductive success of fishes that use the Delta and Suisun Bay as rearing habitats. The evidence for this is that the native fish assemblage had reproductive seasons timed to winter-spring peak flows, whereas currently dominant non-native species generally spawn later in the spring and into the summer when inflows to the Delta are generally high to support human water use, but outflow from the Delta is generally low (Moyle 2002; Moyle and Bennett 2008). Reis *et al.* (2019) recently described super-critical water years with respect to Delta outflow. Several studies have indicated that low flow years and droughts in particular result in low native fish production in the Bay-Delta (Meng *et al.* 1994; Jassby *et al.* 1995; Kimmerer 2002b; Feyrer *et al.* 2015). Droughts recur and may contribute to cumulative impacts to native fishes like delta smelt. For instance, recent droughts have been particularly problematic for delta smelt (Moyle *et al.* 2018). Thus, the frequency of these super-critical water years, which has been much higher since 1968 than it was from 1920-1967 (Figure 10), is a conservation challenge that the Service and its partners have to contend with.

There are several fish species in the Bay-Delta that have historically been shown to have demonstrable positive population responses to freshwater flows into or out of the Delta. These include the well-described relationships for the survival of emigrating Sacramento basin Chinook salmon (*Oncorhynchus tschawytscha)* smolts with Sacramento River inflows (Kjelson and Brandes 1989; Perry *et al.* 2010), the relationship of Sacramento splittail (*Pogonichthys macrolepidotus*) production to Yolo Bypass flow (Moyle *et al.* 2004; Feyrer *et al.* 2006), and the 'fish-X2' relationships for striped bass (*Morone saxatilis*), longfin smelt (*Spirinchus thaleichthys*), and starry flounder (*Platichthys stellatus*) (Turner and Chadwick 1972; Jassby *et al.* 1995; Kimmerer 2002b). The life-history of delta smelt with its affinity for fresh and low-salinity waters seems consistent with that of a fish one could expect to respond similarly to variation in Delta outflow or X2. Researchers searched for some form of analogous relationship for the delta smelt for several decades, but no persistent relationship was found (Stevens and Miller 1983; Moyle *et al.* 1992; Jassby *et al.* 1995; Kimmerer 2002b; Bennett 2005; Mac Nally *et al.* 2010; Thomson *et al.* 2010; Miller *et al.* 2012). Further, Rose *et al.* (2013a,b) did not find salinity variation *per se* to have much impact on predictions of delta smelt population growth rate. The larger predicted impact in their individual-based model related to flow was due to simulated entrainment in exported water (Rose *et al.* 2013b; Kimmerer and Rose 2018). Although entrainment was predicted to lower the population growth rate, in and of itself, it could not convert a strongly positive growing population into a declining one without at least one additional factor impacting survival at the same time.

The IEP (2015) reported a correlation between February-May X2 and ratios of the 20-mm Survey index for delta smelt and either the Spring Kodiak Trawl (SKT) or FMWT indices of the parental stock that produced the 20-mm fish. This relationship emerged in data beginning at the time of the pelagic organism decline (POD) in 2002. This relationship is stronger when considered in terms of salinity at Chipps Island (He and Nobriga 2018), possibly because salinity can be measured more accurately than Delta outflow when net freshwater flow is very low (Monismith 2016). Castillo *et al.* (2018) used a simulation based on SKT data to suggest a link between Delta outflow and adult delta smelt abundance. In addition, several teams have reported statistical associations of delta smelt spatial distribution and salinity that imply the population spatial distribution co-varies with Delta outflow, X2, or similar indices of freshwater input to the estuary (Feyrer *et al.* 2007; 2011; Nobriga *et al.* 2008; Kimmerer *et al.* 2009; 2013; Bever *et al.* 2016; Polanksy *et al.* 2018; Simonis and Merz 2019). The strength of this covariation and its management utility have been contested (e.g., Murphy and Hamilton 2013; Manly *et al.* 2015; Latour 2016; Polanksy *et al.* 2018) and supported (Sommer *et al.* 2011; Bever *et al.* 2016; Feyrer *et al.* 2016; Mahardja *et al.* 2017a) in several recently published papers.

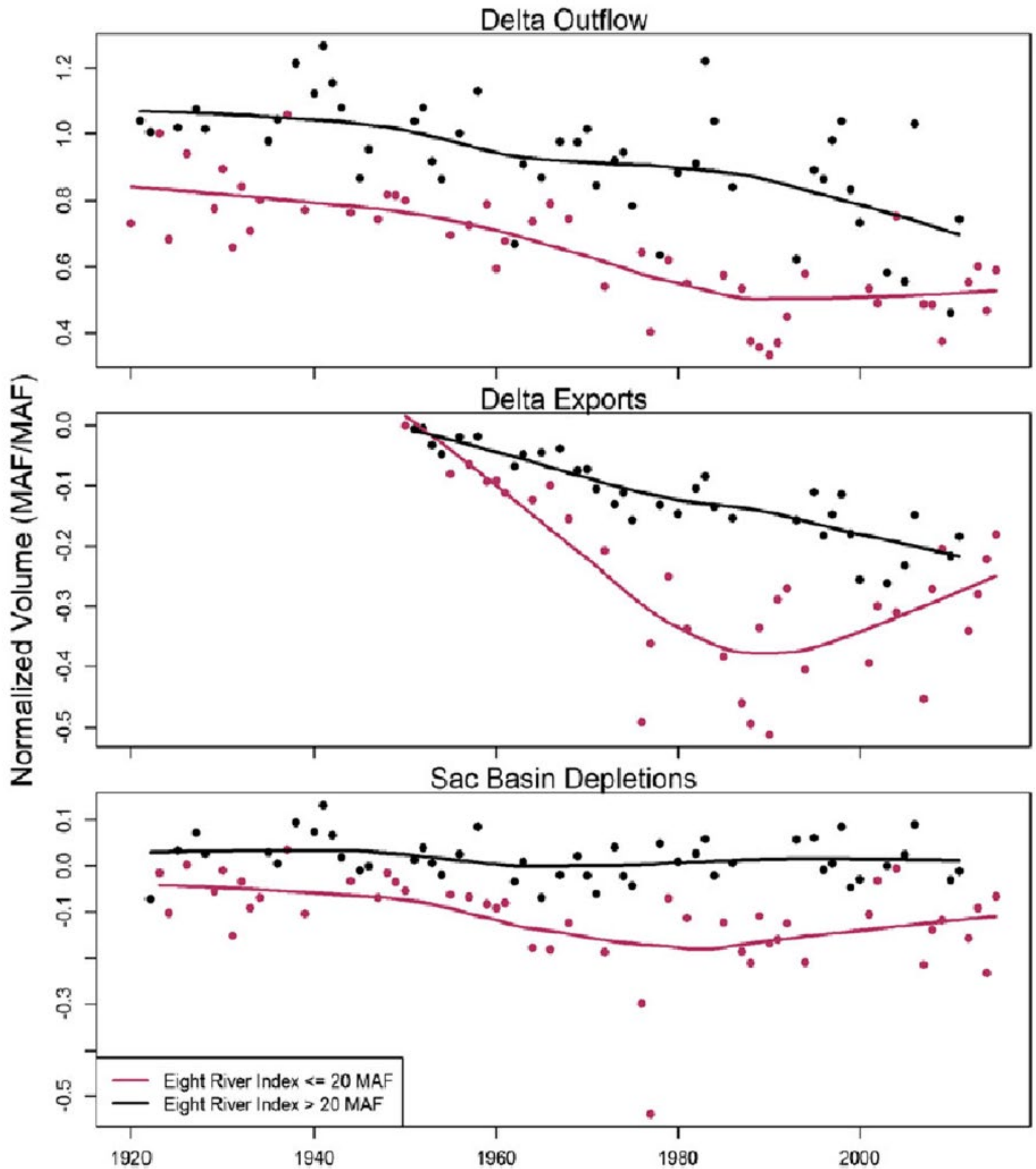

Figure 9. Time series (1922-2015) of statistical trend outputs of annual Delta outflow (top panel), Delta exports treated as depletions so increasing exports are represented by more negative values (middle panel), and water diversions from the Sacramento River basin upstream of the Delta (bottom panel). Black symbols and lines are for years in which the eight river index, a measure of water availability in the Bay-Delta watershed, was greater than 20 MAF. Red symbols and lines are for years in which the eight river index was less than or equal to 20 MAF. Source: Hutton *et al.* (2017b).

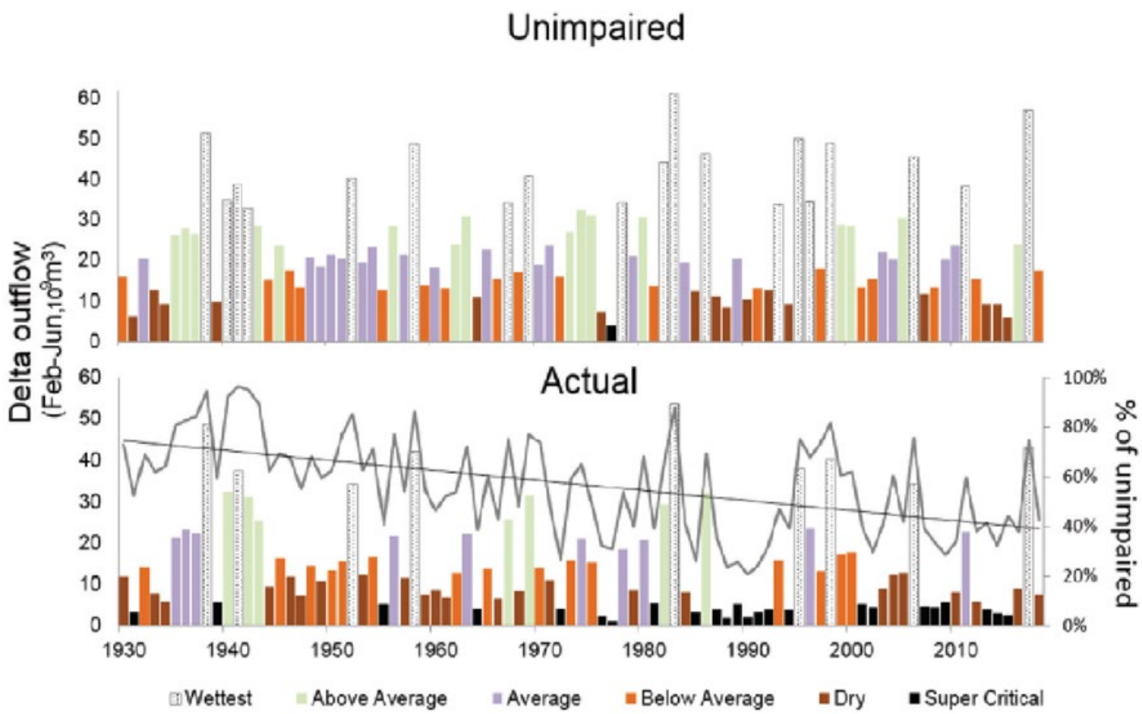

Figure 10. Time series of estimates of unimpaired (upper panel) and actual (lower panel) Delta outflow (February-June) color-coded according to six water year types, 1930-2018. The water year types based on basin precipitation are shown in the upper panel. In the lower panel, the water year types were re-assessed based on their fraction of the estimated unimpaired outflow. The long-term trend in this fraction as "% of unimpaired" is shown on the second y-axis of the bottom panel. Source: Reis *et al.* (2019).

Delta Smelt Population Trend

The CDFW's TNS (http://www.dfg.ca.gov/delta/data/townet/indices.asp?species=3) and FMWT Survey (http://www.dfg.ca.gov/delta/data/fmwt/indices.asp) are the two longest running indicators of the delta smelt's abundance trend. Indices of delta smelt relative abundance from these surveys date to 1959 and 1967, respectively (Figures 11 and 12). The FMWT index has traditionally been the primary indicator of delta smelt trend because it samples later in the life cycle, providing a better indicator of annual recruitment than the TNS (Service 1996). It has also sampled more consistently and more intensively than the TNS. The FMWT deploys more than 400 net tows per year over its four-month sampling season (September through December). The highest FMWT index for delta smelt (1,673) was recorded in 1970 and a comparably high index (1,654) was reported in 1980 (Figure 12). The last FMWT index exceeding 1,000 was reported in 1993. The last FMWT indices exceeding 100 were reported in 2003 and 2011. In 2018, the FMWT index was zero for the first time. The TNS index for delta smelt has been zero four times since 2015. Thus, the TNS and FMWT have recorded a 40-50 year decline in which delta smelt went from a minor (but common) species to essentially undetectable by these long-term surveys (Figures 11 and 12).

Following the listing of the delta smelt, the CDFW launched a 20-mm Survey (1995) and a SKT Survey (SKT; 2002) to monitor the distribution and relative abundance of late larval stage and adult delta smelt, respectively. These newer indices have generally corroborated the trends implied by the TNS and the FMWT (Figures 11 and 12). The CDFW methods generate abundance indices from each survey but each index is on a different numeric scale. This means the index number generated by a given survey only has quantitative meaning relative to other indices generated by the same survey. Further, the CDFW indices lack estimates of uncertainty (variability) which limits interpretation of abundance changes from year to year even within each sampling program. The Service recently completed a new delta smelt abundance indexing procedure using data from all four of these surveys (Polansky *et al.* 2019). The Service method improves upon the CDFW method because it generates abundance indices in units of numbers of fish, including attempts to correct for different sampling efficiencies among surveys, and the method includes measures of uncertainty. Service indices of spawner abundance based on combined January and February SKT sampling are listed with their confidence intervals in Table 9. The estimates show the most recent 19 years of the delta smelt's longer-term decline in numbers of fish as best as they can be approximated with currently available information. The 2020 abundance estimate of 5,213 is the lowest on record, though the upper confidence limit for the 2020 estimate overlaps the lower confidence limits from 2016 and 2018. This indicates there is more than a five percent chance that the 2020 abundance index is not different from 2016 and 2018. Regardless of this recent year uncertainty, the 2020 abundance index is much lower than peak abundance estimates in Table 9 which themselves are all based on data streams that started after the species had already declined considerably (Figures 11 and 12).

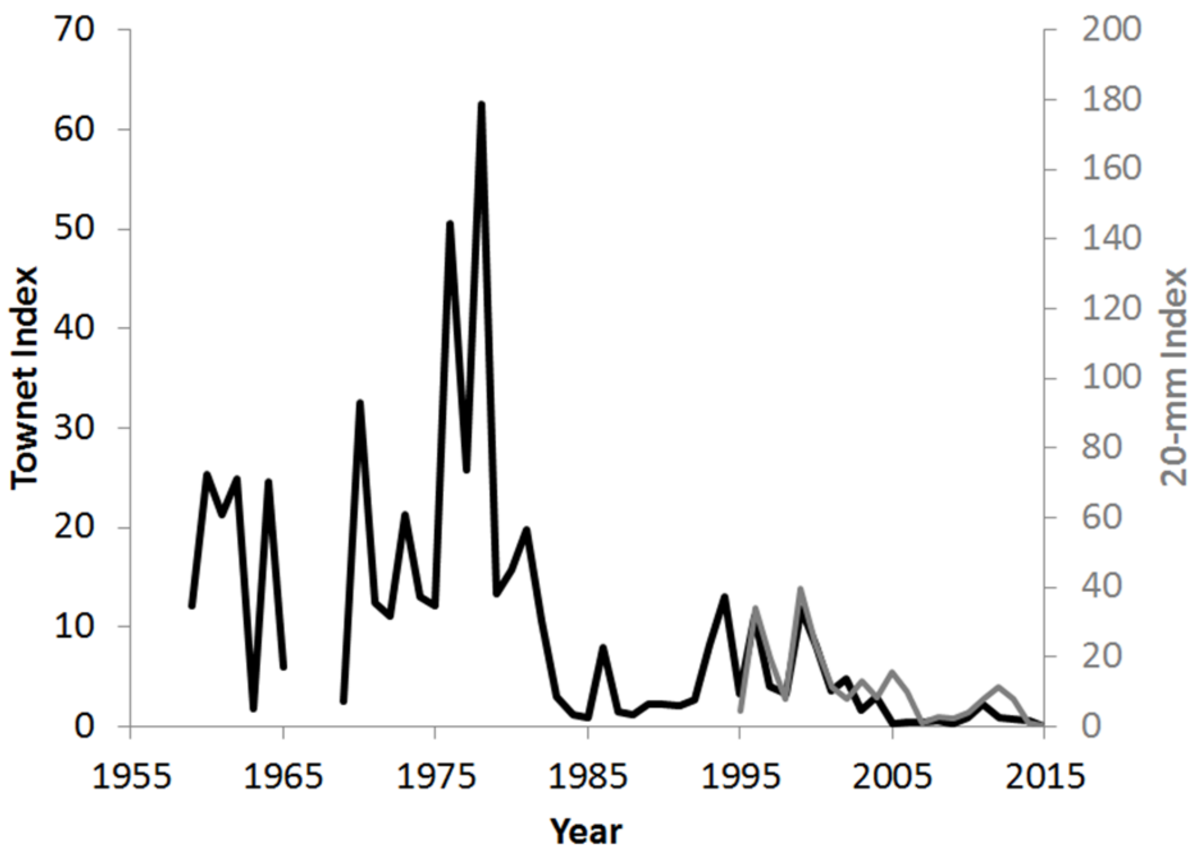

Figure 11. Time series of juvenile and larval delta smelt relative abundance as depicted by the California Department of Fish and Wildlife's TNS and 20-mm Survey, respectively. The TNS began in 1959 and the 20-mm Survey began in 1995. The second y-axis was scaled to better align the indices which are calculated on different numeric scales.

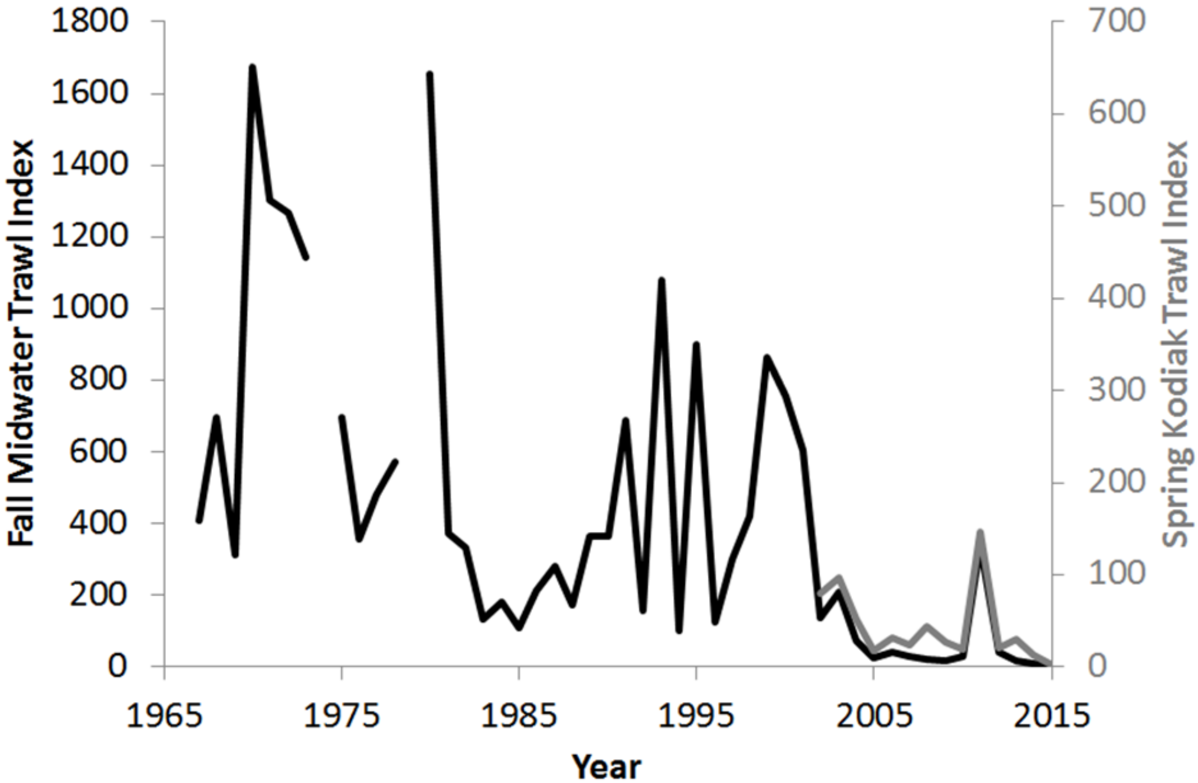

Figure 12. Time series of juvenile and larval delta smelt relative abundance as depicted by the California Department of Fish and Wildlife's FMWT and SKT Survey, respectively. The FMWT survey began in 1967 and the SKT trawl survey began in 2002. The second y-axis was scaled to better align the indices which are calculated on different numeric scales.

Table 9. Estimates of adult delta smelt population size during January-February of 2002 through 2020 with 95% confidence intervals.

			95% Confidence Interval			Number of Delta Smelt Caught in the SKT Survey		
Year	Abundance Estimate	Standard Error	Lower Bound	Upper Bound		January	February	Year-to-Year Ratio
2002	1,093,244	195,329	760,332	1,523,294		262	394	NA
2003	996,055	261,205	581,197	1,597,198		NA	232	0.91
2004	966,981	262,190	553,729	1,573,002		380	300	0.97
2005	715,858	147,190	470,572	1,044,828		220	218	0.74
2006	272,327	42,400	198,681	364,438		44	84	0.38
2007	449,466	128,731	249,216	749,168		109	107	1.65
2008	509,428	188,396	236,859	963,839		132	36	1.13
2009	1,166,145	523,856	459,083	2,464,804		579	61	2.29
2010	251,863	54,580	161,753	374,582		88	57	0.22
2011	461,599	202,547	185,712	962,088		177	128	1.83
2012	1,177,201	328,682	662,728	1,939,836		320	287	2.55
2013	333,682	89,809	191,886	541,064		100	125	0.28
2014	308,972	91,474	167,858	522,884		148	55	0.93
2015	213,345	76,639	101,434	397,439		21	68	0.69
2016	25,445	9,584	11,661	48,622		7	6	0.12
2017	73,331	23,342	38,010	128,459		18	8	2.88
2018	26,649	21,397	5,215	82,805		10	4	0.36
2019	5,610	4,395	1,138	17,135		1	1	0.21
2020	5,213	3,644	1,241	14,710		1	1	0.93

Climate Change

Climate projections for the San Francisco Bay-Delta and its watershed indicate that changes will be substantial by mid-century and considerable by the year 2100. Climate models broadly agree that average annual air temperatures will rise by about 2°C at mid-century and about 4°C by 2100 if current atmospheric carbon emissions accelerate as currently forecasted (Dettinger *et al.* 2016). It remains highly uncertain whether annual precipitation in the Bay-Delta watershed will trend wetter or drier (Dettinger 2005; Dettinger *et al.* 2016). The warmer air temperature projections suggest more precipitation will fall as rain rather than snow and that storms may increase in intensity, but will have more dry weather in between them (Knowles and Cayan 2002; Dettinger 2005; Dettinger *et al.* 2016). The expected consequences are less water stored in spring snowpacks, increased flooding and an associated decrease in runoff for the remainder of the year (Hayhoe *et al.* 2004). Changes in storm tracks may lead to increased frequency of flood and drought cycles during the 21st century (Dettinger *et al.* 2015).

As of 2009, sea level rise had not had much effect on X2 (Hutton *et al.* 2017b). However, additional sea level rise is another anticipated consequence of a warming global climate and if it is not mitigated, sea level rise will likely increase saltwater intrusion into the Bay-Delta (Rath *et al.* 2017). During the summer of 2015, variation in sea level interacted with very low Delta inflows to cause frequent recurrence of net negative Delta outflow (Monismith 2016).

Since the early 1980s, climate change is thought to have increased wind speed along the central California coast, resulting in a more frequent and longer lasting upwelling season (Garcia-Reyes and Largier 2010). Coastal upwelling causes colder deep water to rise to the ocean surface, bringing with it nutrients that stimulate the coastal food web. One effect of wind blowing over the estuary is that it resuspends sediment deposited in shallow areas like San Pablo Bay, Grizzly Bay, and Honker Bay (Ruhl *et al*. 2001). Thus, higher wind speeds blowing onto the coast might be expected to result in higher turbidity of the water in parts of the estuary. In contrast to this expectation, Bever *et al*. (2018) reported a recent reduction in wind speed over the Bay-Delta during 1995-2015, which these authors associated with lower turbidity in Suisun Bay. The Service notes these contrasting results for completeness but we cannot reconcile these opposing trends in wind speed at this time. We show below that Secchi disk depths (an indicator of water turbidity) have not increased since the mid-1980s near the (mobile) location of X2 even though suspended sediment concentrations in Suisun Bay have decreased since about 2000 (Schoellhamer 2011; Bever *et al*. 2018).

Central California's warm summers are already a source of energetic stress for delta smelt and warm springs can already severely compress the duration of their spawning season (Rose *et al.* 2013a,b). We expect warmer estuary temperatures to present a significant conservation challenge for delta smelt in the coming decades (Brown *et al.* 2013; 2016a; Figure 13). Feyrer *et al.* (2011) and Brown *et al.* (2013; 2016a) have evaluated the anticipated effects of projected climate change on several delta smelt habitat metrics. Collectively, these studies indicate the future will bring chronically compressed fall habitat, fewer 'good' turbidity days (defined by the authors as a mean turbidity greater than or equal to 18 Nephelometric Turbidity Units (NTU)), a spawning window of similar duration but that is shifted 2 to 3 weeks earlier in the year, and a substantial increase in the number of days delta smelt will need to endure lethal or near lethal summer water temperatures.

The delta smelt lives at the southern limit of the inland distribution of the family Osmeridae along the Pacific coast of North America. The anticipated effects of a warming climate are expected to create increasing temperature related challenges for delta smelt at some future point. The amount of anticipated change to the regional climate expected in the near term is lower than it is for the latter half of the century (Figure 13). Therefore, it is less certain that any measurable change from current conditions will occur in the next approximately 10 years than by 2050 or

2100. For the time being, water temperatures are stressful to delta smelt, but not of themselves lethal in most of the upper estuary (Komoroske *et al.* 2015).

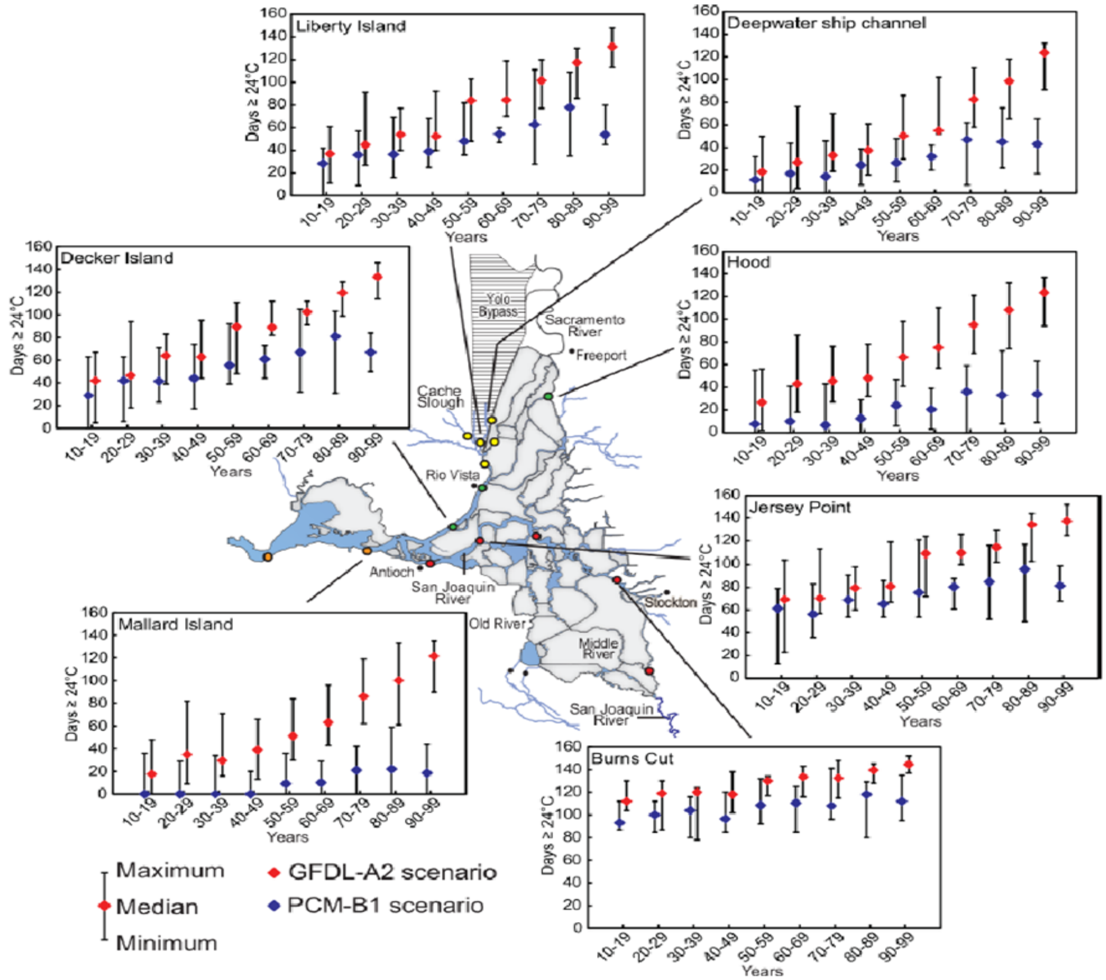

Figure 13. **Plots of median, maximum, and minimum number of days each year with an estimated average daily water temperature greater than or equal to 24°C (75°F) at selected sites in the Delta by decade for the 21st century. The water temperature threshold reflects one chosen by the authors to represent near lethal conditions for delta smelt. Source: Brown *et al.* (2016a).**

<u>Recovery and Management</u>

Following Moyle *et al.* (1992), the Service (1993) indicated that SWP and CVP exports were the primary factors contributing to the decline of delta smelt due to entrainment of larvae and juveniles and the effects of low flow on the location and function of the estuary mixing zone (now called the low-salinity zone). In addition, prolonged drought during 1987-1992, in-Delta water diversions, reduction in food supplies by nonindigenous aquatic species (specifically overbite clam and nonnative copepods), and toxicity due to agricultural and industrial chemicals were also factors considered to be threatening the delta smelt. In the Service's December 15, 2008 *Formal Endangered Species Act Consultation on the Proposed Coordinated Operations of the Central Valley Project (CVP) and State Water Project (SWP)* (2008 BO), the Reasonable and Prudent Alternative (RPA) required protection of all life stages from entrainment and augmentation of Delta outflow during the fall of Wet and Above-Normal years as classified by the State of California (Service 2008). The expansion of entrainment protection for delta smelt in the 2008 BO was in response to large increases in juvenile and adult salvage in the early 2000s (Kimmerer 2008; Brown *et al.* 2009). The fall X2 requirement in the 2008 RPA was in response to increased fall exports that had reduced variability in Delta outflow and lowered habitat suitability during the fall months and the 2008 proposed action was anticipated to reduce it further (Feyrer *et al.* 2011).

The Service's (2010c) recommendation to uplist delta smelt from threatened to endangered included a discussion of threats related to reservoir operations and water diversions upstream of the estuary as additional water operations mechanisms interacting with exports from the Delta to restrict the LSZ and concentrate delta smelt with competing and predatory fish species. In addition, Brazilian waterweed (*Egeria densa*) and increasing water transparency were considered new detrimental habitat changes. Predation was considered a low-level threat linked to increasing waterweed abundance and increasing water transparency. Additional threats considered potentially significant by the Service in 2010 were entrainment into power plant diversions, contaminants, and reproductive problems that can stem from small population sizes. Conservation recommendations included: establish Delta outflows proportionate to unimpaired flows to set outflow targets as fractions of runoff in the Central Valley watersheds; minimize reverse flows in Old and Middle rivers; and, establish a genetic management plan for captive-reared delta smelt with the goals of minimizing the loss of genetic diversity and limiting risk of extinction caused by unpredictable catastrophic events. The Service (2012) recently added climate change to the list of threats to the delta smelt.

Maintaining protection of the delta smelt from excessive entrainment, improving the estuary's flow regime, suppression of nonnative species, increasing zooplankton abundance, and improving water quality are among the actions the Service has previously indicated are needed to recover the delta smelt.

There have been several recent papers suggesting it is time to consider supplementation of the wild delta smelt population with captive-bred fish as part of a broad-based conservation strategy to avoid extinction in the wild, also known as extirpation (Moyle *et al.* 2016; 2018; Hobbs *et al.* 2017; Lessard *et al.* 2018). In 2019, pilot research conducted by the California Department of Water Resources (DWR) has demonstrated that captive-bred delta smelt held within steel enclosures can survive in the Delta for at least 30 days. This is long enough to show that the fish can feed themselves and did not die from acute water toxicity in either of two locations tested thus far. The fish will be evaluated for chronic toxic exposure, but that work is not finished. These results are promising and similar research is planned this year.

The status of the delta smelt is poor. The current estimated delta smelt population sizes are so low that it seems unlikely the species can be habitat- or food-limited even though both physical and food web-related habitat attributes have degraded over time. It is more likely that delta smelt have been marginalized by non-native fishes and invertebrates that compete with and prey on them. When fish populations reach very low levels, they can fall victim to demographic problems (often termed Allee effects in the scientific literature). These include problems concentrating enough individuals in particular locations for successful spawning, successful feeding, or maintaining large enough egg supplies, or shoals and schools of juvenile and adult fish to provide effective protection from predators (Liermann and Hilborn 2001; Keith and Hutchings 2012).

Summary of the Status of Delta Smelt - The relative abundance of delta smelt has reached very low numbers for a small forage fish in an ecosystem the size of the Bay-Delta and the species is approaching extinction in the wild (Moyle *et al.* 2016; 2018; Hobbs *et al.* 2017). The extremely low 2018-2020 abundance indices reflect decades of habitat change and marginalization by non-native species that prey on and out-compete delta smelt. The anticipated effects of climate change on the Bay-Delta and its watershed such as warmer water temperatures, greater salinity intrusion, lower snowpack contribution to spring outflow, and the potential for frequent extreme drought, indicate challenges to delta smelt survival will increase.

Delta Smelt Critical Habitat

Legal Status

The Service designated critical habitat for the delta smelt on December 19, 1994 (Service 1994). The geographic area encompassed by the designation 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); the length of Goodyear, Suisun, Cutoff, First Mallard (Spring Branch), and Montezuma sloughs; and the existing contiguous waters contained within the legal Delta (as defined in section 12220 of the California Water Code) (Service 1994).

Conservation Role of Delta Smelt Critical Habitat

The Service's primary objective in designating critical habitat was to identify the key components of delta smelt habitat that support successful completion of the life cycle, including spawning, larval and juvenile transport, rearing, and adult migration back to spawning sites. Delta smelt are endemic to the Bay-Delta and the vast majority only live one year. Thus, regardless of annual hydrology, the Bay-Delta estuary must provide suitable habitat all year, every year. The primary constituent elements considered essential to the conservation of the delta smelt as they were characterized in 1994 are physical habitat, water, river flow, and salinity concentrations required to maintain delta smelt habitat for spawning, larval and juvenile transport, rearing, and adult migration (Service 1994). The Service recommended in its designation of critical habitat for the delta smelt that salinity in Suisun Bay should vary according to water year type, which it does. For the months of February through June, this element was codified by the SWRCB "X2 standard" described in D-1641 and the SWRCB's current Water Quality Control Plan.

See the Detailed Review of the Habitat Use and Distribution of Delta Smelt above in the Status of the Species section.

Description of the Primary Constituent Elements

PCE #1: "Physical habitat" is defined as the structural components of habitat (Service 1994). As reviewed above, physical habitat in the Bay-Delta has been substantially changed with many of the changes having occurred many decades ago (Andrews *et al.* 2017; Gross *et al.* 2018). Physical habitat attributes are important in terms of spawning substrate, rearing habitat in terms of how geographic location and bathymetry affect tidal current velocities (Bever *et al.* 2016), and possibly, foraging opportunities near the edges of emergent marshes (Whitley and Bollens 2014; Hammock *et al.* 2019). Information on spawning habitat is incomplete and it is difficult to protect spawning habitat without knowing what it is.

PCE #2: "Water" is defined as water of suitable quality to support various delta smelt life stages that allow for survival and reproduction (Service 1994). Certain conditions of turbidity, water temperature, and food availability characterize suitable habitat for delta smelt and are discussed in detail below. Contaminant exposure can degrade this primary constituent element even when the basic habitat components of water quality are otherwise suitable (Hammock *et al.* 2015).

Turbidity: Turbidity is the measure of relative clarity of a liquid. It is an optical characteristic of water and is a measurement of the amount of light scattered by material in the water when a light is shined through the water sample. The higher the intensity of scattered light, the higher the turbidity. Material that causes water to be turbid can include clay, silt, particulate organic matter, algae, dissolved colored organic compounds, and other microscopic organisms. In the Bay-Delta, turbidity results mainly from sediment suspended in the water column and to a lesser degree phytoplankton (Cloern and Jassby 2012). Turbidity can play an important role in structuring fish communities; one mechanism by which this can occur is the scale dependence in how fish of different sizes can have their prey detection enhanced or impaired (Utne-Palm 2002). Turbidity typically lowers the reactive distance of fishes feeding on zooplankton or each other. However, if the turbidity increases prey contrast (which it often does for fish larvae and planktivorous species), then it can enhance the feeding of these small fishes while still impairing the ability of their predators to see them.

The delivery of suspended sediment to the estuary increased substantially following the era of hydraulic gold mining in the watershed (Schoellhamer 2011). It increased again during rapid regional population growth and development after World War II. Since then, the delivery of new sediment to the estuary has declined (Wright and Schoellhamer 2004; Schoellhamer 2011). In addition, summertime phytoplankton production has been greatly diminished (Cloern and Jassby 2012). These changes have resulted in a general clearing of the estuary's waters (Figure 14); however, the clearing trend has been strongest in the Delta where expansive beds of SAV further filter fine sediment from the water (Kimmerer 2004; Feyrer *et al*. 2007; Nobriga *et al*. 2008; Hestir *et al*. 2016). Water exports from the south Delta may also have contributed to the trend toward clearer estuary water by removing suspended sediment in exported water (Arthur *et al.* 1996); however, the contribution of exports to the total suspended sediment budget in the estuary is small (Schoellhamer 2012).

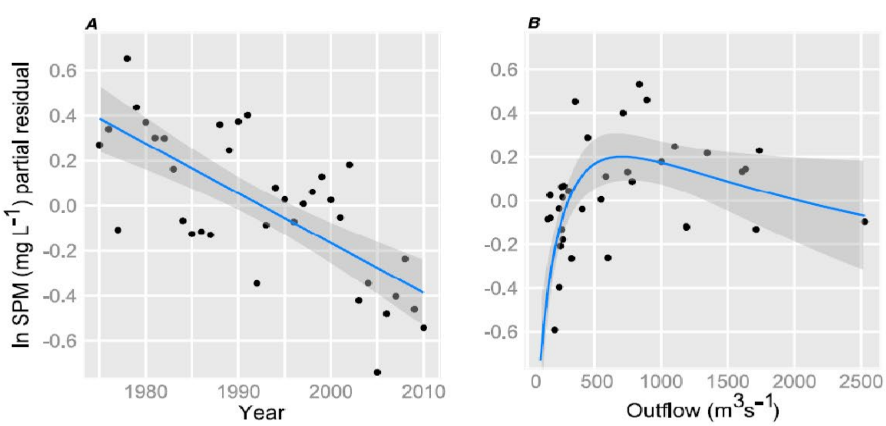

Figure 14. Partial residual plots for a regression model that accounts for variability in annual average concentration of suspended particulate matter at IEP station D8 in Suisun Bay as a result of its long-term trend (left panel) and its relationship to annual average Delta outflow (right panel). The blue lines are loess smoothers and the gray shading is the 95% confidence interval around the line. Source: Cloern and Jassby (2012).

The available catch data for delta smelt imply the species has an affinity for turbid water throughout most, if not all, of its free-swimming life (e.g., Nobriga *et al.* 2005; 2008; Feyrer *et al.* 2007; 2011; Grimaldo *et al.* 2009; Kimmerer *et al.* 2009; Mahardja *et al.* 2017a; Polansky *et al.* 2018; Simonis and Merz 2019), but there have been some recent suggestions that turbidity in the water affects the ability of fishing gears to catch delta smelt perhaps more than it is an actual habitat attribute (Latour 2016). The aquaculture techniques developed for delta smelt include rearing in black tanks under low light conditions because the fish are sensitive to highly lit circumstances (Lindberg *et al.* 2013; Hasenbein *et al.* 2016a). In addition, the tanks are circular and kept free of in-water structures. These captive rearing techniques are consistent with inhabitation of low visibility environments in the wild such as maintaining a spatial association with turbid water.

Below, we review process-based laboratory research that supports the 'turbidity as habitat' hypothesis. Then, we summarize long-term data on Secchi disk depths to demonstrate how water has remained relatively turbid where estuarine physics (Monismith *et al*. 1996; 2002) interacting with shallow water wind wave mixing (Ruhl *et al*. 2001; Bever *et al*. 2016) may contribute to an important refuge for delta smelt even though the biological productivity of this region has been substantially diminished (i.e., that phytoplankton currently contributes less to the turbidity than it once did). This turbid-water refuge occurs in the LSZ and is one of only two remaining in the range of the delta smelt. Turbid water may be a needed present-day habitat attribute because it provides cover for foraging delta smelt (Ferrari *et al*. 2014). By extension, it may be a factor modulating feeding success; one recent study found histopathologic evidence of elevated delta smelt feeding success in the turbid Cache Slough Complex and Suisun Marsh (Hammock *et al*. 2015); a follow-up study found elevated stomach fullness of delta smelt inhabiting the LSZ even though they were spatially disconnected from where zooplankton density was highest (Hammock *et al*. 2017). These findings are also qualitatively consistent with a more macroscopic study of the Delta's fish assemblages that found most native fishes, including delta smelt, to be more common in lower productivity turbid habitats than higher productivity SAV habitats (Nobriga *et al*. 2005). For these reasons, the Service believes delta smelt's association with turbid water, which in the present state of the Bay-Delta system is mainly caused by sediment suspended in the water, is a true habitat association.

It has been shown experimentally that delta smelt larvae require particles in the water to see their transparent prey (Baskerville-Bridges *et al.* 2004). Thus, without some kind of turbidity in the water, delta smelt larvae will starve to death. Another recent laboratory study using late larval stage delta smelt found that feeding success and survival varied across a gradient of turbidity (Hasenbein *et al.* 2016a). The results implied bell-shaped response curves in which both survival and feeding success were highest at intermediate values, though the results among treatment levels were only significantly different in a few cases. A similar experiment using 120-day-old juvenile delta smelt produced different results (Hasenbein *et al.* 2013). In this experiment, the authors reported that feeding success decreased as turbidity was increased; however, their results indicate that statistically speaking, turbidity had no effect except at the highest treatment level. The highest treatment level was 250 NTU which is exceptionally turbid water. It is worth noting two things about these studies. First, the turbidity in the tanks was created using algae, which is not the dominant source of water turbidity in the estuary. Second, in the studies described by Hasenbein *et al.* (2013; 2016b), the experiments were conducted under low light conditions even when turbidity was low (~ 1 lux). In the wild, a surface-oriented fish might have the benefit of both turbidity and high light conditions similar to those that experimentally optimized successful first feeding (Baskerville-Bridges *et al.* 2004).

In another laboratory experiment, the vulnerability of delta smelt to predation by largemouth bass was lower in a circa 3 NTU treatment (again, using algae) than a clear-water treatment (Ferrari *et al.* 2014). In a DNA-based diet study of field-caught predators, the predation of delta smelt larvae was strongly affected by water turbidity (Schreier *et al.* 2016). Thus, the available evidence suggests that delta smelt require turbid water to succeed in the contemporary Bay-Delta food web.

In fish survey data, the longest-term indicator of water turbidity is Secchi disk depth measurements that for several decades have accompanied most individual net tows. Secchi disk depths are basically inverses of turbidity because the less turbid the water is, the deeper into the water column a Secchi disk remains visible. The FMWT Secchi disk depth data set summarized below dates to 1967 (Figure 15).

The Secchi disk depth information suggests the increasing water clarity trends discussed above are not uniform across the upper estuary (Figure 15). From a regional perspective, they have been most pronounced in the San Joaquin River half of the Delta where SAV proliferation has been most expansive (Feyrer *et al.* 2007; Nobriga *et al.* 2008; Hestir *et al.* 2016). Consistent with this, boxplots depicting the time series of Secchi disk depth measurements from the FMWT show the previously reported increasing trend is most pronounced when and where the Secchi disk depths were taken in fresh water (upper left panel of Figure 15). In this upper left panel for which the Secchi disk depth data were summarized only when and where salinity was lower than 1.25 ppt, the previously reported trend of increasing water transparency is apparent; median Secchi disk depths have increased from about 0.5 meters with extreme values seldom exceeding 1 meter early in the time series to medians typically exceeding 1 meter and extreme values near 4 meters in recent years. When data summaries include these freshwater samples along with samples from the LSZ, the trend and extreme data points remain (upper right panel of Figure 15). This could lead to the erroneous conclusion that Secchi disk depths have been similarly increasing in the LSZ.

However, it is also important to consider the hydrodynamic aspect of water turbidity in the estuary. As mentioned above, X2 is a boundary upstream of which salinity tends to be the same from the surface of the water to the bottom, and downstream of which salinity varies from top to bottom (Jassby *et al.* 1995). That variability in salinity from surface to bottom waters is indicative of a front that helps to aggregate turbidity near X2. This does not mean it all aggregates precisely at X2; tidal dispersion results in a spatially complex distribution of sinking particles widely distributed in the LSZ (Kimmerer *et al.* 2014a). Thus, when the FMWT Secchi disk depth data set are constrained to brackish water samples, the long-term trend looks very different (lower panels of Figure 15). There is still an increasing trend over time, but it is much more modest. In particular, at a salinity near 2 to 5 ppt, Secchi disk depths have not consistently increased since the mid-1980s and observations exceeding 1 meter are still rare. Thus, there is a turbid water refuge for delta smelt that persists in the LSZ similar to the one that persists in the Cache Slough Complex.

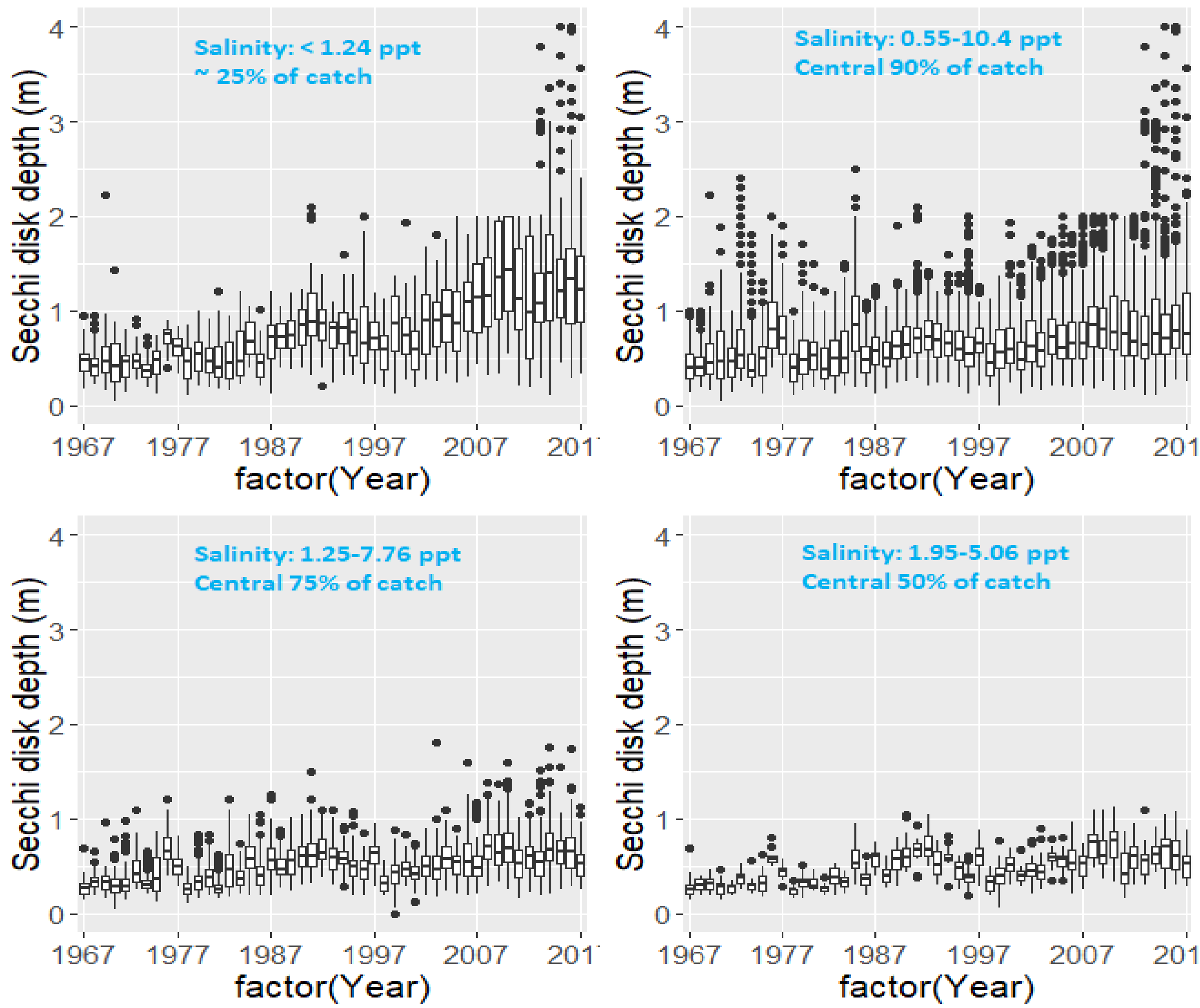

Figure 15. Boxplot time series of Secchi disk depth measurements taken during the California Department of Fish and Wildlife Fall Midwater Trawl Survey, 1967-2017. The boxes depict the central 50% of observations; the line through each box is the median. The black circles are observations outside the central 95% of observations. The data have been grouped into four salinity bins based on statistical summaries of delta smelt data (Kimmerer *et al.* 2013). The salinity range graphed is reported on each panel as is the predicted fraction of FMWT delta smelt catch. Source: Service unpublished data analysis using a specific conductance to salinity conversion described by Schemel (2001) and generalized additive model results provided by W. Kimmerer.

Water temperature: Water temperature is the primary driver of the timing and duration of the delta smelt spawning season (Bennett 2005). Water temperature also affects delta smelt's metabolic and growth rates which in turn can affect their susceptibility to contaminants (Fong *et al*. 2016), food limitation (Rose *et al*. 2013a), and readiness to spawn (Hobbs *et al.* 2007b). Water temperature is not strongly affected by variation in Delta inflows or outflows except at the margins of the Delta where these inflows enter (Kimmerer 2004). The primary driver of water temperature variation in the delta smelt critical habitat is air temperature (Wagner *et al.* 2011). Very high flows can transiently cool the upper estuary (*e.g.,* flows in the upper 10th percentile, Kimmerer 2004), but the system rapidly re-equilibrates once air temperatures begin to warm. Thus, like duration of the spawning season, other water temperature-driven mechanisms affecting recruitment and survival are not freshwater flow mechanisms.

Research initially suggested an upper water temperature limit for delta smelt of about 25°C, or 77°F (Swanson *et al.* 2000). Newer research suggests delta smelt temperature tolerance decreases as the fish get older, but is a little higher than previously reported, ranging from nearly 30°C or 86°F in the larval life stage down to about 25°C in post-spawn adults (Komoroske *et al.* 2014). These are upper *acute* water temperature limits meaning these temperatures will kill, on average, one of every two fish. Subsequent research into delta smelt's thermal tolerances indicated that molecular stress response begins to occur at temperatures at least 4°C cooler than the acute thermal maxima (Komoroske *et al.* 2015).

In the laboratory and the wild, delta smelt appear to have a physiological optimum at temperatures of about 16-20°C or 61-68°F (Nobriga *et al.* 2008; Rose *et al.* 2013a; Eder *et al.* 2014; Jeffries *et al.* 2016). Most of the upper estuary exceeds this water temperature from May or June through September (Komoroske *et al.* 2015). Thus, during summer, many parts of the estuary are energetically costly and physiologically stressful to delta smelt (Komoroske *et al.* 2014). Generally speaking, spring and summer water temperatures are cooler to the west and warmer to the east due to the differences in overlying air temperatures between the Bay Area and the warmer Central Valley (Kimmerer 2004). In addition, there is a strong water temperature gradient across the Delta with cooler water in the north and warmer water in the south. The much higher summer inflows from the Sacramento River probably explain this north-south gradient. Note that water temperatures in the north Delta near Liberty Island and the lower Yolo Bypass where summer inflows are low to non-existent, are also typically warmer than they are along the Sacramento River. This may have consequences for the survival of freshwater-resident delta smelt during comparatively warm summers (Bush 2017).

Food: Food and water temperature are strongly interacting components of the "Water" element of delta smelt critical habitat because the warmer the water, the more food delta smelt require (Rose *et al.* 2013a). If the water gets too warm, then no amount of food is sufficient. The more food delta smelt eat (or must try to eat) the more they will be exposed to predators and contaminants.

The open-water habitat use of delta smelt is reflected in their diet composition, which is largely made up of planktonic and epibenthic crustaceans (Moyle *et al.* 1992; Nobriga 2002; Hobbs *et al.* 2006; Slater and Baxter 2014). Some of the epibenthic crustaceans discussed below (e.g., amphipods and mysids) ascend into the water column at times (Kimmerer *et al.* 2002) and are therefore available to predators foraging in the open water. A large majority of the identifiable prey of delta smelt larvae is copepods, particularly the early life stages of copepods (Nobriga 2002; Hobbs *et al.* 2006; Slater and Baxter 2014). Juvenile delta smelt feeding in the summer months also have copepod-dominated diets, but these larger individuals tend to eat adult copepods and also begin to include prey taxa in their diets that grow larger than copepods (Slater and Baxter 2014; Figure 16). The older juveniles and adults continue to prey on copepods, but have less reliance on them and greater diet diversity (Moyle *et al.* 1992; Slater and Baxter 2014; Whitley and Bollens 2014; Figures 17 and 18). All of the delta smelt's major prey taxa (e.g., copepods, amphipods) are ubiquitously distributed, but which prey species are present at particular times and locations changes from early morning to mid-day, season to season, and has changed dramatically over time (Kimmerer *et al.* 2002; Winder and Jassby 2011; Kratina *et al.* 2014). The latter two have likely affected delta smelt feeding success (Kimmerer and Rose 2018).

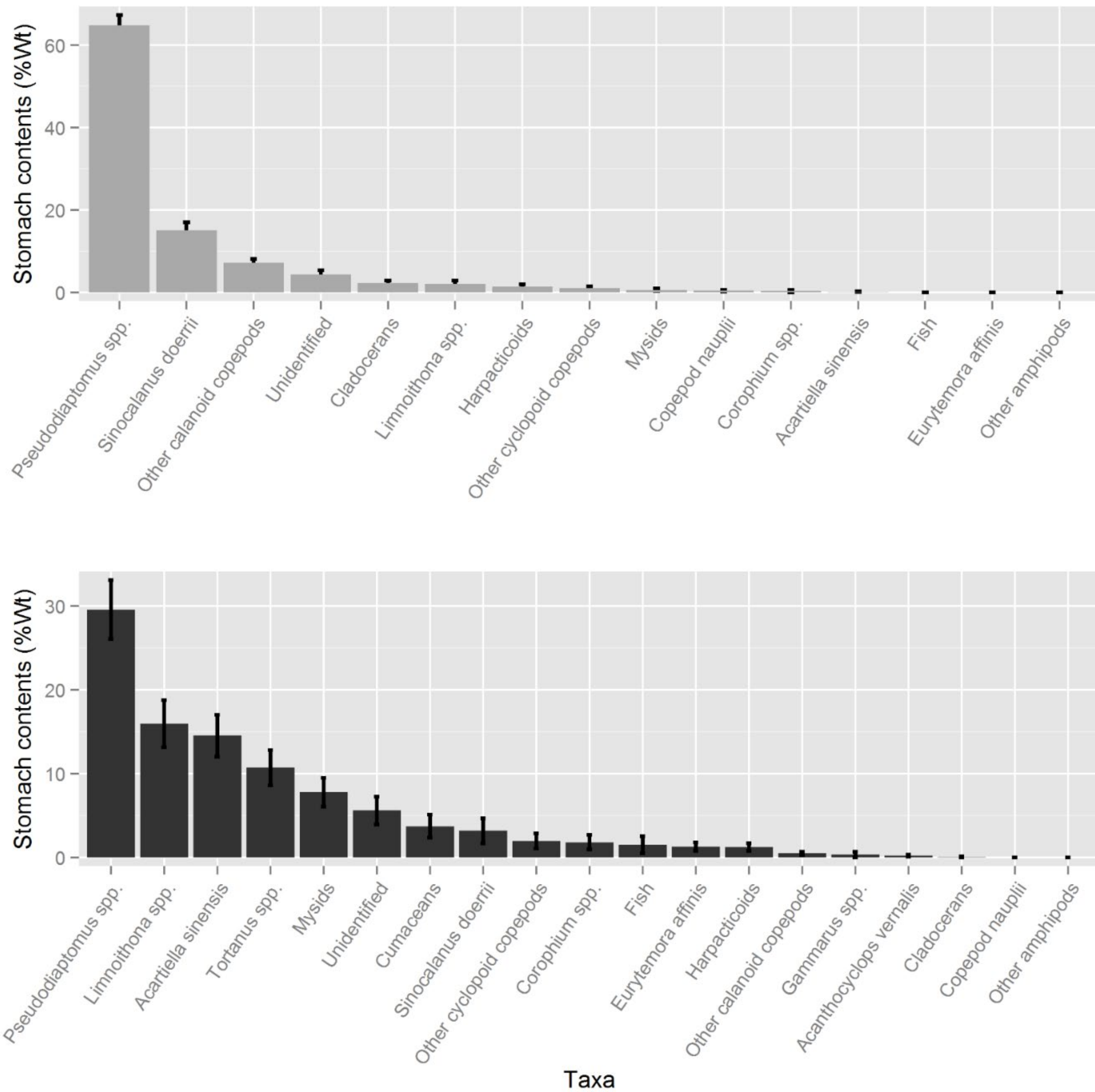

Figure 16. Diet compositions of delta smelt collected by the TNS upper panel for stations with a salinity lower than 0.55 ppt and lower panel for stations with a salinity greater than or equal to 0.55 ppt. Of the prey taxa listed on the x-axis, the ones that are *not* copepods are Cladocerans, Mysids, Corophium spp., Fish, Other Amphipods, Cumaceans, and Gammarus spp. Source: supplemental material for Hammock *et al.* (2017).

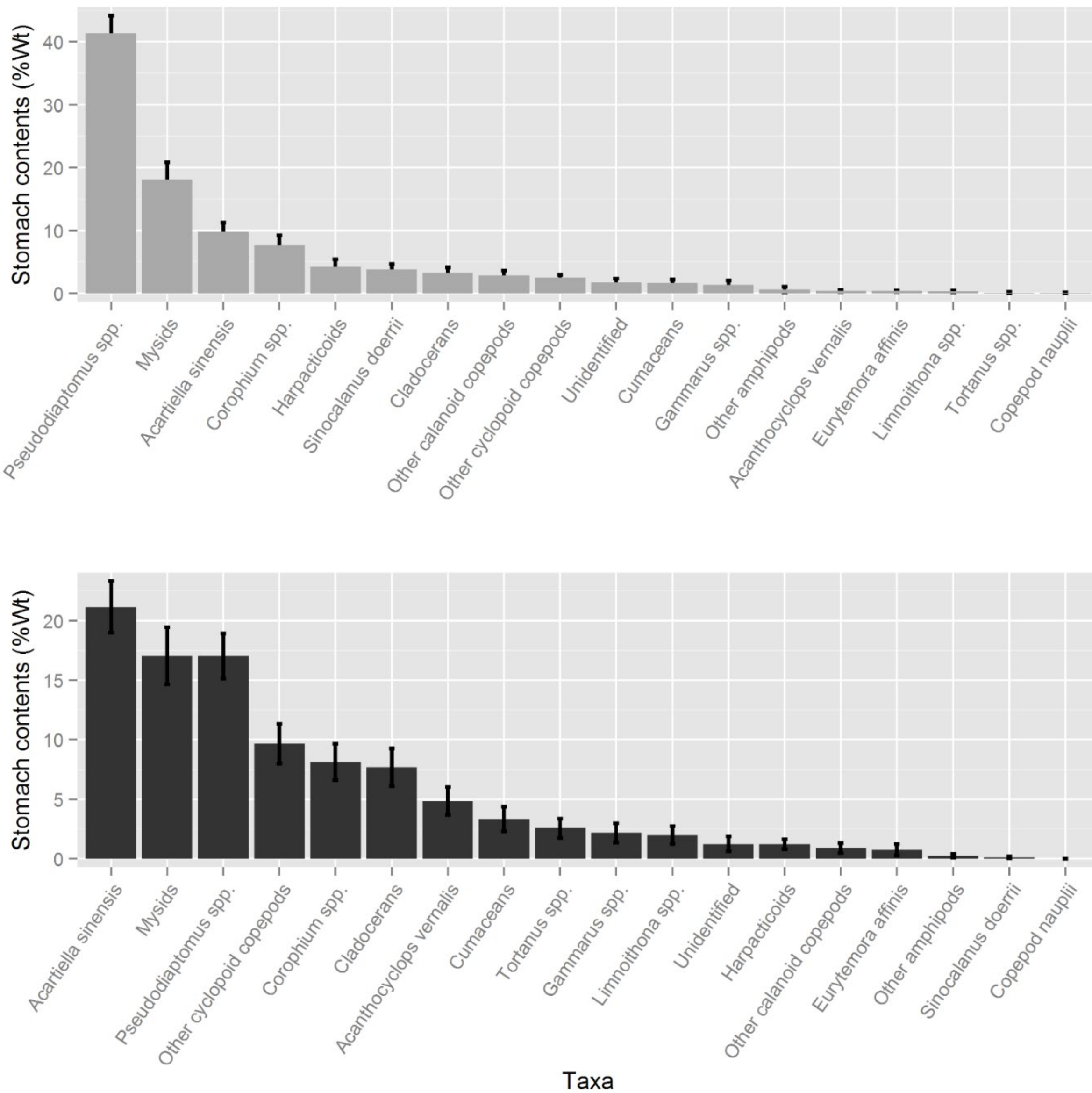

Figure 17. Diet compositions of delta smelt collected by the FMWT upper panel for stations with a salinity lower than 0.55 ppt and lower panel for stations with a salinity greater than or equal to 0.55 ppt. Of the prey taxa listed on the x-axis, the ones that are *not* copepods are Cladocerans, Mysids, Corophium spp., Other Amphipods, Cumaceans, and Gammarus spp. Source: supplemental material for Hammock *et al.* (2017).

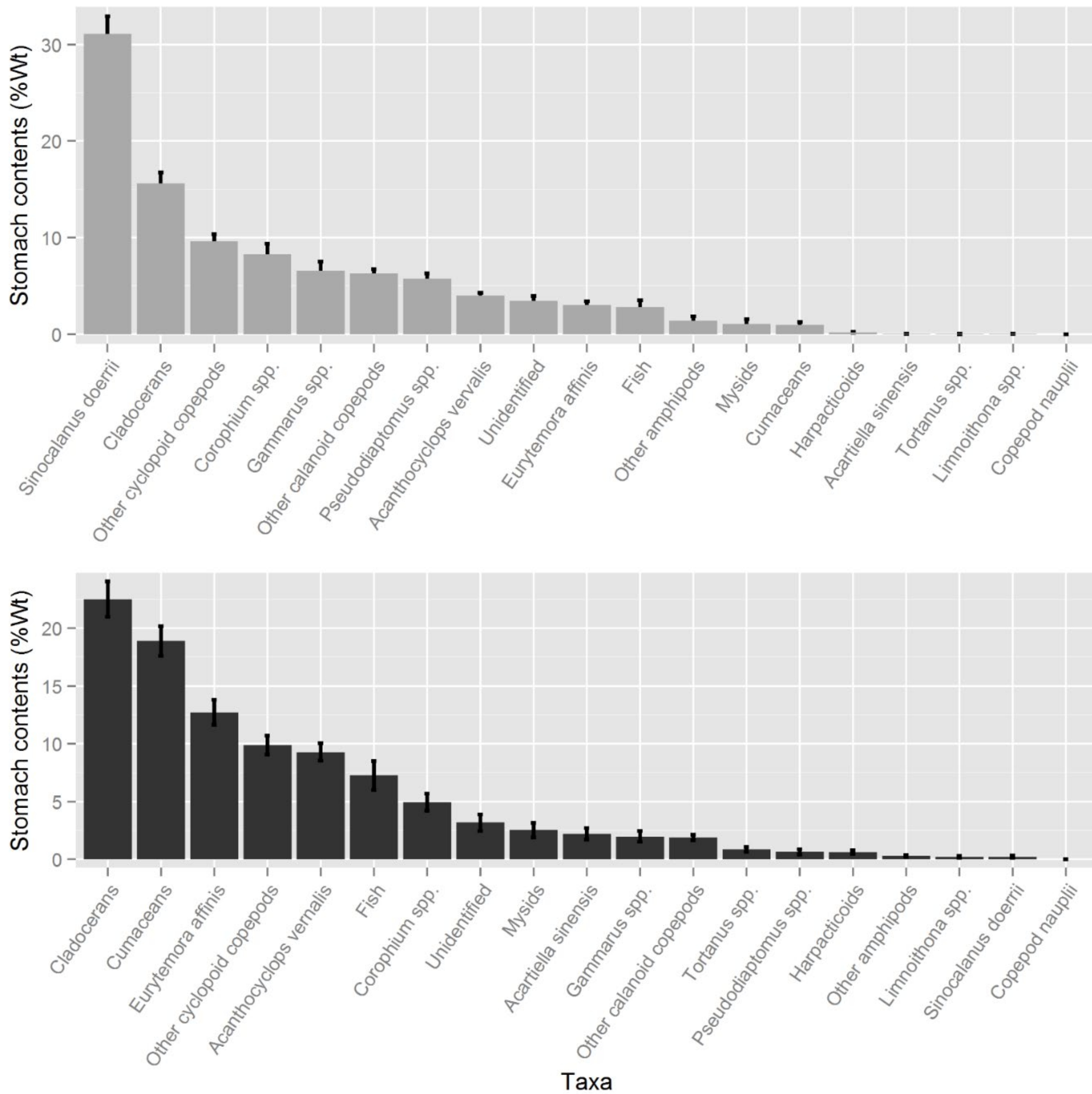

Figure 18. Diet compositions of delta smelt collected by the SKT upper panel for stations with a salinity lower than 0.55 ppt and lower panel for stations with a salinity greater than or equal to 0.55 ppt. Of the prey taxa listed on the x-axis, the ones that are *not* copepods are Cladocerans, Mysids, Corophium spp., Fish, Other Amphipods, Cumaceans, and Gammarus spp. Source: supplemental material for Hammock *et al.* (2017).

An influence of copepod production on the production of delta smelt has been a common finding in quantitative modeling research on delta smelt's population dynamics (Mac Nally *et al.* 2010; Maunder and Deriso 2011; Miller *et al.* 2012; Rose *et al.* 2013a; Hamilton and Murphy 2018; Kimmerer and Rose 2018).

The earliest published paper on a freshwater flow influence on fish production in the Bay-Delta posited that the mechanisms producing striped bass worked primarily through the LSZ food web (Turner and Chadwick 1972). Specifically, these authors suggested that higher Delta inflow stimulated the food web that supported striped bass and increased turbidity which hid them from their predators. Because IEP monitoring was originally set up to better understand striped bass recruitment, the IEP has monitored the pelagic food web extensively since the 1970s (Brown *et al.* 2016b).

The varied sources of primary productivity that fuel estuarine fish production are an area of active research in the Bay-Delta (Sobczak *et al.* 2002; 2005; Grimaldo *et al.* 2009; Howe and Simenstad 2011; Schroeter *et al.* 2015). As is the general case in open-water food webs of estuaries and coastal marine systems, diatoms are the dominant source of primary productivity supporting open-water fish production (Sobczak *et al.* 2002; 2005; Grimaldo *et al.* 2009). Phytoplankton-based and submerged aquatic vegetation-based food webs can be separated on the basis of stable isotopes of carbon and nitrogen, but phytoplankton-based food web paths cannot be clearly separated from pathways based on terrestrial vegetation using these isotopes (Grimaldo *et al.* 2009; Schroeter *et al.* 2015). Sulfur isotopes may provide greater ability to discern among sources within and near tidal marsh environments, but to date, have not been extensively evaluated in the Bay-Delta (Howe and Simenstad 2011). The production of littoral and bottom-feeding fishes is supported by a greater fraction of non-planktonic primary producer sources (Grimaldo *et al.* 2009; Schroeter *et al.* 2015). These non-planktonic food web pathways likely have some importance to delta smelt (Whitley and Bollens 2014; Hammock *et al.* 2019).

There may be tremendous potential for benthic and epiphytic processes to periodically subsidize delta smelt's food supply, and these subsidies may occur at critical times of need, yet such pathways remain underemphasized and understudied. It is common for estuarine amphipods to rise into the water column to relocate to newly formed depositional areas, where they feed on deposited detritus and other organic materials; their successive landward movements via repeated use of selective tidal stream transport (STST, or "tidal surfing") diminish in terms of distance of upstream travel, but ultimately place them within depositional habitats (Hough and Naylor 1992; Forward and Tankersley 2001; Naylor 2006). This behavior results in the amphipods spending a great deal of time in the water column, especially when the water is dimly lit. Being in the water column may make the amphipods more available as prey for delta smelt, but the amphipods are nevertheless energetically tied to benthic basal resources, despite their spending a great deal of time in the water column (i.e., they are still energetically tied to primary production that is bottom-associated: vascular plant detritus, phytodetritus, or benthic microalgae, as opposed to phytoplankton). Mysids, on the other hand, are harder to generalize, as some species are herbivorous, some are predatory, and some are omnivorous. They also use STST, which likely increases their availability to (adult) delta smelt (Wooldridge and Erasmus 1980; Orsi 1986). Thus, depending on mysid species, they may or may not link delta smelt to benthically driven energy pathways.

Jassby *et al*. (1993) estimated benthic microalgae to be responsible for nearly 30% of the primary production in upper San Francisco Bay, inclusive of delta smelt habitat. Light penetration has since improved as turbidity has decreased (Parker *et al*. 2012a), and so this ~30% contribution may have increased dramatically. Jassby *et al*. (1993) provided no estimate for epiphytic microalgae associated with SAV and the zones of emergent grass stems (in marshes) that are near the surface and within the photic zone. Even if the photic zone is just a few centimeters deep, these substrates, when added together, can provide very large surface areas for epiphytic production.

There are two clam species that affect phyto- and zooplankton biomass within the distribution of the delta smelt population. The freshwater *Corbicula fluminea*, which has been in the Delta and its tributary rivers since the 1940s, and the estuarine overbite clam *Potamocorbula amurensis*, which started invading the estuary in 1986 and was well-established within a year (Alpine and Cloern 1992). The freshwater clam can suppress diatom production in shallow freshwater habitats (Lucas *et al.* 2002; Lopez *et al.* 2006). However, the overbite clam appears to have a larger impact on the food web than the freshwater clam (Alpine and Cloern 1992; Jassby *et al.* 2002; Kimmerer and Thompson 2014), so the focus of this review will be on the overbite clam.

In the 1970s and early 1980s, scientists had learned that year-to-year variation in Delta inflow (or salinity at Chipps Island) - especially during the spring and summer - drove the year-to-year variation in the productivity of the low-salinity zone food web (Cloern *et al.* 1983; Knutson and Orsi 1983). In wet years, the flow brought a lot of nutrients and organic carbon into the low-salinity zone (Jassby and Cloern 2000) where it fueled food web production as Delta outflow seasonally decreased into an optimal range estimated by Cloern *et al.* (1983) to be about 100 to 350 cubic meters per second (about 3,500 to 12,400 cubic feet per second (cfs)). In dry years, elevated salinity allowed a marine clam (*Mya arenaria*) to colonize Suisun Bay and graze the diatoms down to low levels. This in turn lowered the production of the mysid shrimp (*Neomysis mercedis*), which was a key food source for several fish species, particularly striped bass (Knutson and Orsi 1983; Orsi and Mecum 1996; Feyrer *et al.* 2003). This stimulation of mysid shrimp production was one of the food web mechanisms that Turner and Chadwick (1972) had hypothesized led to higher striped bass production in higher flow years. Similar 'fish-flow' relationships were later established for longfin smelt (*Spirinchus thaleichthys*) and starry flounder (*Platyichthys stellatus*); both of these fish are also mysid shrimp predators and were shown to have step-declines in their abundance indices associated with the overbite clam invasion (Kimmerer 2002b).

The overbite clam, once established (~ 1987), resulted in a permanent source of loss to diatoms and copepods in the LSZ that resulted in rapid step-declines in the abundance of the most important historical food web components: diatoms, mysid shrimp, and *Eurytemora affinis*; the latter is a copepod that was a major prey for both the opossum shrimp (Knutson and Orsi 1983) and delta smelt (Moyle *et al.* 1992). Unlike striped bass, longfin smelt, and starry flounder, no change in delta smelt abundance occurred coincident with the establishment of the overbite clam (Stevens and Miller 1983; Jassby *et al.* 1995; Kimmerer 2002b; Mac Nally *et al.* 2010; Thomson *et al.* 2010). However, the average size of delta smelt declined somewhat (Sweetnam 1999; Bennett 2005).

Some scientists have hypothesized that the diatom decline was caused by wastewater treatment plant inputs of ammonium or changes in the ratios of dissolved forms of nitrogen that support aquatic plant growth more than by overbite clams (Glibert *et al.* 2011; Dugdale *et al.* 2012; Parker *et al.* 2012b; Wilkerson *et al.* 2015). One piece of evidence used to support this hypothesis is an observation that ammonium was frequently crossing a critical 4 micro-molar threshold concentration for diatom growth at about the same time the overbite clam became established. These researchers have established that uptake of dissolved ammonium inhibits the growth rate of diatoms in the Bay-Delta. However, diatoms can still grow on ammonium, and actually take it into their cells preferentially over nitrate; they just grow more slowly using ammonium as their cellular nitrogen source (Glibert *et al.* 2015). This means that 'but for' the overbite clam, the diatom population in the LSZ would eventually build up enough biomass each year to metabolize ambient ammonium concentrations to levels below the 4 micro-molar threshold and then increase their growth rate using the nitrate that is also in the water. Thus, although nitrogen chemistry could be a problem, a more fundamental one is that as Delta outflow declines during the spring into early summer to levels that could enable diatom blooms, the water temperature is rising and that supports reproduction of the overbite clam. With help from a few other abundant grazers (Kimmerer and Thompson 2014), the growing overbite clam population depletes diatoms faster than they can metabolize the ammonium in the water. Thus, clam grazing is the fundamental reason that summer-fall diatom blooms no longer occur (Cloern and Jassby

2012; Kimmerer and Thompson 2014; Cloern 2019). During spring when Delta outflow is higher, outflow can interact with other factors to limit diatom accumulation as well (Dugdale *et al.* 2012; 2016). Note that Dugdale *et al.* (2016) suggested that available estimates of the overbite clam grazing rate were over-estimates, but this assertion has been contested (Kimmerer and Thompson 2014; Cloern 2019).

The largest source of dissolved ammonium is the Sacramento Regional Wastewater Treatment Plant. Upgrades to the facility are expected to occur in 2021-2023, which will result in reductions in dissolved ammonium concentrations in the Delta. It is scheduled to significantly reduce its nitrogen effluent concentrations beginning in 2023. Once that happens, it should become apparent within a few years how important ammonium ratios are in limiting diatom production in the Bay-Delta.

Because the overbite clam repressed the production of historically dominant diatoms and zooplankton, there were numerous successful invertebrate species invasions and changes in plant communities that followed for a decade or so thereafter (Kimmerer and Orsi 1996; Bouley and Kimmerer 2006; Winder and Jassby 2011). Changing nutrient ratios (including the forms of nitrogen and the ratios of nitrogen and phosphorus) necessary for plant growth may also have contributed to changing phytoplankton and plant communities (Glibert *et al.* 2015; Dahm *et al.* 2016). In addition, extreme drought and propagule pressure are also thought to have directly contributed to the zooplankton species changes (Winder *et al.* 2011). The most important changes for delta smelt have been changes to the copepod community. The copepod invasions of the late 1980s and early 1990s actually helped stem (but not recover the system from) what had been a major decline in copepod abundance (Winder and Jassby 2011). Prior to the overbite clam, delta smelt had diets dominated by *E. affinis* from the time the larvae started feeding in the spring until at least the following fall (Moyle *et al.* 1992). The overbite clam suppressed the production of *E. affinis* (Kimmerer *et al.* 1994; Kimmerer and Orsi 1996) and that seems to have opened the door for several non-native copepods including *Pseudodiaptomus forbesi*, which became the new main prey of delta smelt from late spring into the fall (Moyle *et al.* 1992; Nobriga 2002; Hobbs *et al.* 2006; Slater and Baxter 2014; Hammock *et al.* 2017; Figures 16 and 17).

There is general agreement among quantitative delta smelt models that the production of copepods including *P. forbesi* are important to recruitment and survival (Kimmerer 2008; Maunder and Deriso 2011; Miller *et al.* 2012; Hamilton and Murphy 2018; Kimmerer and Rose 2018; Simonis and Merz 2019). Recognition of *P. forbesi*'s importance to delta smelt led to substantial research into this non-native copepod's population dynamics (Kimmerer and Gould 2010; Sullivan *et al.* 2013; Kimmerer *et al.* 2014b; Kayfetz and Kimmerer 2017; Kimmerer *et al.* 2018a,b). The delta smelt's primary historical prey (*E. affinis*) bloomed from within the LSZ and had peak abundance near X2 (Orsi and Mecum 1986). This copepod still blooms each spring, but disappears by summer due to overbite clam grazing (Kimmerer *et al.* 1994). The same thing happens to *P. forbesi* in the LSZ (Kayfetz and Kimmerer 2017). However, the *P. forbesi* population survives the summer because its center of reproduction is in freshwater habitats landward of the LSZ. It would disappear from the LSZ altogether were it not for a constant replenishment (or subsidy) from upstream where the overbite clam and a predatory non-native copepod are less abundant. It is the combination of tidal mixing and Delta outflow that seems to provide this subsidy (Kimmerer *et al.* 2018a,b). Thus, this subsidy of *P. forbesi* to delta smelt inhabiting the turbid water refuge of the LSZ appears to be of substantial importance – particularly during the summer and fall.

The most obvious test of whether the overbite clam affected delta smelt is a before-after comparison. As mentioned above, this has been tested several times and no obvious effect like the ones reported for striped bass, longfin smelt, and starry flounder has been established. Rather, the first big decline in delta smelt abundance occurred prior to the overbite clam invasion and the second one about 15 years afterward. Thus, if copepod production limits delta smelt production, it is either a part-time limit (e.g., Hamilton and Murphy 2018), or (a) it was a limiting factor prior to the overbite clam, and (b) it did not become a further limit until sometime thereafter. These are not mutually exclusive hypotheses.

Contaminants: Research conducted over the past 10 years suggests that delta smelt are fairly susceptible to contaminants (e.g., Connon *et al.* 2009; 2011a,b; Hasenbein *et al.* 2014; Jeffries *et al.* 2015; Jin *et al.* 2018). The effects of ambient Sacramento River water, pyrethroid pesticides, several herbicides, copper, and ammonium have all been examined and all of these compounds have shown at least sub-lethal effects represented by changes in gene expression. In some cases, delta smelt were exposed to higher than observed concentrations of some compounds in order to estimate their LC_{50}, the estimated concentration that kills half of the test fish over the study duration. Exposure durations have varied widely among studies (4 hour to 1 week), which limits the ability to quantitatively compare toxicity among studies. The loading of some contaminants into the habitats occupied by delta smelt can be functions of freshwater flow inputs (e.g., Kuivila and Moon 2004; Weston *et al.* 2014; 2015) so in some instances, the impacts of contaminants can be freshwater flow mechanisms. However, the impacts of others may be related to where individuals are located (Hammock *et al.* 2015), what delta smelt eat, or water temperature-based demand for prey, all of which could affect the quantities of biomagnifying substances that get ingested over the life span of the fish.

PCE #3: “River flow” was originally believed to be critical as transport flow to facilitate an extended spawning migration by adult fish and the transport of offspring to LSZ rearing habitats (Service 1994). However, it has since been shown that although some individual fish may embark on what could be considered a short spawning migration, there is no population-scale spawning migration *per se*, and that most transport and retention mechanisms for delta smelt (and their prey) involve the selective use of tidal currents rather than net flows (Kimmerer *et al.* 1998; 2002; Bennett *et al.* 2002; Kimmerer *et al.* 2014a; Bennett and Burau 2015). River flow includes both inflow to and outflow from the Delta, both of which influence the net movements of water through the Delta and further into the estuary (Kimmerer and Nobriga 2008). As mentioned above, these variations in freshwater flow affect the spatial distribution of salinity including X2, which in turn exert some influence on the distribution of delta smelt (Sweetnam 1999; Dege and Brown 2004; Feyrer *et al.* 2007; Nobriga *et al.* 2008; Sommer *et al.* 2011; Manly *et al.* 2015; Polansky *et al.* 2018; Simonis and Merz 2019).

Net water movements in the Delta have recently been reconstructed and analyzed for long-term trend attribution (Hutton *et al.* 2019; Figure 19). This analysis demonstrated several net flow variables have experienced strong time trends since water exports from the Delta began. In particular, cross-Delta flows have increased during the summer and fall, Rio Vista flows have decreased in the winter and spring and increased in the summer, Jersey Point flow and Old and Middle river flow (OMR) have decreased year-around. The change attribution indicated that CVP and SWP operations were predominantly the source of these net flow changes except for Jersey Point flow in the spring, which is also strongly influenced by in-Delta irrigation demand. The net flow changes ultimately influence Delta outflow, which as discussed above, has been trending downward for more than 100 years.

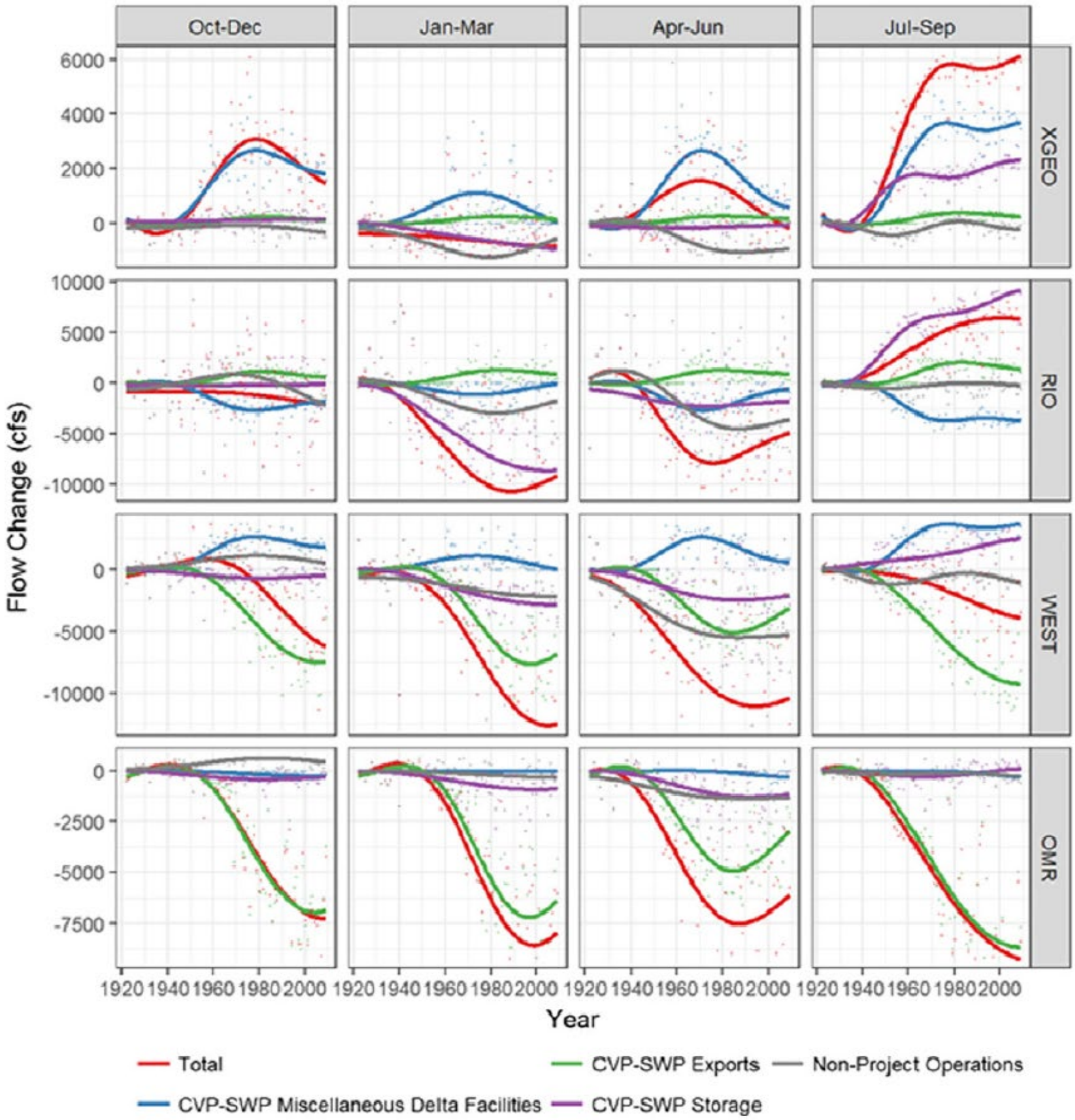

Figure 19. Time series (1922-2009) of statistical trend outputs of annual cross Delta flows (XGEO), net flow at Rio Vista (RIO), net flow at Jersey Point on the San Joaquin River (WEST), and net flow in Old and Middle rivers (OMR). For XGEO net north to south flows have positive values. For RIO and WEST, net seaward (downstream) flows have positive values. For OMR, which seldom has positive values, net north to south flows are depicted as negative values. The colored lines reflect the statistical trend in the time series with the different colors reflecting the relative contributions of the sources listed in the legend. Source Hutton *et al.* (2019).

A concise summary of the contemporary Delta outflow hydrograph is shown in Figure 20. A value on the y-axis of 0.5 suggests that an outflow on a given day has had an equal chance of being at least as high as one or in some cases all three of the chosen thresholds. Delta outflow at least as high as the Roe Island standard freshens the estuary enough for delta smelt to spawn in typically brackish regions like the Napa River and western Suisun Marsh, and tends to reduce the likelihood of entrainment. Delta outflows at least as high as the Chipps Island standard tend to generate LSZ coverage throughout much or all of Suisun Bay. Outflows near the Collinsville standard are associated with a typical X2 slightly upstream of the confluence of the Sacramento and San Joaquin rivers with low-salinity conditions extending into, but not throughout Suisun Bay and marsh. The water management response to D-1641 has been to increase the intra-annual variability in outflows. The greater intra-annual variability is related to the more frequent meeting of these flow thresholds in the winter and spring as required by D-1641, with lower frequency in the fall. This pattern is especially pronounced for outflows greater than or equal to 7,100 cfs ("Collinsville") and 11,400 cfs (Chipps Island; Figure 20). The same pattern is visible for 27,200 cfs ("Roe Island"; Figure 20), but with less change (mainly days 100-150 and 325-350, which correspond to April and the November-December transition). This does more closely mimic the timing and duration of the natural Delta outflow hydrograph than occurred during the 1968-1994 period, though the magnitude is considerably lower as discussed above (Figures 5, 9, and 10). Note that the DAYFLOW calculations used to make Figure 20 can be highly uncertain at values lower than about 10,000 cfs (Monismith 2016).

The tidal and net flow of water toward the south Delta pumping plants is frequently indexed using OMR (Grimaldo *et al.* 2009; Andrews *et al.* 2017; Figure 19). The tidal and net flows in Old and Middle rivers influence the vulnerability of delta smelt larvae, juveniles, and adults to entrainment at the Banks and Jones facilities (Kimmerer 2008; 2011; Grimaldo *et al.* 2009). Currently available information indicates that OMR is a very good indicator of larval delta smelt entrainment risk (Kimmerer 2008; 2011). When the fish reach the juvenile stage, they can leave the south Delta to avoid adverse water temperatures (Kimmerer 2008). When maturing adults disperse the following winter, their advection into the south Delta can be affected by OMR flow, but turbidity is also an important mediator of their entrainment risk (Grimaldo *et al.* 2009). The Service's experience, particularly since 2008, is that the risk of seeing entrained fish in CVP or SWP fish salvage is low if south Delta turbidity remains less than 12 NTU.

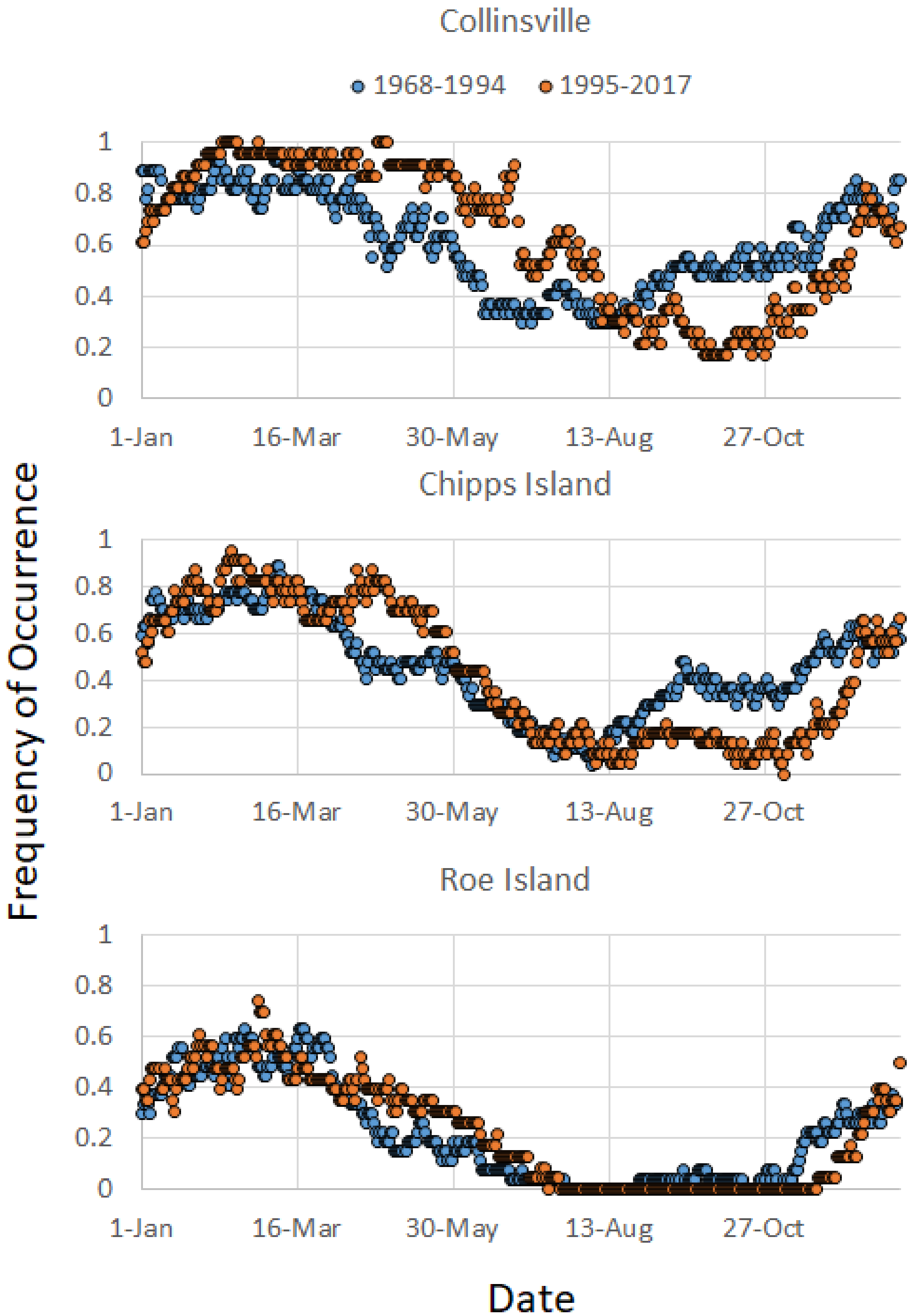

Figure 20. Daily frequency that the Net Delta Outflow Index (NDOI) was at least as high as the steady-state thresholds for the D-1641 'X2 standard' for January 1 to December 31, 1968-1994 (pre-Bay Delta Accord; blue symbols) and 1995-2017 (post Bay Delta Accord; orange symbols). The X2 standards outlined in the Bay Delta Accord were adopted into D-1641. The steady-state NDOI thresholds used to calculate the frequencies were Roe Island ≥ 27,200 cfs, Chipps Island ≥ 11,400 cfs, and Collinsville ≥ 7,100 cfs. For reference, a frequency of 0.5 means an NDOI at least as high as the threshold occurred half of the time on a given day. Note that this plot is intended to provide a concise view of the seasonality of Delta outflow. It is not intended to reflect anything about compliance or non-compliance with D-1641, which can be based on Delta outflow, salinity, or X2. Source: Service unpublished analysis of the DAYFLOW database.

PCE # 4: "Salinity". Fish assemblages are able to lessen competition among species and life stages by partitioning habitats. For instance, some fish species and life stages are more shoreline oriented whereas others are more offshore oriented. Some species are better adapted to midwater or surface waters, while others are more adapted to stay close to the substrate. Some fish are tolerant of turbidity, while others are not. In estuaries, salinity is often a dominant factor separating different groups of fishes (e.g., Bulger *et al.* 1993; Edgar *et al.* 1999). Similarly, in the Bay-Delta, dominant fishes replace one another at several places along the salinity gradient (Feyrer *et al.* 2015).

Delta smelt is part of the fish assemblage that uses the low-salinity waters of the estuary (Kimmerer *et al.* 2009; 2013). Thus, the Primary Constituent Element "Salinity" helps define its nursery habitat (Service 1994). Freshwater flow into the estuary, and Delta outflow in particular, is the most significant mechanism affecting the salinity distribution of the estuary (Jassby *et al.* 1995; MacWilliams *et al.* 2015). Thus any recruitment or survival mechanisms that change in intensity as functions of salinity, or where particular ranges of salinity are distributed, are ultimately freshwater flow mechanisms (see Kimmerer 2002a). As discussed above, these may include the spatial extent of spawning habitat (Hobbs *et al.* 2007a), the availability of low velocity water refuges that remain turbid (Bever *et al.* 2016), and population-scale entrainment in water diversions (Kimmerer and Nobriga 2008; Kimmerer 2008). Some contaminant exposure and dilution mechanisms are also related to changes in freshwater flow inputs. For instance, the toxicity of water in creeks flowing into Suisun Marsh and the Delta can increase when storms increase flows that mobilize contaminated sediment (Weston *et al.* 2014; 2015). At a larger spatial-temporal scale, water toxicity varies regionally and seasonally, and may on average, be higher in years with low winter-spring inflows (Werner *et al.* 2010).

Initial research indicated that delta smelt have an upper acute salinity tolerance of about 20 ppt (Swanson *et al.* 2000) which is about 60% of seawater's salt concentration of 32-34 ppt. Newer research suggests that some individual delta smelt can acclimate to seawater, but that about one in three juveniles and one in four adults die within a few days if they are rapidly transitioned from low-salinity water to marine salinity water (Komoroske *et al.* 2014). The survivors can live for at least several weeks in seawater, but lose weight (Komoroske *et al.* 2014; 2016). This clear evidence of physiological stress for delta smelt exposed to seawater has not been observed at lower salinity challenges – including salinities as high as 18-19 ppt. Different molecular responses have been observed, particularly at salinities higher than 6 ppt (Komoroske *et al.* 2016). These different molecular responses may reflect physiological stress, but this is not certain. There are currently several published studies that have examined aspects of delta smelt physiology at salinities in the 12-19 ppt range; none have found obvious evidence of an inability of the delta smelt to adjust its physiology to handle salinity in this range (Komoroske *et al.* 2014; 2016; Kammerer *et al.* 2016; Davis *et al.* 2019).

These findings are interesting because peak catches of early life stage wild delta smelt have occurred in fresh- or very low-salinity water and peak catches of juvenile and sub-adult fish have occurred at salinities that typify the LSZ. This contrast between where most wild delta smelt have been collected and what laboratory research indicates they can tolerate suggests one of three things. One possibility is there is a persistent laboratory artifact, though we are not aware of what such an artifact would be. A second possibility is that the analyses that have been done to date may not have accounted for change through time that has covaried with declining catches. For instance, in a recent analysis of the SKT Survey, Castillo *et al.* (2018) found that when salinity was higher during sampling (i.e., during periods of low outflow) delta smelt and other fishes were collected from a higher mean salinity. The third possibility is that a discrepancy between field salinity distribution and laboratory results may be evidence that delta smelt's distribution along the estuary salinity gradient is due to a factor or factors other than salinity *per se*. Historically, delta smelt's prey were most abundant in the LSZ, but that has not been the case for more than 30 years. One explanation that may better align with recent laboratory research is that turbidity is the more important physical habitat attribute. Relatively turbid waters occur as a mobile front within the LSZ (Figure 15), occur regularly in Grizzly and Honker bays (Bever *et al.* 2016), and the Cache Slough complex (Sommer and Mejia 2013), all of which are places delta smelt have frequently been collected. This could mean that hiding from predators or minimizing competition are the more relevant drivers of delta smelt distribution. The Service has permitted the use of cultured fish enclosures placed along the estuary salinity gradient to explore this possibility.

The Service used the FMWT data to re-evaluate delta smelt salinity distribution and included equivalent data for five other open-water species to provide context. We analyzed the data separately for pre- and post-overbite clam eras given the large changes in food web function and fish distribution that occurred following its invasion (e.g., Kimmerer 2002b; Kimmerer 2006). To generate Figure 21, we converted the specific conductance data recorded during FMWT sampling to salinity using the equation provided by Schemel (2001) and created salinity bins spanning 1 ppt. We normalized the catch of each species each year relative to salinity so that years of high abundance would not contribute to the results more than years of low abundance. We did this by setting each year's maximum catch of each species to one, and converting smaller catches to fractions of these annual maxima. We then summarized the results with boxplots that show the interannual variability in normalized catch relative to the salinity gradient. Note that catch data were converted to biomass estimates before normalizing.

Of the species summarized in Figure 21, the delta smelt showed the smallest change in distribution relative to salinity after the overbite clam invasion. This is partly because delta smelt is the only one that has never been recorded at a salinity higher than about 20 ppt, which is consistent with previous field data summaries and the laboratory results reviewed above. There are small modes in delta smelt biomass in the LSZ and a general tapering off (with occasional exceptions in particular 1 ppt bins) out to 20 ppt. The northern anchovy data show the skew toward more marine waters that was described by Kimmerer (2006). Longfin smelt and age-0 striped bass had a more even distribution relative to salinity after the overbite clam than they did before. In contrast, American shad had a relatively even distribution across the salinity gradient before the overbite clam, but its distribution has been skewed into somewhat fresher water since. Threadfin shad appear to have greater relative use of the LSZ since the overbite clam, and perhaps higher salinity water more generally. Collectively, these data suggest some re-distribution of the upper estuary fish assemblage has occurred since the 1980s. We note that because mean salinity of the FMWT sampling grid has increased as well (Feyrer *et al.* 2007; 2011) some of these changes may also reflect that trend (e.g., northern anchovy, longfin smelt, striped bass, and threadfin shad). In contrast, the shift toward fresher water by American shad and the lack of major change by delta smelt suggest these species' spatial distribution has changed – if it had not, they would be distributed in more saline water like the other four species. For delta smelt, this distribution shift to the east is consistent with what has been reported previously (Feyrer *et al.* 2007; 2011; Sommer *et al.* 2011; Sommer and Mejia 2013).

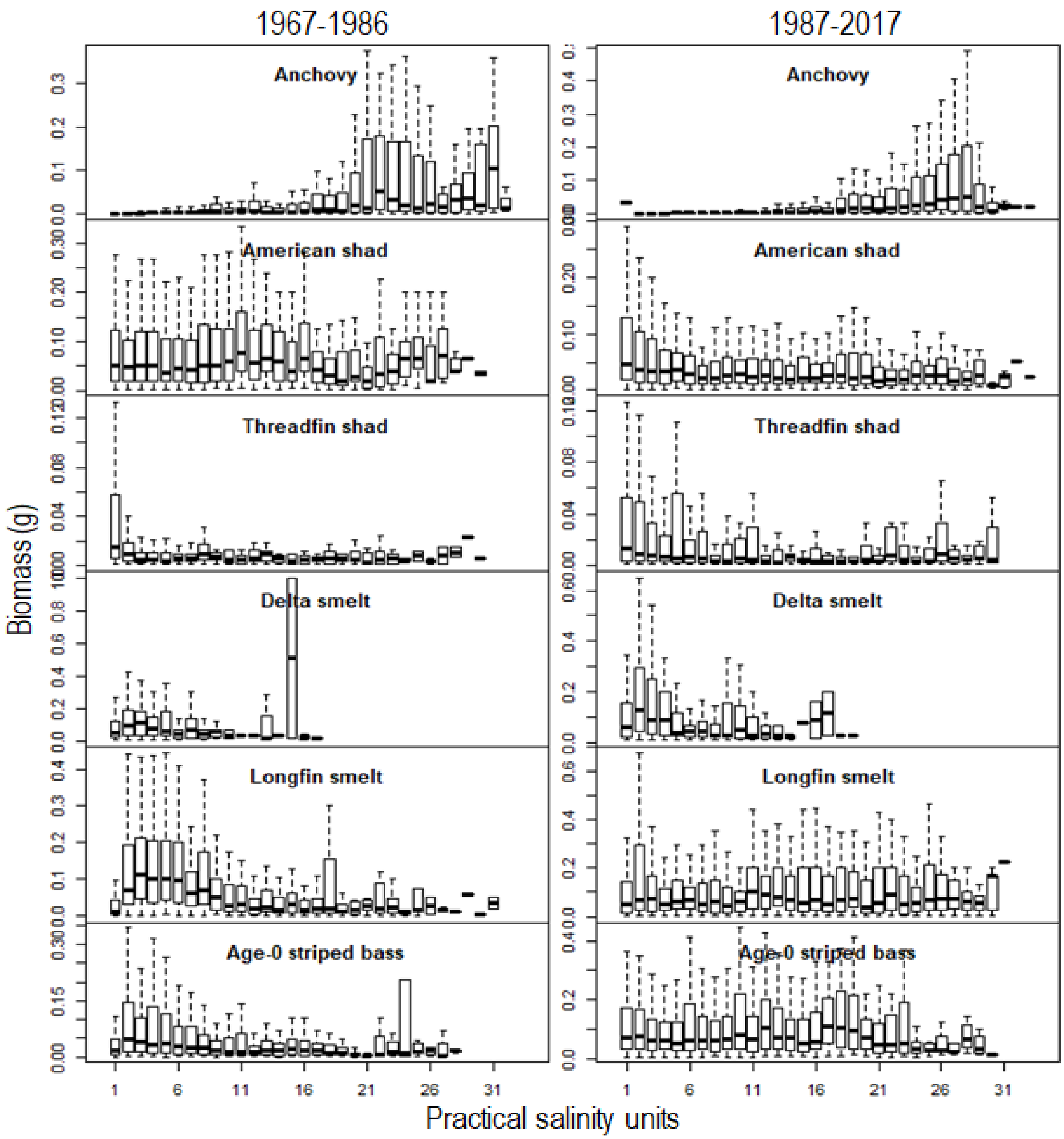

Figure 21. Salinity distributions of Fall Midwater Trawl catch for six pelagic San Francisco Estuary fishes, summarized by pre-overbite clam invasion years (1967-1986) and post-invasion years (1987-2017). Each Fall Midwater Trawl sample was associated with a specific conductance measurement, which was converted to practical salinity units. Annual frequencies of positive catches for each species, binned into one salinity unit increments, were divided by the total positive catch for each year-species combination, to yield proportional positive catch by salinity. Proportions represented annual distributions along the salinity gradient. Within each salinity bin and across years, the distributions of proportional catches were summarized with boxplots.

Summary of Status of Delta Smelt Critical Habitat

The Service's primary objective in designating critical habitat was to identify the key components of delta smelt habitat that support successful completion of the life cycle.

The delta smelt's critical habitat is currently not adequately serving its intended conservation role and function because there are very few locations that consistently provide all the needed habitat attributes for larval and juvenile rearing at the same times and in the same places (Table 10). The Service's review indicates it is rearing habitat that remains most impacted by ecological changes in the estuary, both before and since the delta smelt's listing under the Act. As described above, those changes have stemmed from chronic low outflow, changes in the seasonal timing of Delta inflow, and lower flow variability, species invasions and associated changes in how the upper estuary food web functions, declining prey availability, high water temperatures, declining water turbidity, and localized contaminant exposure and accumulation by delta smelt.

Table 10. Summary of habitat attribute conditions for delta smelt in six regions of the estuary that are permanently or seasonally occupied in most years.

	Landscape	Turbidity	Salinity	Temperature	Food
Montezuma Slough	Appropriate	Appropriate	Appropriate *when outflow is sufficient, or when the Suisun Marsh Salinity Control Gates are operated to lower salinity*	Usually appropriate	Appropriate
Suisun Bay (including Honker and Grizzly bays)	Appropriate except in shipping channel	Usually appropriate	Appropriate *when outflow is sufficient*	Usually appropriate	Depleted
West Delta	Limited area 4 to 15 feet deep	Marginal, declining	Appropriate	Can be too high during summer	Depleted
North Delta (Cache Slough region)	Appropriate	Appropriate	Appropriate	Can be too high during summer	Appropriate, but associated with elevated contaminant impacts
Sacramento River above Cache Slough confluence	Limited area 4 to 15 feet deep; swift currents	Marginal except during high flows, declining	Appropriate, but possibly lower than optimal	Usually appropriate	Likely low due to swift currents and wastewater inputs
South Delta	Appropriate except too much coverage by submerged plants	Too low	Appropriate	Too high in the summer	Appropriate

Giant Garter Snake

For the most recent comprehensive assessment of the species' range-wide status, please refer to the *Giant Garter Snake (Thamnophis gigas) 5-year Review: Summary and Evaluation* (Service 2020). No change in the species listing status was recommended in this 5-year review. Threats evaluated during that review and discussed in the final document have continued to act on the species since the 2020 5-year review was finalized, with loss of habitat being the most significant effect. While there have been continued losses of snake habitat throughout the various recovery units, to date, no project has proposed a level of effects for which the Service has issued a biological opinion of jeopardy for the species.

Western Yellow-Billed Cuckoo

For the most recent assessment of the species range-wide status please refer to the October 3, 2014, *Determination of Threatened Status for the Western Distinct Population Segment of the Yellow-billed Cuckoo (Coccyzus americanus occidentalis)* (Service 2014b). Ongoing threats to the yellow-billed cuckoo include habitat loss from flood control projects and maintenance, alterations to hydrology, climate change, and invasive species. While these threats continue to affect the yellow-billed cuckoo throughout its range, no project, to date, has proposed a level of effect for which the Service has issued a biological opinion of jeopardy for the yellow-billed cuckoo.

Environmental Baseline

Environmental baseline refers to the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline.

The proposed project occurs along the mainstem Sacramento River from river mile (RM) 46 upstream to the American River confluence (RM 60), along the Sacramento north of the existing Sacramento Weir (RM 63), the lower American River from RM 0 to RM 11, and portions of the NEMDC, Arcade Creek, and Magpie Creek.

The Sacramento River in this part of the Sacramento Valley is moderately sinuous with the channel confined on both sides by man-made levees. The channel is a fairly uniform width and is not able to migrate due to the levees. Portions of the bank along the Sacramento River have had rock revetment placed to halt erosion of the bank and levees. Narrow bands of riparian habitat occur along the Sacramento River and tends to be comprised of cottonwoods, willows, buttonbush and box elder. Activities in this area consist mostly of maintenance of the levees and recreation consisting of walking, biking, and fishing. Wave wash erosion occurs from boaters in the Sacramento River.

The lower American River is not as constrained as the Sacramento River with portions of the levees set back from the river channel. This results in wider bands of riparian habitat, though there are sections where it is not continuous due to the levee being close to the river or to other land use such as golf courses which preclude native habitats. Non-native species such as black locust (*Robinia pseudoacacia*), tree of heaven (*Ailanthus altissima*), and red sesbania (*Sesbania punicea*) occur throughout the area. Recreation impacts the lower American River, particularly in the form of unauthorized camping which can result in the loss of vegetation and fires, which remove riparian vegetation.

The NEMDC, Arcade Creek, and Magpie Creek are all smaller waterways with levees adjacent to them. Riparian habitat is sporadic and, in some areas, completely missing. These creeks interface between urbanized areas and the open space of Sacramento County.

Valley Elderberry Longhorn Beetle

Habitat for the valley elderberry longhorn beetle occurs within riparian habitat along the Sacramento River, the American River, Arcade Creek and Sacramento Weir expansion footprint.

Sacramento River - Riparian habitat along the Sacramento River, south of the city of Sacramento, occurs in narrow bands along the riverbank and levee. Generally, an overstory layer is present, composed of cottonwood, sycamore, and oak trees. Shrubs occur as a mid-story layer including buttonbush, blue elderberry, white alder, and Oregon ash. Elderberry shrubs occur randomly along the reach of river proposed for improvements. The Corps has documented at 2.82 acres of valley elderberry longhorn beetle habitat and 40 individual shrubs that occur within the action area for erosion and seepage and stability work along the Sacramento River. Natural river processes of erosion and accretion effect elderberry shrubs which is the host plant of the valley elderberry longhorn beetle by eroding away bank and potentially elderberry shrubs. Levee maintenance can adversely affect elderberries within this stretch of the Sacramento River either by pruning or drift of herbicides used along the levee slope.

American River – Valley elderberry longhorn beetles have been identified along the lower American River Parkway in the CNDDB (2021). The Corps has designed and built six sites along the lower American River as habitat for the valley elderberry longhorn beetle. These sites extend from RM 0.9 up to RM 21. Bank protection along the lower American River has 37.23 acres of habitat for the valley elderberry longhorn beetle. Levee maintenance can adversely affect elderberry shrubs, though the largest threat to valley elderberry longhorn beetle is fires that have been started in the parkway and burned habitat that supports valley elderberry longhorn beetles.

Arcade Creek – Arcade Creek is dominated by grassland, with some areas of oak woodland and cottonwood forest. Two elderberry clusters of elderberry shrubs are located along Arcade Creek. Similar to elderberry shrubs along the Sacramento and American Rivers, these shrubs are subject to flood maintenance activities.

Sacramento Weir – At the Sacramento Weir expansion 2.82 acres of valley elderberry longhorn beetle occurs within riparian habitat, along a railroad embankment. The Sacramento River is to the east of the embankment with a continuous canopy of trees extending to the river, but with very little understory and a walnut orchard to the west.

Delta Smelt

The portions of the Action Area that fall within the range of delta smelt include the Sacramento River east levee, south of Sacramento and the Sacramento Weir. Delta smelt typically migrate up into this area as early as December and move out in the spring and summer. The proposed project contains habitat components that can be used for feeding, spawning, rearing, and movement. According to a 2007 riprap database done for the Corps rock erosion protection currently exists between RMs 46 and 60 for a total of 19 miles, this includes both sides of the river. This section of the river is highly constrained with levees close to the river channel, which results in a good portion of the Sacramento River's bank is also in the levee template. The Corps' project will occur within 30 acres of delta smelt shallow water habitat.

Delta Smelt Critical Habitat

The erosion work along the Sacramento River will occur within critical habitat for delta smelt. These sites contain Primary Constituent Element #1, described above. The proposed project is occurring in the upper limits of the designated critical habitat, which includes potential spawning habitat. Sediment load in this portion of the Sacramento River is high and depending on the water year, sediment can drop out and cover areas with large amounts of cobble creating potential spawning habitat, or flush out accredited sediment and expose areas that are less suitable for spawning.

Giant Garter Snake

The proposed project is located within both the American Basin Recovery Unit (NEMDC borrow area) and the Yolo Basin Recovery Unit (ditch in the Sacramento Bypass) both are identified in the *Recovery Plan for the Giant Garter Snake* (Service 2017). Habitat within the proposed project occurs within the NEMDC and in the enlarged Sacramento Bypass. A borrow site located adjacent to the NEMDC in the southern part of the Natomas basin is upland giant garter snake habitat. The borrow site is on the southern edge of the agricultural lands and developed land interface. The NEMDC near this borrow site is an aquatic feature with large open areas of grassland that can serve as upland habitat for the giant garter snake. A snake observed 0.5 mile to the west of the NEMDC along Elkhorn Boulevard in 1996 (CNDDB 2021). Borrow site 2's northern boundary is Elkhorn Boulevard on the east side of the NEMDC. Giant garter snakes could be using the NEMDC for aquatic habitat and the surrounding grasslands for uplands.

Snakes have been located within the Yolo Bypass within 2 miles of the Sacramento Bypass. Numerous irrigation and drainage canals exist which provide connectivity from the Sacramento Bypass and areas that are known to support snakes in the Yolo Bypass. The canal segment between the southern cross canal and the Tule Canal that will be modified as a result of construction of the Bypass Transport Channel contains about 38.4 acres of giant garter snake habitat (3.4 acres of aquatic habitat and 35 acres of upland habitat).

Western Yellow-Billed Cuckoo

Riparian habitat along the Sacramento River is narrow and linear. This habitat is not wide enough to support a nesting pair of cuckoos. Yellow-billed cuckoos use riparian habitat for foraging and nesting. Larger habitat patches exist within the lower American River. There are 65 acres of riparian habitat along the Lower American River that yellow-billed cuckoos could be using in the project area. The Corps will remove 110 acres of riparian habitat along the Sacramento River and disturb an additional 50 acres of riparian habitat by removing the understory and placing rock around the large trees. Riparian habitat exists landside of the levee at the Sacramento Weir extension. There are 13.74 acres of riparian that the cuckoo could use during migration at the Sacramento Weir extension.

Effects of the Action

Valley Elderberry Longhorn Beetle

Vegetation removal, including elderberry shrubs can cause mortality of any beetle larvae within the elderberry shrub. Transplanting the shrubs between November 1 and February 15, when the shrubs are dormant, will minimize the likelihood of killing larvae within the shrub. However, with transplantation there is no guarantee that the shrub will live which would result in both the death of any larvae in the shrub and the loss of habitat for the beetle. Proper care of the transplants through watering in the initial years can minimize this loss and increase the likelihood that the shrub will survive and provide habitat for the valley elderberry longhorn beetle.

The Corps is avoiding a large number of elderberries along the lower American River and Sacramento River. Elderberry shrubs along the Sacramento River are being avoided with at least a 20 foot buffer from the dripline. On the lower American River 8.34 acres of valley elderberry longhorn beetle riparian habitat will have construction occurring within 20 feet of the dripline of elderberry shrubs, but the shrubs will be protected in place. Construction and geotechnical studies that occur near elderberry shrubs that will be protected in place can kill adult beetles if construction equipment is operating between the months of March and July when valley elderberry longhorn beetles have emerged from the elderberry shrubs, are locating mates for reproduction, and laying eggs on the elderberry shrubs. Fencing the area which contains riparian habitat, specifically elderberry shrubs, will minimize the likelihood of killing an adult beetle, but given the large amount of construction that will be occurring, the project will cause mortality to adult beetles.

The linear nature of this project could result in a loss of habitat connectivity for the valley elderberry longhorn beetle, which will affect the long-term viability of the beetle in the lower American River and along the Sacramento River because the beetle is a poor disperser. A large number of elderberry shrubs are being transplanted out of the construction footprint. Because final designs have not been completed for all of the bank protection work, the Corps is including the Service in the design process as well as in the selection and design of mitigation sites. Sites will be selected that increase both habitat connectivity as well as habitat patch size. Fulfilling recovery actions in the VELB Recovery Plan will be considered when selecting mitigation sites.

Overall, the Corps is transplanting the following amounts of elderberry shrubs: 7.11 acres along the lower American River; 0.12 acre along the Sacramento River for bank protection; 0.69 acre at Sacramento Weir; and 40 individual shrubs along the Sacramento River for seepage and stability. The 7.92 acres of elderberry shrubs are within a total of 27.21 acres of riparian that the beetle could be using to disperse from elderberry shrub to elderberry shrub. The 40 individual elderberry shrubs were not associated with riparian habitat and the Corps is proposing to offset adverse effects through the creation of 3.31 acres of valley elderberry longhorn beetle habitat. The Corps is proposing to offset the loss of this habitat through the creation of 84.94 acres of valley elderberry longhorn beetle habitat primarily along the lower American River and at the

Stone Lakes Conservation site, with up to 8.22 acres protected at a valley elderberry longhorn beetle conservation bank.

These components of the action (the creation and protection of valley elderberry longhorn beetle habitat and the purchase of bank credits) will have the effect of protecting and managing lands for the species' conservation in perpetuity. The compensatory lands will provide suitable habitat for breeding, feeding, or sheltering commensurate with or better than habitat lost as a result of the proposed project. Providing this compensatory habitat in a way that provides relatively large, contiguous blocks of conserved land may contribute to recovery efforts for the valley elderberry longhorn beetle.

Operations and Maintenance - Trimming of elderberry shrubs can result in the loss of some habitat for the valley elderberry longhorn beetle. Unlike transplantation however, the shrub remains within the riparian corridor and can provide habitat for the beetle during dispersal. There is potential for one of the pruned stems to contain the larvae of the valley elderberry longhorn beetle. While elderberry shrubs do resprout readily, there is a temporal loss of habitat for the beetle and as part of the maintenance, any resprouted stems will be removed in order to provide maintenance equipment access. To offset these effects, the local maintaining agencies have proposed to create a 40-acre conservation area for the valley elderberry longhorn beetle. This area will be selected as described in the preceding paragraph. This will ensure habitat connectivity and help with long-term maintenance and monitoring of these lands.

Delta Smelt

Construction along the Sacramento River will place bank protection along a total of 43,000 non-contiguous linear feet (total of 8.14 miles) sections of the left bank of the Sacramento River. This will result in the majority of this section of river having rock bank protection placed on it. Delta smelt are a pelagic species typically associated with open water. However, as described in the status of the species they do spawn on sandy beaches in shallow water habitat. Suitable spawning habitat in this portion of the Sacramento River is present along the riverine edge of the left bank where proposed activities will occur. The rock footprint and other construction related activities below the mean high-water mark will change the substrate up to 43,000 linear feet (30 acres of shallow water habitat).

In-water construction activities (July 1 through October 31) will avoid the adult migration season and exposure to the adult spawning, incubation *(i.e.*, eggs/embryos), and larval transport from heavy equipment such as barges and cranes. Infrequent detection of larger juveniles in beach surveys suggests that the Sacramento River serves as a spawning ground and not as a nursery ground (Service 2020). Therefore, the early start of construction of July 1 in this section of the Sacramento River, while has the potential to effect individuals, this will be a small number of individuals. The bulk of the work will be completed during the August 1 to November 30 work window that typically avoids effecting individual delta smelt.

Effects due to increasing sediment downstream of the work area will be minimized through the conservation measures involving monitoring water quality during construction to ensure that effects do not extend into the portion of the Delta that delta smelt occupies during the late summer/fall period.

Construction to widen the Sacramento Weir will involve excavation of 5.56 acres of riverine habitat and roughly 2 acres of excavation of the upper bank. Once completed there will be 7.5 of riverine habitat with natural substrate. Only 1 acre of riprap will be used in this area immediately around the fish passage channel to limit erosion. The 7.5 acres of riverine habitat will be available to delta smelt the following year, resulting in no loss of habitat available to the delta smelt.

The primary adverse effect of the project is on potential spawning habitat is the modification of substrate within the shallow water zone (*e.g.*, sand to riprap). Rock used for bank protection is large enough to retard erosional forces of the river and therefore has interstitial spaces. Should delta smelt spawn over this riprap substrate, it is very likely that any eggs will fall into these interstitial spaces resulting in the loss of eggs and potentially causing fertilization to not occur if the eggs fall into the interstitial spaces. Rock slope protection limits the lateral mobility of a river channel, increases flow velocities (Sedell et al. 1990), limit sediment transport, and eliminates bankside refugia areas (Gregory et al. 1991). Rock placement can also affect primary productivity through the loss of vegetation. The Corps will protect large trees in place and plant riparian benches at the conclusion of the rock placement to replace some of the loss of vegetation. Planting benches and vegetation planting will help to offset the increased velocities that the bank protection sites will experience due to the smoother rock surface. Current designs of the sites have a launchable toe, which is designed to provide protection against toe erosion. Because this is a feature that could move in the future, the Corps has committed to analyzing the likelihood and effects to the on-site planting bench if the toe rock launches. If it is found that the launch of the toe rock will affect the long-term viability of the on-site mitigation, the Corps will consult with the Service to determine how the launchable toe could affect the delta smelt and its critical habitat and reintitiate consultation if necessary.

To offset the loss spawning potential and the loss of riverine edge habitat the Corps has proposed to purchase or create up to 90 acres of credits at a Service-approved delta smelt conservation bank or through other Service-approved mitigation actions for the effects to up to 30 acres of shallow water habitat. From a temporal perspective it is assumed that mitigation will be in place and available to the species by the end of construction, assuming construction will be done by 2025. The Corps is coordinating with the Service on the development of mitigation. If they find that mitigation will not be completed by the anticipated time they will work with the Service to determine what the effects to delta smelt will be if mitigation is not completed by 2025 and reinitiate consultation as appropriate.

The proposed conservation plan of the action will have the effect of protecting and managing lands for the species' conservation in perpetuity. The compensatory lands will provide suitable habitat for breeding, feeding, or sheltering commensurate with or better than habitat lost as a result of the proposed project. Providing this compensatory habitat in a way that provides relatively large, contiguous blocks of conserved land may contribute to recovery efforts for the delta smelt.

Operations and Maintenance - The Corps has proposed to evaluate effects to listed species including delta smelt when long-term maintenance activities for the Sacramento River can be described. Therefore, this biological opinion does not address effects to the delta smelt from any long-term levee maintenance activities.

Delta Smelt Critical Habitat

Implementation of the proposed project will affect PCE #1 Physical Habitat as described under the environmental baseline section above. The placement of rock or other construction activities under the mean high-water mark will change the substrate of shallow water habitat for 30 acres. Any loss of shallow water habitat will be compensated through the purchase of credits at a delta smelt conservation bank, creation of on-site shallow water planting benches, or a Service-approved mitigation site. Creation of on-site benches can minimize and mitigate effects to delta smelt critical habitat if they are in the shallow water habitat zone and accessible to delta smelt during the spawning season. Previous erosion repair sites have accreted sandy soils on the benches which will be available to the delta smelt for spawning. This would not be available every year given it is dependent on the Sacramento River flows. A Conservation Measure which includes the Service in the development of the plans for the planting benches will ensure that the benches can provide habitat for the delta smelt. It is expected that planting portions of the sites post-construction will replace loss of primary productivity within the Sacramento River water column. On-site mitigation will be determined on a site by site case in consultation with the Service. The current discussion of off-site mitigation includes sites which are not currently connected to the river, through some sort of levee breach. This would open up new potential spawning habitat to the delta smelt within critical habitat.

Giant Garter Snake

Borrow Site 2 – Upland habitat for the giant garter snake will be disturbed at borrow site 2 (5.5 acres) when heavy equipment is brought in to remove soil for the Arcade Creek levee repair. Removal of soil from the site will result in the crushing of burrows that snakes use for aestivating and thermoregulation. Fencing the borrow site prior to borrow excavation will minimize the likelihood that snakes will be in the borrow site when construction equipment begins to mobilize. Fencing the site will temporarily (one active season) exclude the use of the area for giant garter snake. This could result in snakes having to move further distances to find upland refugia in the summer months and expose them to predation or other sources of mortality such as being run over by a vehicle on the levee road on the opposite side of the NEMDC. About 1.2 acres of aquatic habitat for the giant garter snake would be unavailable to the snake for up to 3 months during the snake's active season due to dewatering. Since snakes use aquatic habitat to forage for food, thermoregulate, and evade predators, the loss of this 1.2 acres will negatively affect the giant garter snake. Snakes will have to find alternative areas to forage in during these 3 months which could leave snakes more vulnerable to predation as they move to other areas for foraging.

Upon completion of the project, the site will restored and re-graded to create three habitat types. The 0.4 acre of freshwater marsh will provide a small increase in habitat along the bank during the summer months when the snake is active and will provide cover, an area for prey production, and refugia from predators. Additionally, the seasonal wetland bench will only provide aquatic habitat in the winter months when the snake is typically in burrows. The wetland bench will provide some upland habitat for the giant garter snake during the summer when the snake is active in the form of basking habitat and if dried wetland vegetation remains, some refugia from predators. However, because the site will be flooded in the winter it will not serve as overwintering habitat for the snake. The remaining 3.5 acres of the borrow site will be restored to native grassland and will function as summer upland refugia and basking habitat and in the winter serve as overwintering habitat for the snake.

Sacramento Bypass – Enlarging the Sacramento Bypass and Weir will result in temporary effects to giant garter snake habitat. Geotechnical borings will be conducted during the active season of the snake and will be done in a manner that tries to avoid areas where giant garter snakes may be underground in burrows. Creation of the Bypass Transport Channel will result in temporary effects to 2.3 acres of aquatic habitat and 32.7 acres of upland habitat. An additional 0.3 acre of aquatic and 3.1 acres of upland habitat will be permanently affected through the filling of a section of canal. Construction effects will result in the project area being unavailable to the giant garter snake for one year. Construction equipment and earthmoving activities will result in collapsing of burrows and crushing of snakes that are in the project area. Upon the one year completion of this portion of the project there will be an additional 6.7 acres of aquatic habitat available to the giant garter snake. Water availability should be similar to existing conditions with agricultural drainage providing a water source in the summer months when the snake is active. Conservation measures including working during the snake's active season will minimize the amount of individuals that could be killed or injured.

Operation of the expanded Sacramento Weir and Bypass will result in an increase of water surface elevation of approximately 0.5-foot on the levee slopes on either side of the Yolo Bypass. However, when this increase occurs, during a 200-year flood event, the Yolo Bypass levees already contain water up to 21 feet deep. As a result, giant garter snake burrows would likely already be saturated before the additional water associated with the widened Sacramento Bypass is a factor. The additional 0.5-foot resulting from this action would not significantly change the timing or duration of this flooding and would not result in further impacts to giant garter snake habitat.

The Corps has proposed to evaluate effects to listed species including giant garter snake when long-term maintenance activities for the Sacramento Bypass can be described. If maintenance activities will affect giant garter snakes the Corps will reinitiate consultation with the Service. Therefore, this biological opinion does not address effects to the giant garter snake from any long-term levee maintenance activities.

Yellow-Billed Cuckoo

Sacramento River – The Corps is planning on removing 70 acres of riparian habitat along the Sacramento River. The riparian corridor in this section of the Sacramento River is narrow (about 100 feet wide) because the levees were constructed so close to the edge of the channel bank. This bank of riparian habitat is too narrow for the yellow-billed cuckoo to nest; however it is possible for the yellow-billed cuckoo to use the habitat as a stopover when migrating to the Central Valley to breed. Vegetation removal under the proposed project will reduce the width of the riparian corridor from 100 feet to 40 feet on average. The Corps proposal to plant the bank protection sites will create at least a 25-foot-wide soil filled planting berm. Similar to the discussion above under delta smelt effects, these planting benches will have a launchable rock toe that could deploy over the life of the project. The study the Corps is currently undertaking will determine the likelihood and effect to the planting bench. If it is found that the launch of the toe rock will affect the long-term viability of the on-site mitigation, the Corps will consult with the Service to determine the effects to the yellow-billed cuckoo and its habitat. The Corps proposes to offset the loss of the 70 acres of riparian habitat through creation of habitat on-site and the creation of up to 140 acres of riparian habitat along the lower American River. The Corps is including the Service in the development of the mitigation sites such that they can be sited and designed to create riparian habitat that will benefit the yellow-billed cuckoo.

American River – The construction of launchable rock trench and bank protection will remove up to 65 acres of riparian habitat along the lower American River. While large patches of riparian habitat will not be removed (only a strip will be removed adjacent to the levee), the removal of this strip could reduce the size of some of the riparian areas in the lower American River that could serve as potential nesting areas for the cuckoo.

To compensate for this loss of riparian habitat, the Corps is proposing to plant up to 130 acres of riparian habitat along the lower American River. As described in the Conservation Measures, a variable sized soil filled planting bench will be constructed in the bank repair sites, where feasible. This will be used to offset some of the effects of loss of riparian vegetation. The launchable toe is also proposed for the bank protection and effects to on-site mitigation will occur as discussed in the Sacramento River effects section above. The remainder of the mitigation will occur along the lower American River.

Sacramento Weir – Due to the expansion of the weir and Sacramento Bypass, the Corps will remove 13.74 acres of valley oak riparian that is on the railroad alignment and to the east of the railroad alignment. This area will be converted to a concrete weir. While this patch, similar to riparian along the Sacramento River, does not serve as nesting habitat for the yellow-billed cuckoo because of its small size, it does provide migratory stopover habitat for the cuckoo. The Corps is proposing to compensate for the loss of this habitat either in the Lower American River, at the Beach Stone Lakes Conservation Area, or through the purchase of riparian floodplain credits at a mitigation bank.

In addition to the habitat loss for both the Sacramento and American Rivers, construction activities have the potential to adversely affect individual yellow-billed cuckoos. Construction that occurs when the cuckoo is in the Sacramento Valley has the potential to harass the bird due to noise. To minimize effects to the cuckoo due to construction noise, the Corps' conservation measure to do pre-construction bird surveys prior to beginning construction and to remove all vegetation outside of the migratory bird nesting season (March 1 to September 31), will enable the Corps to avoid nesting yellow-billed cuckoos. However, cuckoos that could be foraging in the area could be disturbed due to construction activities and noise and move to other locations in the lower American River parkway which could expose individual cuckoos to increased predation.

The conservation areas will provide both habitat for yellow-billed cuckoo and valley elderberry longhorn beetles. These areas will also ensure that there is a net increase of potential yellow-billed cuckoo nesting habitat along the lower American River Parkway. Recognizing that there is overlap in valley elderberry longhorn beetle habitat and yellow-billed cuckoo habitat and due to the different ratios proposed by the Corps, impacts due to the proposed project and mitigation sites will be developed and coordinated with the Service to ensure that habitat is created and balanced for both species. In total there will be up to 306 acres of habitat that will be heterogenous and provide habitat for the valley elderberry longhorn beetle, yellow-billed cuckoo, and salmonids. This acreage will be broken up in a combination of on-site, off-site, and conservation bank credits and will be coordinated with the Service.

The proposed conservation plan of the action will have the effect of protecting and managing lands for the species' conservation in perpetuity. The compensatory lands will provide suitable habitat for breeding, feeding, or sheltering commensurate with or better than habitat lost as a result of the proposed project. Providing this compensatory habitat in a way that provides relatively large, contiguous blocks of conserved land may contribute to recovery efforts for the yellow-billed cuckoo.

Operation and Maintenance - The Corps has proposed to evaluate effects to listed species including yellow-billed cuckoo when long-term maintenance activities for the Sacramento River and American River can be described. If maintenance activities will affect yellow-billed cuckoos the Corps will reinitiate consultation with the Service. Therefore, this biological opinion does not address effects to the yellow-billed cuckoo from any long-term levee maintenance activities.

Cumulative Effects

Cumulative effects include the effects of future State, Tribal, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act. During this consultation, the Service did not identify any future non-federal actions that are reasonably certain to occur in the action area of the proposed project.

Conclusion

After reviewing the current status of the valley elderberry longhorn beetle, delta smelt, giant garter snake, and yellow-billed cuckoo, the environmental baseline for the action area, the effects of the proposed American River Common Features 2016, and the cumulative effects, it is the Service's biological opinion that the American River Common Features 2016, as proposed, is not likely to jeopardize the continued existence of the valley elderberry longhorn beetle, delta smelt, giant garter snake, and yellow-billed cuckoo. The Service reached this conclusion because the project-related effects to the species, when added to the environmental baseline and analyzed in consideration of all potential cumulative effects, will not rise to the level of precluding recovery or reducing the likelihood of survival of the species based on the following:

1) Conservation measures that limit when work will occur to avoid when listed species are in the action area, or when they are less likely to be affected by the project;

2) Providing and protecting up to 396 acres of habitat for the valley elderberry longhorn beetle, delta smelt, and yellow-billed cuckoo; and

3) Create habitat on-site to allow connectivity for all for species.

After reviewing the current status of designated critical habitat for the delta smelt, the environmental baseline for the action area, the effects of the proposed American River Common Features 2016, and the cumulative effects, it is the Service's biological opinion that the American River Common Features 2016, as proposed, is not likely to destroy or adversely modify designated critical habitat. The Service reached this conclusion because the project-related effects to the designated critical habitat, when added to the environmental baseline and analyzed in consideration of all potential cumulative effects, will not rise to the level of precluding the function of the delta smelt critical habitat to serve its intended conservation role for the species based on the following:

1) Habitat effected within critical habitat for delta smelt will be offset through the creation/preservation of 3 times that which is being affected within the critical habitat area and

2) Benches will be constructed on-site in the shallow water habitat zone will be created on-site and created in a way that allows for sediment to accrete and serve as potential delta smelt spawning habitat.

The effects to delta smelt critical habitat are being mitigated both on-site and off-site and are not expected to appreciably diminish the value of the critical habitat or prevent it from sustaining its role in the conservation of the delta smelt.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harass is defined by Service regulations at 50 CFR 17.3 as an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. Harm is defined by the same regulations as an act which actually kills or injures wildlife. Harm is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavior patterns, including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary and must be undertaken by the Corps so that they become binding conditions of any grant or permit issued to the applicant, as appropriate, for the exemption in section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered by this incidental take statement. If the Corps (1) fails to assume and implement the terms and conditions or (2) fails to require the contractor to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the contract, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Corps must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement [50 CFR §402.14(i)(3)].

Amount or Extent of Take

Valley Elderberry Longhorn Beetle

The Service anticipates that incidental take of valley elderberry longhorn beetle will be difficult to detect due to its life history and ecology. Specifically, valley elderberry longhorn beetles can be difficult to locate since most of their life cycle is spent in the elderberry shrub and finding a dead or injured individual is unlikely due to their relatively small size. There is a risk of harm, harassment, injury and mortality as a result of the proposed construction activities; therefore, the Service is authorizing take incidental to the proposed action as harm, harassment, injury, and mortality of all valley elderberry longhorn beetles within 7.92 acres of habitat that will be transplanted as a result of construction and 40 acres of elderberry shrubs that will be trimmed for maintenance purposes over the project's 50 year life.

Delta Smelt

The Service expects that incidental take of delta smelt will be difficult to detect or quantify for the following reasons: the small size of adults, their occurrence in turbid aquatic habitat makes them difficult to detect, and the low likelihood of finding dead or impaired specimens. The Service anticipates that the extent of incidental take will be minimized due to the proposed conservation measures and low relative abundance. Due to the difficulty in quantifying the number of delta smelt that will be taken as a result of the proposed action, the number of acres of affected habitat becomes a surrogate for the species that will be taken. The Service anticipates that all individual adult delta smelt in the 30 acres of the action area may be subject to incidental take in the form of harm as described in this biological opinion. Incidental take of delta smelt for maintenance activities is not covered in this biological opinion.

Giant Garter Snake

The Service anticipates that incidental take of the snake will be difficult to detect or quantify for the following reasons: snakes are cryptically colored, secretive, and known to be sensitive to human activities. Snakes may avoid detection by retreating to burrows, soil crevices, vegetation, and other cover. Individual snakes are difficult to detect unless they are observed, undisturbed, at a distance. Most close-range observations represent chance encounters that are difficult to predict. It is not possible to make an accurate estimate of the number of snakes that will be harassed during construction activities, including in staging areas and roads carrying vehicular traffic. In instances when take is difficult to detect, the Service may estimate take in numbers of species per acre of habitat lost or degraded as a result of the action as a surrogate measure for quantifying individuals. Therefore, the Service anticipates the number of giant garter snakes that may be found in 12.7 acres of aquatic and upland habitat will be harmed or killed as a result of habitat modification due to the proposed project. Incidental take of giant garter snake for maintenance activities is not covered in this biological opinion.

Yellow-Billed Cuckoo

The Service anticipates that incidental take of yellow-billed cuckoo will be difficult to detect due to its life history and ecology. Specifically, yellow-billed cuckoos can be difficult to locate due to their cryptic appearance and behavior and finding a dead or injured individual is unlikely. There is a risk of harm and harassment as a result of proposed construction activities and operations and maintenance of the restoration plantings; therefore, the Service is authorizing take incidental to the proposed action as harm and harassment of all yellow-billed cuckoos within 135 acres. Incidental take of yellow-billed cuckoo for maintenance activities is not covered in this biological opinion.

Upon implementation of the following reasonable and prudent measures, incidental take of valley elderberry longhorn beetle, delta smelt, giant garter snake, and yellow-billed cuckoo associated with the American River Common Features 2016 will become exempt from the prohibitions described in section 9 of the Act. No other forms of take are exempted under this opinion.

Effect of the Take

In the accompanying biological opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the species.

Reasonable and Prudent Measures

All necessary and appropriate measures to avoid or minimize effects on the [Species] resulting from implementation of this project have been incorporated into the project's proposed conservation measures. Therefore, the Service believes the following reasonable and prudent measure is necessary and appropriate to minimize incidental take of the valley elderberry longhorn beetle, delta smelt, giant garter snake, and yellow-billed cuckoo:

1) All conservation measures, as described in the biological assessment and restated here in the Project Description section of this biological opinion, shall be fully implemented and adhered to. Further, this reasonable and prudent measure shall be supplemented by the terms and conditions below.

Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the Act, the Corps must ensure compliance with the following terms and conditions, which implement the reasonable and prudent measure described above. These terms and conditions are nondiscretionary.

1. The Corps shall include full implementation and adherence to the conservation measures as a condition of any permit or contract issued for the project.

2. In order to monitor whether the amount of incidental take anticipated from implementation of the proposed project is approached, the Corps will adhere to the following reporting requirement.

    a. For those components of the action that will result in habitat degradation or modification whereby incidental take in the form of harm is anticipated, the Corps shall provide a letter prior to construction of the actual impacts and mitigation as well as a precise accounting of the total acreage of habitat impacted per contract to the Service at the completion of the construction season.

    b. The Corps shall immediately contact the Service's Sacramento Fish and Wildlife Office (SFWO) at (916) 414-6541 to report direct encounters between listed species and project workers and their equipment whereby incidental take in the form of, harm, injury, or death occurs. If the encounter occurs after normal working hours, the Corps shall contact the SFWO at the earliest possible opportunity the next working day. When injured or killed individuals of the listed species are found, the Corps shall follow the steps outlined in the Salvage and Disposition of Individuals section below.

Salvage and Disposition of Individuals

Injured listed species must be cared for by a licensed veterinarian or other qualified person(s), such as the Service-approved biologist. Dead individuals must be sealed in a resealable plastic bag containing a paper with the date and time when the animal was found, the location where it was found, and the name of the person who found it, and the bag containing the specimen frozen in a freezer located in a secure site, until instruction s are received from the Service regarding the disposition of the dead specimen. The Service contact person is Jennifer Hobbs at the SFWO at (916) 414-6541.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. The Service recommends the following actions:

1) The Service recommends the Corps develop and implement restoration measures in areas designated in the Delta Fishes Recovery Plan (Service 1996) the Giant Garter Snake Recovery Plan (2017) and the Valley Elderberry Longhorn Beetle Recovery Plan (2019).

2) The Corps and SAFCA should develop and implement projects that support DWR's Central Valley Flood System Conservation Strategy. This document provides goals and measurable objectives and potential projects which could be implemented in a manner that while improving the riverine ecosystem also will improve the flood system.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

REINITIATION—CLOSING STATEMENT

This concludes formal consultation on the American River Common Features 2016. As provided in 50 CFR §402.16(a), reinitiation of consultation is required and shall be requested by the federal agency or by the Service where discretionary federal involvement or control over the action has been retained or is authorized by law, and:

1) If the amount or extent of taking specified in the incidental take statement is exceeded;

2) If 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;

3) If the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion; or written concurrence, or

4) If a new species is listed or critical habitat designated that may be affected by the identified action.

If you have any questions regarding this biological opinion, please contact Jennifer Hobbs (jennifer_hobbs@fws.gov), at the letterhead address or at (916) 414-6541.

Sincerely,

Michael Fris
Field Supervisor

ec:
Rena Eddy, Sacramento District Corps of Engineers, Sacramento, CA
Robert Chase, Sacramento District Corps of Engineers, Sacramento, CA
Nicole Schleeter, Sacramento District Corps of Engineers, Sacramento, CA
Nathaniel Martin, Sacramento District Corps of Engineers, Sacramento, CA
Brad Anderson, Sacramento District Corps of Engineers, Sacramento, CA
Blake Prawl, Sacramento District Corps of Engineers, Sacramento, CA
Kimberly Watts, Sacramento District Corps of Engineers, Sacramento, CA
Keleigh Duey, Sacramento District Corps of Engineers, Sacramento, CA
KC Sorgen, Sacramento Area Flood Control Agency, Sacramento, CA
David Moldoff, California Department of Water Resources, Sacramento, CA
Miles Claret, California Department of Water Resources, Sacramento, CA
Kalia Schuster, California Department of Water Resources, Sacramento, CA
Allison Lane, National Marine Fisheries Service, Sacramento, CA

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