The BDCP conservation measures are expected to benefit 57 species, 11 of them fish, and 14 natural communities, and reduce the effects of a broad range of ecological stressors in the Sacramento–San Joaquin Delta (Delta). Based on the effects analysis, it is anticipated that the BDCP will conserve all 57 fish and wildlife species covered by the plan. State and federal fish and wildlife agencies will further review this information before making permit determinations under the Natural Community Conservation Planning Act and federal Endangered Species Act.

The expected outcomes of BDCP implementation are analyzed and described in Chapter 5, Effects Analysis (EA), which reflects extensive scientific study throughout the Delta region. The EA describes how implementation of all 22 conservation measures and covered activities would affect ecosystems, natural communities, and covered species in the plan area. Proposed actions will result in fundamental, systemic, and long-term physical changes to the Delta. These changes include substantial alterations to water conveyance and management and extensive restoration of tidal, floodplain, and terrestrial communities. Based on the effects analysis, the BDCP is expected to conserve all 11 covered fish species.

The Effects Analysis is long and very complex due to:
- Size of the plan area
- Large number of natural communities and covered species addressed by the Plan
- Scale of covered activities
- Duration of Plan implementation (50 years)
- High variability within the Delta in terms of hydrology, salinity, potential impacts of climate change, and more

The EA represents a systematic, scientific evaluation of the potential beneficial, adverse, and net effects of the BDCP. The EA also provides state and federal fish and wildlife agencies with information needed to issue permits and authorizations for the BDCP and to address scientific uncertainty through adaptive management and monitoring.

A broad range of analytical tools, including hydrologic and hydrodynamic models, temperature models, water quality models, biological lifecycle models, habitat models, conceptual models, and literature reviews were used to assess the effects of BDCP activities on covered species over the 50-year plan implementation period.
Development of the Effects Analysis

To evaluate the effects of BDCP actions, comparisons are made between an environmental baseline condition and conditions that are expected to occur under BDCP. The environmental baseline reflects the existing or pre-implementation condition in the plan area. The EA compares all conservation measures at various times during plan implementation. As required by the Endangered Species Act, the effects analysis also describes the level of take (loss, harm, or harassment of species) and the effect of that take from BDCP actions.

The BDCP conservation measures will be implemented at different times over the 50-year period, and according to conditions expected at the following intervals:

- Current (immediately preceding plan implementation)
- Within 10 years (“Near Term”)
- Within 15 years (“Early Long-Term”)
- Within 50 years (“Late Long-Term”)

The effects analysis also considers the impacts of climate change over the entire implementation period.

Net Effects

The BDCP EA evaluates the combined effects of all covered activities, including the conservation measures, to determine the net effect of implementing the Plan for:

- Ecosystem and Landscape
- Natural Communities
-覆盖ed Plants and Wildlife
- Covered Fish

To calculate the net effects, different methods were developed for each of the categories listed above. For each category, the positive and negative effects were combined to determine the overall net effect.

The following sections focus on the net effects of BDCP. For details regarding the positive and negative effects for each category, see Chapter 5 Effects Analysis of the BDCP.

Environmental Baseline

The biological response to BDCP conservation measures are evaluated against an environmental baseline of existing biological conditions, such as:

- Extent of species habitats
- Water quality and pollutant inputs
- Water temperatures
- Flow

Temporary and Construction Effects

The following section focuses on net effects of BDCP actions. For more information about temporary and construction related impacts, see Chapter 5 Effects Analysis of the BDCP. Additional information regarding temporary and construction impacts is included in the Environmental Impact Report/EIS.

Scientific Uncertainty

Because the Delta is an ecologically complex estuary, there is a degree of scientific uncertainty. Where a high level of uncertainty is associated with the ability of a conservation measure to achieve plan objectives, that uncertainty will be addressed through research, monitoring, and the adaptive management program.
Tools Used to Develop the EA

The BDCP EA uses literature reviews and a total of 68 environmental and biological models to determine net effects. Chapter 5 of the BDCP provides the full list of models used. The following is a brief description of the types of models used in the EA.

Conceptual Models

Conceptual models organize information within a logical structure that provides a plausible explanation for a phenomenon. A conceptual model describes key attributes, linkages, and structure associated with an issue. Conceptual models explicitly lay out assumptions and logic underlying arguments and assessments.

Qualitative models

Qualitative models likewise describe a logical relationship between variables. One particular type of qualitative model, a conceptual model, is the first step in constructing quantitative models. These models can also stand alone as working hypotheses of how a particular system works.

Quantitative models

Quantitative models are used to understand environmental and biological functions. These models reflect a conceptual understanding of the relationship between attributes, processes, and outcomes. Development of useful quantitative models requires that sufficient theory and data are available to construct algorithms that explicitly describe the relationship between system attributes.

Environmental Models

Environmental models set the stage for the analysis of biological effects by describing key physical conditions, including flow, temperature, salinity, and turbidity.

Biological Models

Biological models link environmental change, often characterized by the environmental models, to change in biological performance. Biological performance is typically measured as a change in abundance, survival, or physical impact, such as the percentage of a species life stage entrained in pumps.

Habitat Suitability Models

Habitat suitability models evaluate multiple attributes of the environment as habitat for the various life stages of species.

Population and Life History Models

Life history models integrate the effects of multiple stressors across multiple life stages to evaluate impacts of actions at population scales. Currently, the application of life history models is limited because of the difficulty in capturing all of the expected changes from BDCP in one model.
Climate Change

Change is natural and inevitable in the Delta. The change in the global climate system is one of the factors affecting the Delta in several ways. Over the last 100 years, sea level has risen approximately 0.6 feet at the Golden Gate Bridge, and levels are expected to continue to rise. An additional increase of 1.5 feet or more by 2060 is predicted, putting more water pressure against Delta levees, potentially causing instability and seepage. Models predict that higher sea levels will also increase tidal mixing and salinity levels in the Delta. As warmer average temperatures push snow levels higher in the Sierra Nevada mountain range, more winter precipitation will fall as rain. More intense storm runoff and peak flood events will further stress levees. Multiple levee failures from a single flood are possible, depending upon water levels, tides, wind, and other factors. The EA explicitly considers the effects of climate change over the 50- year implementation period by incorporating assumptions of sea level rise, temperature increase, and changes in seasonal precipitation and runoff patterns upstream of the Delta into relevant analyses during years 10 through 15 and years 35 through 50 of BDCP implementation. These future conditions provide points of comparison to starting operations, which also includes the same assumptions of climate change. Sea level is assumed to increase by 49 feet by the end of year 15 of BDCP implementation and by 94 feet above present level by year 50 of BDCP implementation.

In many cases, the effects of climate change on the environment will be greater than the effects of the BDCP. Most of the BDCP’s temperature-related effects are caused solely or substantially by climate change. Because of this, comparisons between scenarios in the Effects Analysis are drawn within the same time period and with the same climate change assumptions.

The BDCP would isolate water deliveries from increasingly stressed Delta levees, while using state-of-the-art fish screens and water project operating rules that minimize potential impacts to fish spawning and migratory patterns. The proposed project would also help California cope with changing weather patterns by enabling the capture of large amounts of winter flood flow that coincide with times of minimal ecological risk. A more reliable facility would also boost the state’s ability to respond to drought.

Climate Change Adaptation

Conservation measures will provide numerous benefits to the Bay-Delta ecosystem, natural communities, and covered species that are expected to reduce species vulnerability to the adverse physical and biological effects of climate change.
Assessing Ecosystem and Landscape Effects

The BDCP used a variety of models to evaluate the effects that the BDCP would have at the ecosystem and landscape level in the plan area. Ecosystem and landscape effects are those that affect general ecological processes. Models analyzing ecosystem and landscape effects of BDCP implementation evaluated flows, water quality, water temperature, dissolved oxygen, sediment, salinity, and contaminants. All of these factors are known to be important in achieving high-quality habitats for fish, plants, and wildlife. Conceptual models also evaluated the aquatic habitat and food web at the ecosystem-scale and the role of BDCP actions in improving the Delta ecosystem, natural communities, and covered species.

Ecosystem and Landscape Effects

The BDCP ecosystem and landscape effects analysis describes the indirect and ecosystem-level effects on covered species during construction and operation of the water facilities, and following habitat restoration implementation.

Overall, the BDCP will result in substantial ecosystem and landscape level effects through:

- Restoration, enhancement, and/or protection of more than 110,000 acres of terrestrial and aquatic habitat
- Shifting the location, amount, and timing of diversion of State Water Project/Central Valley Project (SWP/CVP) water from the Delta during most water-year types

The BDCP results in the following landscape and ecosystem-level effects:

- Substantially improved south Delta flows in the plan area
- Increased frequency and duration of flooding of the Yolo Bypass
- Increased access to habitat for covered species, including floodplains, tidal wetlands, and other natural communities
- Increased aquatic food production and availability
- Changes in lower Sacramento River flows and outflows, depending on the specific outcome of the decision trees and adaptive management.
Ecosystem and Landscape Effects

Flow
The BDCP will fundamentally change how water flows through the Delta. BDCP actions shift a large portion of exports to the north Delta to improve natural east to west flows (outflow to Bay). Additionally, the timing of Delta exports and outflows will be adjusted to specifically benefit the aquatic ecosystem and covered fish species. Additional detail on BDCP changes to Delta flows is provided in Appendix S.C, Attachment S.CA, of the BDCP.

Water Quality
Water quality affects both the physical properties of water (temperature, turbidity) and the chemical properties (salinity, pollutant concentrations) that cause biological responses, such as increased species productivity or mortality in covered fish species. The map on the right shows the water quality aspects addressed in the BDCP EA.

Aquatic Habitat and Foodweb
The proposed tidal marsh, channel margin, floodplain, and riparian restoration measures are expected to increase availability to suitable habitat for covered fish species and restore important ecological functions of the Delta. Uses of this restored habitat include:
- Adult holding, foraging, and spawning
- Egg and larval development
- Juvenile rearing
BDCP aquatic restoration is expected to provide increased production of periphyton, phytoplankton, zooplankton, macroinvertebrates, insects, and small fish that contribute to the aquatic foodweb. The BDCP’s extensive habitat restoration will promote linkages between various habitat types, mimicking historical conditions. Overall, the restoration of tidal natural communities has the potential to provide a large net benefit to several covered fish species, although fully achieving this potential will require careful design, and, when appropriate, management of restored areas. If results of monitoring identify adverse effects that will not support meeting the expected biological outcomes, the existing and future restoration actions will be modified and refined as part of adaptive management.

Water Quality
Water quality issues are a critical concern and are being addressed in the Environmental Impact Report/Environmental Impact Statement (EIR/EIS). BDCP staff will continue to work with local interests to ensure that water quality impacts have been accurately identified.

Salinity
The low salinity zone is an important area for many fish and has historically been tracked and managed for an array of fish and water quality parameters. Many fish species have a preferred range of salinity and a range of physiological tolerance to salinity, both of which can influence their distribution. The estuarine salinity gradient is controlled by Delta outflow. Under the BDCP scenarios, outflows will be nearly the same during the low-flow months of July through October in many years.

Water Conveyance
- Intake
- Water Conveyance Tunnel/Pipeline
- Forebay

Sediment
Sediment eroded from upstream areas is deposited in the Delta in varying degrees, depending on factors, such as flow rate, tidal forcing, and local conditions. Sediment is a critical resource in habitat creation. Additionally, sediments already in the plan area can be raised and transported by wind or water with the potential to redistribute as tidal wetland restoration (CM4) occurs. Implementation of dual conveyance under CM1 Water Facilities and Operation was estimated to result in approximately 8 to 9 percent less sediment entering the plan area from the Sacramento River, the main source of sediment for the Delta and downstream subregions. There will be less sediment entering the plan area but effects on clarity are unclear because of the effects of tidal restoration.

Water Temperature
Water temperatures in the plan area will not change due to the BDCP. The BDCP is committed to avoiding temperature changes in the plan area, including changes to the upper San Joaquin River or tributaries, the Sacramento River, or the Trinity River. The American and Feather Rivers may, in drier years, experience very minor temperature increases due to BDCP operations.

Contaminants
The BDCP will not introduce new contaminants or increase the concentrations of contaminants in the plan area directly, with the exception of herbicides, which will be applied in limited and safe concentrations to control invasive aquatic weeds. However, the conservation strategy includes restoration and changes in water operations that have the potential to change how contaminants already present in the plan area are mobilized and transported. The following conclusions can be drawn from the analysis presented in Appendix S.D of the BDCP:
- Water operations will have few to no effects on toxins in the Delta.
- Restoration will increase bioavailability of certain toxins, especially methylmercury, but the overall effects are expected to be localized and of low magnitude.
- Available data suggest that species exposure to contaminants will be below sublethal levels.
- The long-term benefits of restoration may reduce exposure to existing toxins in the environment and eliminate sources.

Dissolved Oxygen
Covered fish species in the Delta require high dissolved oxygen (DO) levels for survival. Low DO levels can create passage barriers and increase species mortality. The simulations of DO concentrations in the Delta found only minor differences among the BDCP scenarios. For most of the regions, differences due to climate change were larger than those due to the effects of BDCP operations, in models used to determine net effects.
In general, covered activities are expected to result in an increase in the quantity and quality of natural community types covered in the BDCP. The BDCP is expected to have a net increase of 83,056 acres protected. This substantial increase in restored, protected and conserved habitat will support ecosystem connectivity, accommodate sea level rise, and support ecosystem services in the Delta such as nutrient transport, sediment capture, and flood-flow reduction. Restoration of tidal natural communities in particular is expected to benefit a large number of covered species including Delta smelt, longfin smelt, Salt marsh harvest mouse, California black rail, and Suisun thistle.

**Natural communities** are distinct and recurring collections of plants and animals associated with specific physical environmental conditions and ecological processes.

**Assessing Effects for Natural Communities**

To assess the Plan’s effect on natural communities, the amount of habitat lost was quantified for covered natural community types. In addition to the quantitative effects analysis, the effects of BDCP were assessed qualitatively by considering such factors as landscape connectivity, natural community patch size, hydrologic connectivity, native biodiversity, and presence of rare species. Beneficial effects on natural communities were evaluated based on the ecosystem and natural community goals and objectives provided in Section 3.3 and implementation of the conservation measures described in Section 3.4 of this document. The net effects on each natural community were then assessed, taking into consideration losses, restoration, protection, and enhancement, and the anticipated quality of the natural communities conserved relative to that of habitat lost.

**BDCP Effects on Natural Communities**

The following table provides the anticipated net effects for natural communities. Overall, the BDCP is expected to improve the amount, quality, and condition of natural communities within the plan area. The average increase in protected lands is 52 percent, not counting cultivated lands.*

---

**Covered Natural Community Types**

<table>
<thead>
<tr>
<th>Natural Community Types</th>
<th>Existing Condition</th>
<th>Net Effect of BDCP Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total Extent in Plan Area (Acres)</td>
<td>Conservation Lands (Acres)</td>
</tr>
<tr>
<td>Tidal perennial aquatic</td>
<td>86,266</td>
<td>17,503</td>
</tr>
<tr>
<td>Tidal mudflat</td>
<td>8,501</td>
<td>5,673</td>
</tr>
<tr>
<td>Tidal brackish emergent wetland</td>
<td>8,953</td>
<td>3,671</td>
</tr>
<tr>
<td>Tidal freshwater emergent wetland</td>
<td>18,132</td>
<td>5,996</td>
</tr>
<tr>
<td>Valley/FOOTHILL RIPARIAN</td>
<td>6,754</td>
<td>1,803</td>
</tr>
<tr>
<td>NON-TIDAL FRESHWATER PERENNIAL EMERGENT WETLANDS AND NON-TIDAL PERENNIAL AQUATIC</td>
<td>3,723</td>
<td>2,686</td>
</tr>
<tr>
<td>VERNAL POOL COMPLEX</td>
<td>8,547</td>
<td>5,166</td>
</tr>
<tr>
<td>Managed wetland</td>
<td>64,987</td>
<td>53,675</td>
</tr>
<tr>
<td>Other natural seasonal wetland</td>
<td>276</td>
<td>220</td>
</tr>
<tr>
<td>Grassland</td>
<td>78,624</td>
<td>19,599</td>
</tr>
<tr>
<td>Inland dune scrub</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>Cultivated lands</td>
<td>506,627</td>
<td>1,100</td>
</tr>
<tr>
<td>Developed</td>
<td>73,911</td>
<td>2,388</td>
</tr>
<tr>
<td>Total**</td>
<td>862,638</td>
<td>119,603</td>
</tr>
</tbody>
</table>

---

*To avoid skewing average protection in the positive direction, the total increase in cultivated lands natural community protection was not included. The increase in cultivated lands protection is unusually large due to the low number of existing, protected cultivated land acres and the large increase in acres protected.

**Totals may not sum directly due to rounding.
Assessing Effects for Covered Plants and Wildlife

To determine BDCP effects, it is necessary to determine three outcomes for each covered species: the effects of accidental loss or harm, the beneficial effects expected to result from the conservation strategy, and the net effect on the species during the BDCP term.

Developing the EA and determining the net effects for covered plants and wildlife involved several steps:

• A thorough literature review of the most current scientific information regarding species range, habitat use and stressors was conducted. This included plant and wildlife species occurrence data. Using the information gathered from current literature and expert review and input, Geographic Information Systems (GIS) was used to develop habitat models.

• The GIS habitat models and species occurrence information was then used to conduct a quantitative assessment of the anticipated amount of habitat to be adversely and beneficially impacted by BDCP. In some instances, precise impact footprint were included, such as for CM1 Water Facilities and Operations, while hypothetical estimates were used for others, such as CM4 Tidal Natural Communities Restoration.

Using this combination of quantitative and qualitative information, a determination was made as to whether the net effects on each species will result in conservation of the species.

The Plan’s contribution to recovery was guided by the proportion of a species’ range and lifecycle within the plan area and the level of effect on that species. For example, all else being equal, the Plan’s obligation to contribute to recovery for a species with a small portion of its range in the plan area is less than the Plan’s obligation to conserve a species with a large portion of its range in the plan area. For listed species, conservation of a species is defined as the use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures provided under the Endangered Species Act (ESA) are no longer necessary. For non-listed species, contribution to recovery is defined by the BDCP’s contribution to factors that prevent the species’ need to become state or federally listed in the future.

A protected area is a location which receives safeguards because of its recognized natural, ecological, and/or cultural values. They are areas set aside to maintain functioning natural ecosystems, to act as refuges for species and to maintain ecological processes that cannot otherwise survive.

BCDP Effects on Covered Plants and Wildlife

The following table provides EA results for covered terrestrial species. The BDCP will result in a net beneficial effect for all terrestrial species in terms of total extent of habitat, extent of protected habitat, or both.

<table>
<thead>
<tr>
<th>Species</th>
<th>Existing Condition</th>
<th>BCDP Net Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total Extent in Plan Area (Acres)</td>
<td>Protected (Acres)</td>
</tr>
<tr>
<td></td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>Riparian brush rat</td>
<td>5,097</td>
<td>487</td>
</tr>
<tr>
<td>Riparian vole</td>
<td>2,156</td>
<td>110</td>
</tr>
<tr>
<td>Salt marsh harvestman*</td>
<td>35,064</td>
<td>29,640</td>
</tr>
<tr>
<td>California ground fox</td>
<td>3,352</td>
<td>886</td>
</tr>
<tr>
<td>Salt marsh clapper</td>
<td>7,908</td>
<td>5,008</td>
</tr>
<tr>
<td>California fairy shrimp</td>
<td>27,489</td>
<td>20,839</td>
</tr>
<tr>
<td>California clapper</td>
<td>3,063</td>
<td>3,099</td>
</tr>
<tr>
<td>California least tern</td>
<td>80,266</td>
<td>17,503</td>
</tr>
<tr>
<td>Greater sandhill crane</td>
<td>174,707</td>
<td>40,552</td>
</tr>
<tr>
<td>Least bell’s vireo</td>
<td>14,993</td>
<td>5,446</td>
</tr>
<tr>
<td>Suisun song sparrow</td>
<td>27,758</td>
<td>2,880</td>
</tr>
<tr>
<td>Swainson’s hawk</td>
<td>470,562</td>
<td>103,164</td>
</tr>
<tr>
<td>Yellow-billed cuckoo</td>
<td>384,173</td>
<td>91,109</td>
</tr>
<tr>
<td>Western harrowing owl</td>
<td>363,084</td>
<td>79,015</td>
</tr>
<tr>
<td>Western yellow-billed cuckoo</td>
<td>12,805</td>
<td>4,589</td>
</tr>
<tr>
<td>White-tailed kite</td>
<td>513,837</td>
<td>119,261</td>
</tr>
<tr>
<td>Yellow-bellied chat</td>
<td>14,965</td>
<td>6,127</td>
</tr>
<tr>
<td>Bell’s vireo</td>
<td>92,887</td>
<td>25,859</td>
</tr>
<tr>
<td>Western pond turtle</td>
<td>110,599</td>
<td>51,264</td>
</tr>
<tr>
<td>California red-legged frog</td>
<td>7,972</td>
<td>3,694</td>
</tr>
<tr>
<td>California tiger salamander</td>
<td>30,018</td>
<td>11,394</td>
</tr>
<tr>
<td>Valley elderberry longhorn beetle</td>
<td>34,849</td>
<td>10,452</td>
</tr>
<tr>
<td>California clapper</td>
<td>2,156</td>
<td>130</td>
</tr>
<tr>
<td>California least tern</td>
<td>11,040</td>
<td>5,870</td>
</tr>
<tr>
<td>Vernal pool fairy shrimp</td>
<td>11,040</td>
<td>5,870</td>
</tr>
</tbody>
</table>

* While there will be a net decrease in managed wetlands that provide habitat for salt marsh harvest mouse, there will be a net increase in tidal brackish marsh providing habitat with higher long-term conservation value consistent with the recovery plan for this species. Additionally, an ongoing or analysis of the conservation lands in the plan area is expected to show a net increase in the level of habitat protection for this species.

** There will be no net loss of wetted vernal pool acres that provide habitat for this species.
This section describes the net effects on fish based upon modeling focused on potential changes in water flow under the various BDCP scenarios. The species-specific effects included an analysis of potential changes to aquatic habitat including water temperature, water quality, and lifecycle patterns.

BDCP Effects on Fish Species

Assessing Effects for Covered Fish

BDCP implementation will result in incidental take (harassment or harm) of covered fish species. The overall take of covered fish as a result of the conservation measures is not quantifiable. Instead, take was evaluated by determining the mechanism and direction of positive or negative effects. These determinations were used to establish a qualitative scoring of beneficial and adverse effects of the conservation measures. These rankings made it possible to develop a qualitative determination of overall effects and a set of conclusions regarding take. The predicted effects of the Plan will be compared to actual measurements of fish population trends in real-time to ensure permit compliance and to adaptively manage the BDCP.

For fish, the following types of effects could result from the BDCP:

- Reduction in entrainment (capture) of fish in water diversions
- Increase in predation as a result of new structures
- Modification of river flow and Delta outflow
- Increase in suitable habitat
- Increase in food and foraging
- Permanent indirect and other indirect losses

Several of these activities are predicted to benefit covered fish species by increasing habitat and food resources, and more natural flow patterns. Adverse conditions that could result in take are dependent on flow conditions and are evaluated in a detailed quantitative analysis.

Habitat Restoration

The BDCP habitat restoration actions have two principal objectives:

- Increase the amount and quality of available habitat for covered fish species to address their unique life history stage needs
- Enhance the ecological function of the Delta

Upstream Effects

The BDCP is expected to result in minimal changes in upstream flows or reservoir operations. As such, there are few instances in which changes to the environment and related effects on fish may occur in upstream habitats as a result of BDCP:

- No effects on spawning and egg incubation are estimated to result from the BDCP, with the exception of a possible slight reduction for Sacramento River spring-run Chinook.
- No major or consistent adverse effects were detected on upstream habitat conditions (e.g., instream flows) in the Sacramento River, Trinity river, or Clear Creek.
- Small to moderate reductions in flow rates during some summer and fall months are expected in the Feather River.
- Once effects associated with climate change are factored out, average differences in flow during covered fish species migration and transport periods would be minor.

The Delta is a critical migratory corridor for adult fish returning to their spawning grounds and is habitat for several native estuarine species, including imperiled Delta smelt and longfin smelt.
BDCP Effects on Salmon and Steelhead

Salmon and Steelhead are environmentally, commercially, and culturally important species whose habitat will be affected by BDCP activities. Four races (runs) of Chinook salmon and Steelhead are seasonally present in the BDCP plan area and were considered in the effects analysis. All five species have seen dramatic declines in population numbers over the last 150 years. Today, approximately 95 percent of juvenile San Joaquin River salmon and 60 percent of Sacramento River salmon do not survive as they migrate through the Delta. The diagram on the right illustrates how salmon and Steelhead use the Delta throughout their lifecycle and the challenges they currently face.

Salmon and Steelhead included in the Effects Analysis

<table>
<thead>
<tr>
<th>Species</th>
<th>Description</th>
<th>Federal ESA Status</th>
<th>California ESA Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter-run Chinook</td>
<td>Spawning habitat is limited to the upper Sacramento River and possibly Battle Creek. March is the peak month for returning adults entering the Sacramento River basin. Peak emigration of young fish into the Delta is November but can continue through early May. Many winter-run Chinook hold and rear in the Sacramento River for several months before reaching the Delta where they typically remain for several more months.</td>
<td>Endangered</td>
<td>Endangered</td>
</tr>
<tr>
<td>Spring-run Chinook</td>
<td>Spawning habitat is limited to the Sacramento River and a few of its tributaries. The Feather River Hatchery currently produces a large number of spring-run salmon. Adults begin migration upstream in March. Young spring-run emigrate downstream between November and April, with some fish in the Delta into the summer.</td>
<td>Threatened</td>
<td>Threatened</td>
</tr>
<tr>
<td>Fall-run and Late Fall-run Chinook</td>
<td>Fall-run Chinook are present in the Sacramento River and San Joaquin River systems. Late fall-run are currently only present in the Sacramento River system. Adult fall-run typically migrate through the Delta June through December. Fall-run juveniles typically emigrate downstream and enter the Delta in the spring. Late fall Chinook migrate into the Sacramento River October through April. There is a good deal of uncertainty about when young late-fall Chinook enter the Delta.</td>
<td>Species - Copco, Delta</td>
<td>N/A</td>
</tr>
<tr>
<td>Steelhead</td>
<td>Steelhead are currently present in both the Sacramento River and San Joaquin River systems, though the San Joaquin River population is small. Steelhead typically emigrate in the fall, winter, and spring. Young Steelhead typically spend one to two years in their home streams before emigrating through the Delta region.</td>
<td>Threatened</td>
<td>N/A</td>
</tr>
</tbody>
</table>
Effects on Salmon and Steelhead (Winter-run, spring-run, fall- and late fall-run Chinook salmon)

The net effect of the BDCP on salmon and Steelhead is expected to be positive. The magnitude of benefits of the BDCP for salmon and Steelhead at the population level cannot be quantified with certainty. Nonetheless, expanded and improved habitat, increased food supplies, and reduced entrainment are just a few benefits of BDCP. These positive effects have the potential to increase the resiliency and abundance of salmon and Steelhead compared to existing conditions. The BDCP should contribute to recovery of Steelhead compared to existing conditions. The net effect of the BDCP on salmon and Steelhead at the population level cannot be quantified with certainty. Nonetheless, increasing the number of productive habitat locations in the Delta, the BDCP may lead to a more robust salmon and Steelhead population with the resiliency and diversity necessary to cope with a changing environment. The map on the right highlights key benefits of BDCP for Chinook salmon. Specific information on BDCP effects for each species, is provided in Chapter 5, Sections 5.5.3-5.5.6.

Food Benefits
CM2, CM4, CM5, CM6, and CM7 have considerable potential to increase the quantity of food available for juvenile salmon and Steelhead.

Reduced Illegal Harvest
CM17 will help reduce illegal harvest of adult salmon and Steelhead.

The BDCP Salmon and Steelhead Benefits

Upstream Effects
- The BDCP is committed to avoiding effects to habitat for winter-run and spring-run Chinook in the Sacramento River, Trinity River, or Clear Creek, but could result in small positive increase in flows in the Feather River during the adult migration period.
- Habitat conditions for fall-run Chinook juveniles in the Feather and American rivers would be improved due to operation of CM1. Spawning conditions in the Sacramento River would also be improved.
- CM14 will directly improve dissolved oxygen (DO) conditions in the Stockton Deep Water Ship Channel, improving passage conditions for San Joaquin River fall-run adults. Operation of the Suisun Salinity Control Gates will also improve upstream passage conditions for San Joaquin River fall-run adults.

Floodplain Habitat
- CM2 will increase floodplain available and usage in the Yolo Bypass to improve conditions for migrating juvenile and adult salmon and Steelhead.
- CM5 will expand floodplain habitat in the San Joaquin River system to benefit juvenile spring-run and San Joaquin River fall-run salmon.

Reduced Entrainment
- CM1 will reduce entrainment of juvenile salmon and Steelhead due to reduced reliance on the south Delta export facilities. It is estimated that entrainment would be reduced by 40 to 70 percent (depending on race and water year type) compared to existing conditions.
- CM16 and CM1 operations under BDCP have potential to reduce juvenile salmon and Steelhead entry into the interior Delta where they can become trapped or subject to predation.
- Reduced south Delta pumping will also improve migration cues for San Joaquin River fall-run adults and reduce straying into the Sacramento River region.

Reduced Illegal Harvest
CM17 will help reduce illegal harvest of adult salmon and Steelhead.

Reduced Predation
CM1, CM2, CM5, CM6, CM13, CM15, CM16 will all contribute to reducing losses of juvenile salmon and Steelhead at existing localized areas where predation is intense.

Reduced Entrainment
CM4 will increase tidal habitat suitable for juvenile salmon and Steelhead in the Cache Slough and Suisun Marsh as well as other regions in the plan area.

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BDCP Effects on Green and White Sturgeon

Green and white sturgeon are long-lived species that use the plan area as a migration corridor, feeding area, and juvenile rearing area. Both species have been observed throughout the region, including Suisun Bay and the Yolo Bypass.

Green and white sturgeon are two of the largest fresh water fish in North America and are often sought by anglers for their impressive size. Green sturgeon typically spawn more than 300 pounds. White sturgeon can grown up to 19 feet and weight more than 1,000 pounds. Green sturgeon typically spawn in the Sacramento and Feather rivers from January through May. White sturgeon typically spawn in the Sacramento, Feather, and San Joaquin rivers during late winter and spring. Both species spawn multiple times during their lives. Most sturgeon spend the majority of their lives in the brackish and deep waters of the estuary.

The BDCP is expected to positively affect green and white sturgeon through improvements in abundance, productivity, life-history diversity, and spatial diversity in the plan area. The positive effects of the BDCP on the sturgeon populations include increased suitable habitat, greater food production, improved passage, reduced entrainment in the south Delta, lower predation rates, and reduced illegal harvest. The BDCP is also expected to have little effect on flows in the Sacramento River during the green and white sturgeon spawning period; but is expected to moderately improve spawning conditions in the Feather River.

Reduced Illegal Harvest

CM17 is expected to decrease poaching of white and green sturgeon and other covered fish. This expected decrease is especially important for white and green sturgeon because harvest is thought to have a substantial adverse effect on the populations, particularly through the illegal harvest of spawning females. Because of their longevity, late maturation and low populations, white and green sturgeon are particularly susceptible to threats from overfishing.

Flows Conditions

- Under the BDCP, CM4, Feather River operations are expected to result in higher flows during the spring months, which will improve conditions for white and green sturgeon. These flows are expected to have the following benefits:
  - Provide increased freshwater rearing habitat
  - Increase spawning activity cued by higher upstream flows
  - Increase nutrient loading into nursing areas, or increase downstream migration rate and survival through reduced exposure time to predators
  - Benefit incubating eggs
  - Improve upstream passage conditions
  - Adaptively manage spring outflows

Improved Passage

- CM2 and CM14 are expected to improve passage for white and green sturgeon. Improving fish passage at Fremont Weir is expected to reduce stranding and poaching of sturgeon in the stilling basin below the weir after water recedes.
- The BDCP is expected to improve dissolved oxygen (DO) levels near Stockton with implementation of CM14, which may improve conditions for migrating sturgeon.

Improved Habitat Conditions

Overall, restoration is expected to have a high positive effect on white and green sturgeon.

- CM4 will increase the amount of freshwater and brackish marsh habitat that supports production and movement of food sources for juvenile and adult sturgeon that use this habitat as migration pathways through the estuary and plan.
- CM5 may provide a small benefit to sturgeon in the form of habitat and food benefits.
- CM6 may increase the availability and quality of resting habitat for migrating adults.
- CM22 is predicted to provide food downstream in the Delta because of increased flooding frequency and duration.

Photo courtesy of U.S. Fish and Wildlife Service
Delta Smelt

The Delta smelt is a small, translucent fish endemic to the Sacramento-San Joaquin Bay Delta estuary. The Delta smelt life history includes spawning during spring in freshwater areas followed by juvenile migration to the low salinity zone and other turbid, open-water, low-salinity areas of the plan area to feed and mature in the summer and fall.

Longfin Smelt

Longfin smelt is a fish endemic to the west coast of North America. The Delta is an important migratory corridor for adult longfin smelt moving upstream to spawn and a rearing habitat for young longfin smelt on their way back to the San Francisco Bay. Adult longfin smelt are typically present in the Delta portions of the plan area from November through March. Young longfin smelt can be found in the Delta between late winter months through June.

BDCP Effects on Delta Smelt

The BDCP’s main beneficial effect for Delta smelt is potentially greater food production from habitat restoration, with some minor benefits related to reduced entrainment. The BDCP is expected to have at least a minor beneficial effect on the species, but a great potential for larger benefits depending on actual food production and location of the Delta smelt population in the estuary.

BDCP Effects on Longfin Smelt

Overall, the BDCP is expected to have a positive effect on longfin smelt. Reduced entrainment, increased habitat availability, increased food, and an adaptively managed level of spring outflow as determined prior to tunnel operation are expected to improve longfin smelt survival and reproduction.

Adaptive Management

Habitat restoration design and adaptive management will continuously increase the magnitude of benefits for Delta and longfin smelt through efforts such as careful siting and sizing of restoration areas and flow management. The monitoring and adaptive management program will provide the opportunity to address existing uncertainties and alter the BDCP to maximize its long-term benefits. The Adaptive Management Team will provide the ability to respond in the event the conservation measures do not achieve plan biological objectives, or to potential threats to the species that might occur as a result of project operations, changes in species distributions or abundance, or other factors.

Delta and longfin smelt are the two species to which a decision tree is applied in the BDCP prior to the implementation of CM1 to determine initial operations (See BDCP Chapter 3, Section 3.3 for additional information). For Delta smelt, the decision tree is focused on the need for fall outflow to be implemented per the USFWS Biological Opinion Reasonable and Prudent Alternative (2008). For longfin smelt, the decision tree is focused on the need for spring outflow to be as high as possible within the confines of the CVP/SWP.

Reduced Entrainment

• Under CM1, the north Delta intakes will reduce reliance on south Delta pumping, which is expected to reduce or maintain Delta and longfin smelt entrainment at current low levels (due to mandated pumping restrictions) or potentially reduce entrainment from the current levels.

• Decommissioning of agricultural diversions under CM21 in the ROA may also reduce entrainment for Delta and longfin smelt.

Flow Conditions

• The new north Delta facilities will be outside of the Delta and longfin smelt’s primary habitat range, therefore, minimal impingement or entrainment is expected.

• Under BDCP operations will be managed to meet outflow objectives related to the low salinity zone, which is expected to increase and enhance Delta smelt habitat.

• Flows, particularly spring outflows, will also be managed based on the best available information to meet longfin outflow needs for habitat, food supplies, and salinity control.

Natural outflow to ocean

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Pacific and River Lamprey

Knowledge of the relative effects of different stressors on Pacific lamprey is very limited, and even less is known about river lamprey. Because very little is known about river lamprey, much of this discussion uses information about Pacific lamprey. Pacific lamprey spend the majority of their 9- to 12-year lifespan upstream. Except during the periods when they migrate upstream to spawn and downstream toward the ocean after rearing upstream, river lamprey spend 3 to 5 years of their 6- to 7-year lifespan upstream, with the remainder of their lifespan spent in the ocean. A number of stressors affect upstream life stages of both species. Passage barriers include dams, culverts, water diversions, and tidal gates.

Effects on Pacific and River Lamprey

Overall, despite high uncertainty based on a deficiency of available scientific knowledge of lamprey, the EA concluded that the BDCP will provide a small net benefit to both Pacific and river lamprey. Benefits of the BDCP will be similar in magnitude between Pacific and river lamprey, although benefits to Pacific lamprey would be somewhat greater than those to river lamprey because of improved flows during the migration period. If monitoring during BDCP implementation indicates additional methods to improve conservation, conservation measures will be adaptively managed to improve conditions for both species of lamprey to the extent practicable. However, the effects of climate change on upstream flows and water temperatures are expected to be mostly adverse and likely will offset some of the predicted benefits of the BDCP.

Sacramento Splittail

Sacramento splittail is a freshwater fish native to California. The species is native to the San Francisco Estuary and its associated watershed. Its range is entirely encompassed in the plan area. Splittail abundance is strongly related to hydrologic conditions, with wet years producing much stronger year classes than dry years. Consequently, splittail abundance varies greatly from year to year. In 1999, following a 6-year drought, the Sacramento splittail was listed as threatened under the ESA. However, the listing was rescinded in 2003, after a return to wet conditions in the late 1990s that resulted in record abundance for the species. Splittail can live 5 to 7 years and tolerate a wide range of water quality conditions, including salinity, temperature, and dissolved oxygen (DO) levels.

In spring, when California’s Central Valley experiences large amounts of snowmelt and/or rain runoff, adult splittail will move to inundated floodplains or margins of the rivers in the valley to spawn. The Yolo Bypass provides the largest spawning area. Lack of spawning habitat is a primary stressor of splittail and their floodplain habitat has been diminished over the last several decades.

Effects on Sacramento Splittail

Sacramento splittail abundance has been highly variable, which has produced inconsistent findings concerning its regulatory status. The BDCP is expected to have a positive effect on the abundance, productivity, and diversity of splittail populations and reduce risk to its survival. The BDCP would greatly increase available spawning habitat through CM 2, 4, 5, and 6. These increased spawning habitats will result in an enlarged spawning stock, especially if restoration actions increase availability of rearing and foraging habitat for juveniles and adults.

The overall effect of the BDCP on splittail will be to increase the abundance, productivity, and diversity of the species and improve the species’ chances for survival. The BDCP will mitigate the impacts of the covered activities and conserve the species.
For more information, or to submit comments, visit www.BayDeltaConservationPlan.com, call 1-866-924-9955, or email info@BayDeltaConservationPlan.com.