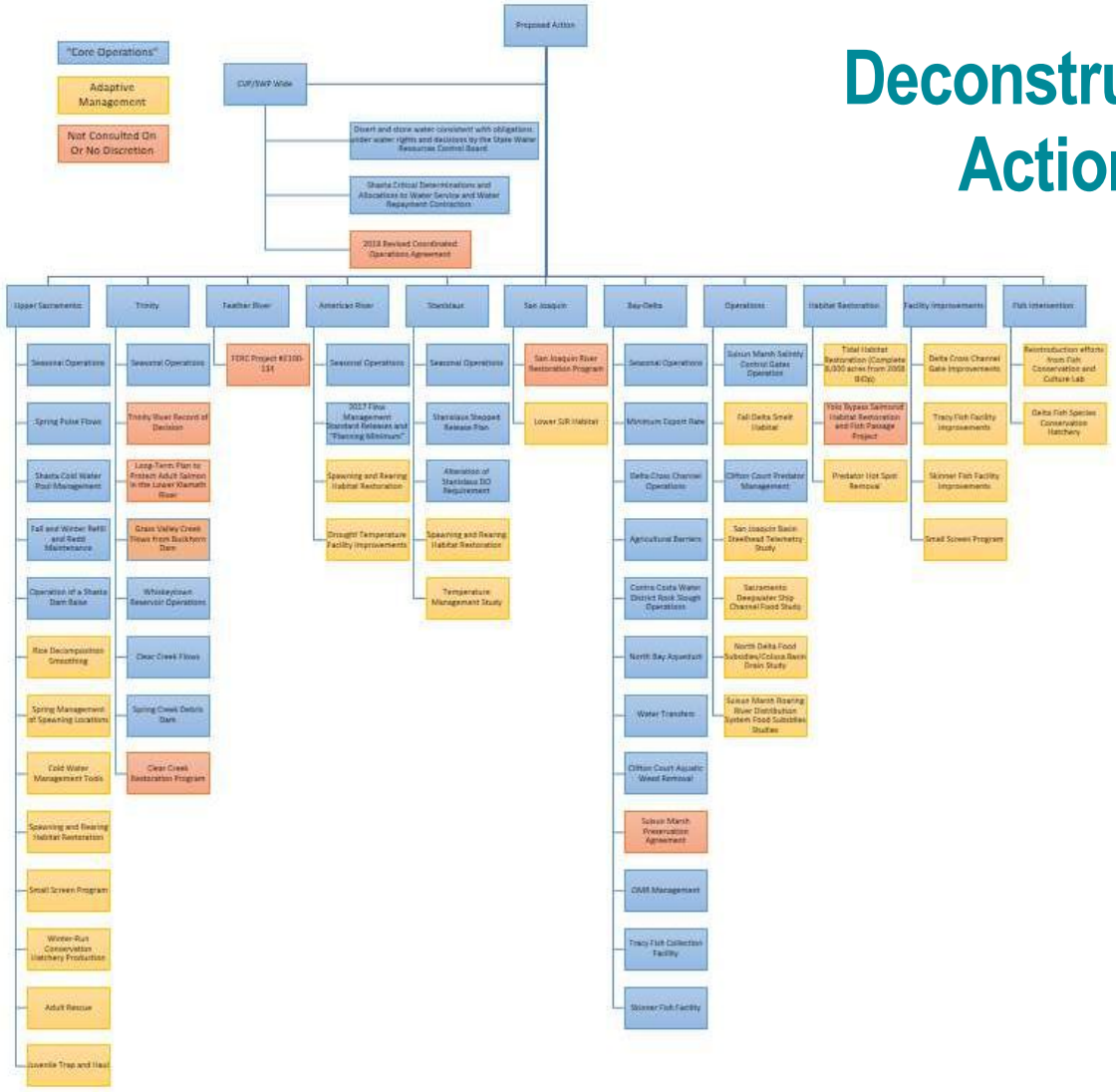
ROC on LTO BiOp and Preliminary Effects Analysis Briefing "Cracking the ROC"

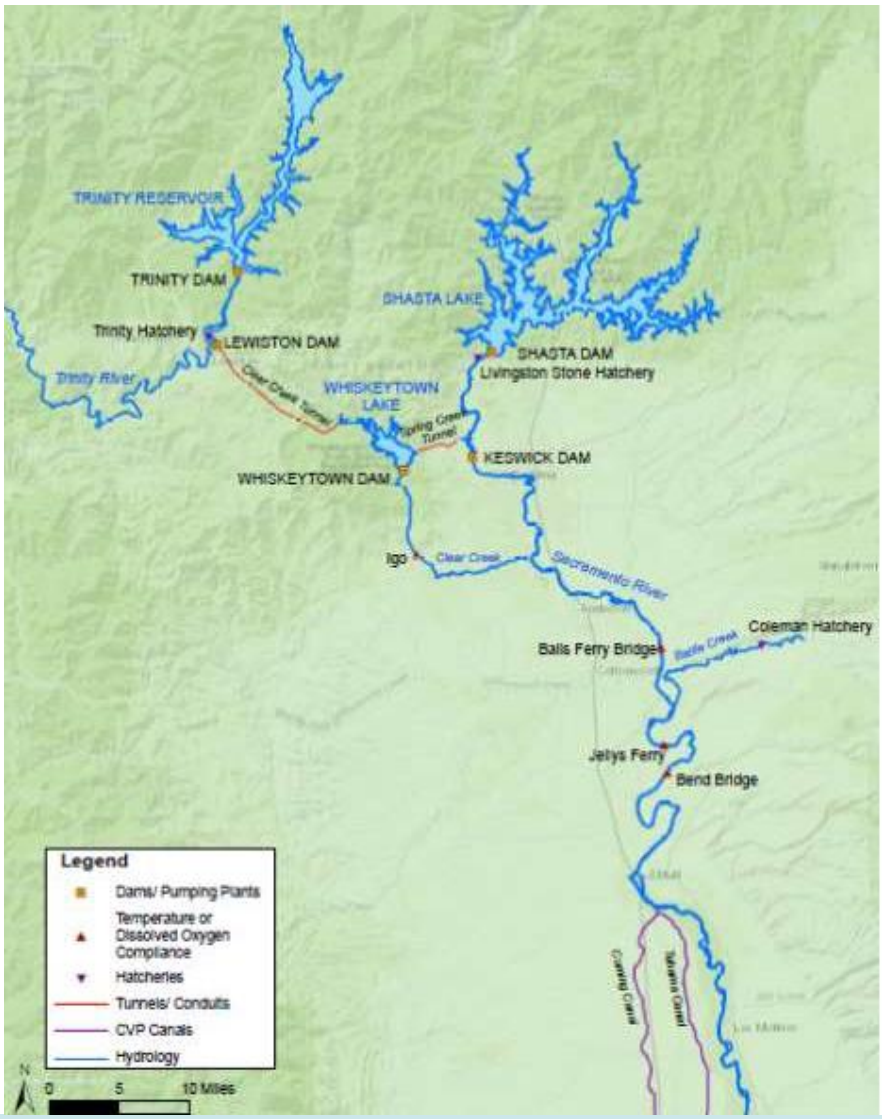
April 30, 2018
Draft April 26 Version

Deconstructed Action

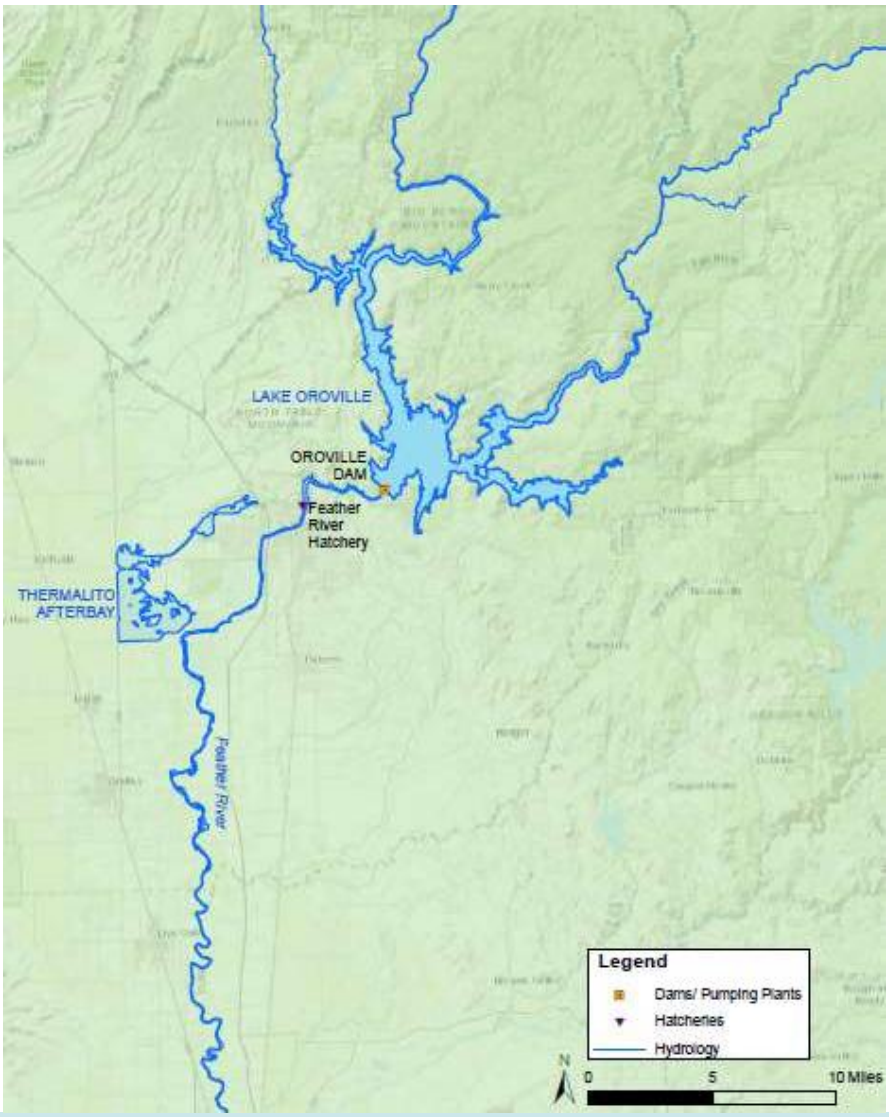


Overview of the System and Action Area

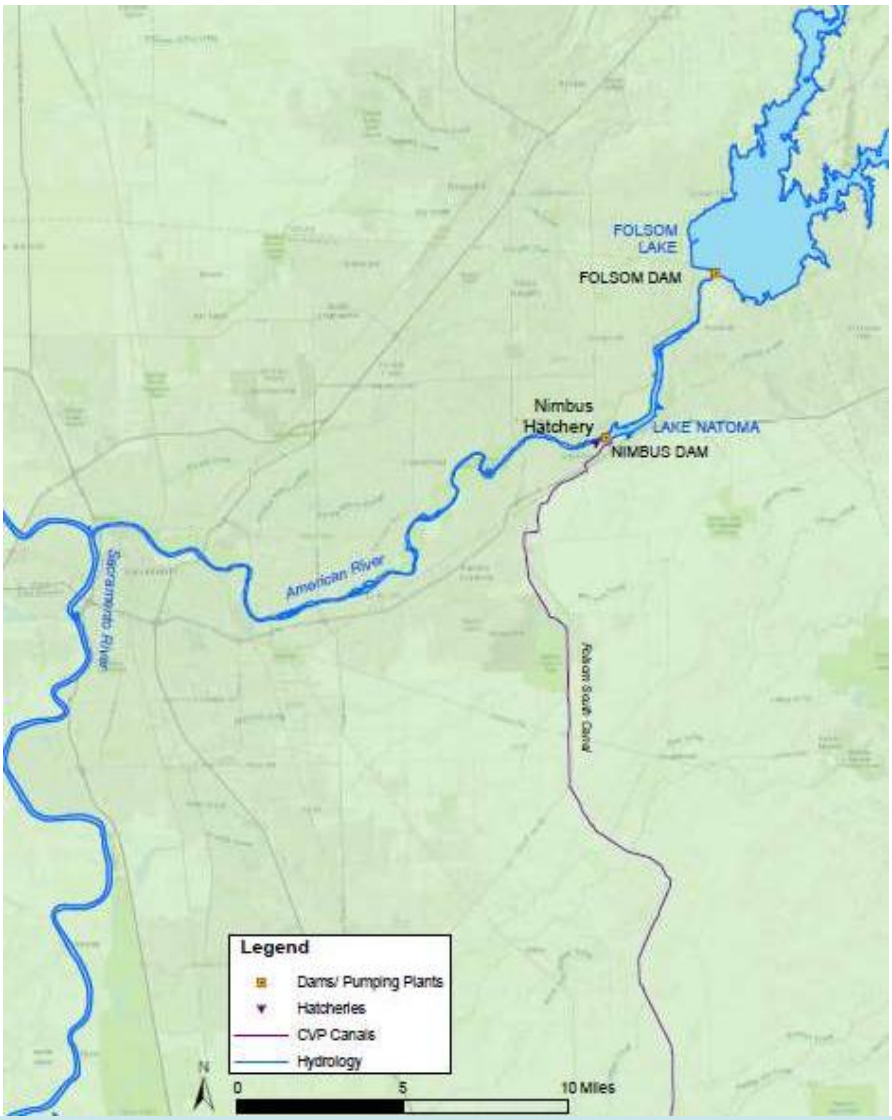
Shasta – Trinity



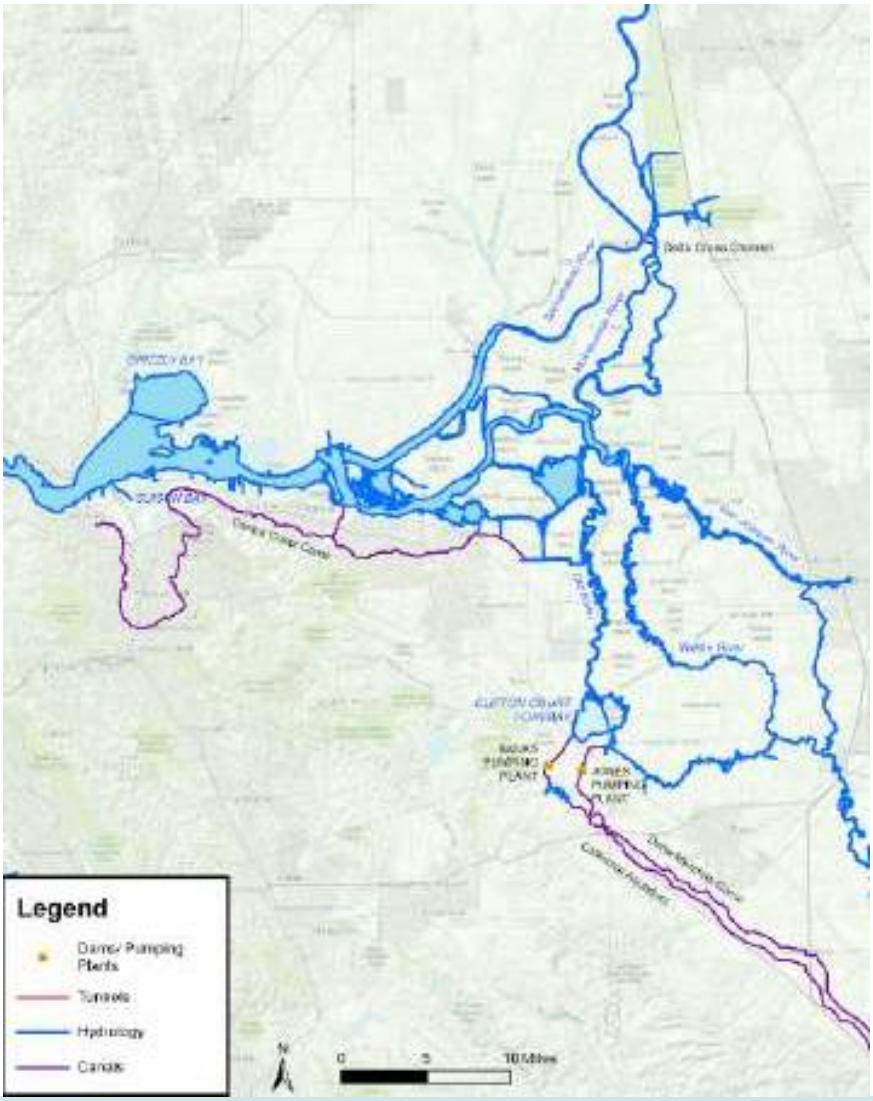
Feather


LAKE OROVILLE
OROVILLE DAM
Feather River Hatchery
THERMALITO AFTERBAY
Feather River
Legend
Dams/ Pumping Plants
Hatcheries
Hydrology
N
0
5
10 Miles

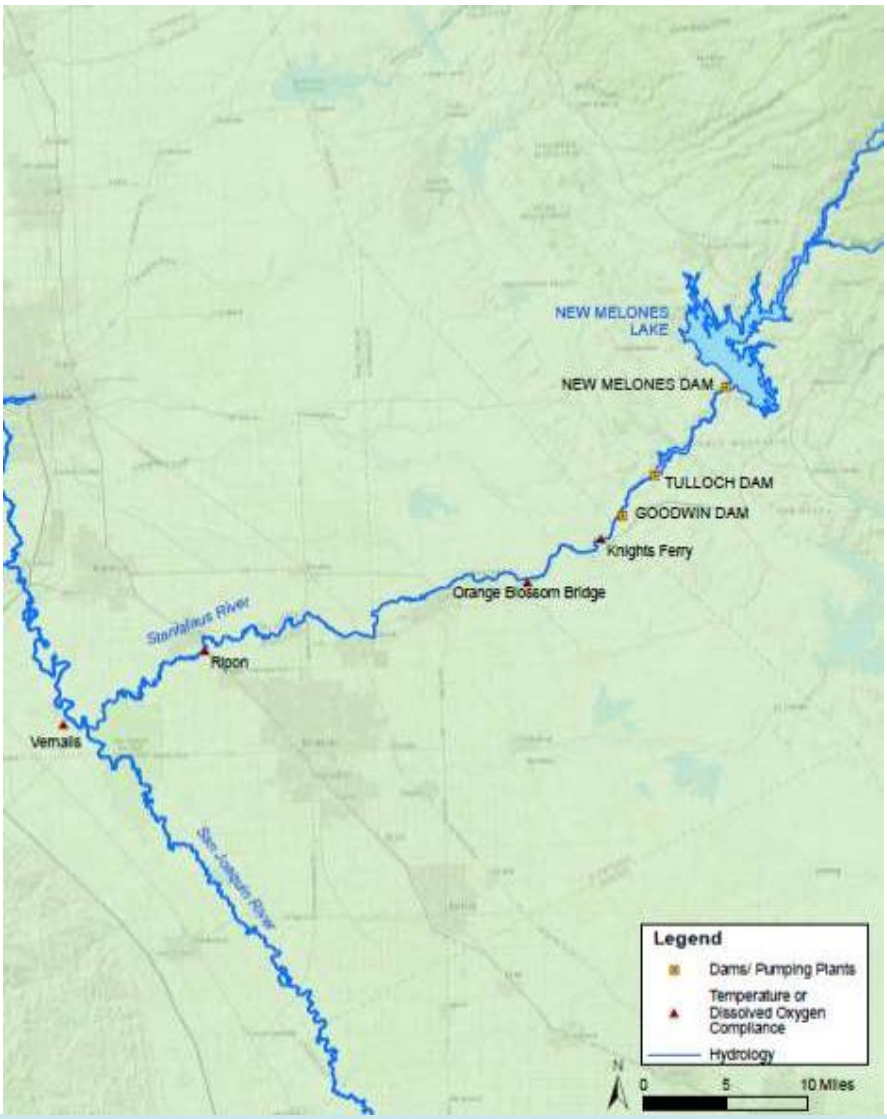
American


FOLSOM LAKE
FOLSOM DAM
Nimbus Hatchery
LAKE NATOMA
NIMBUS DAM
American River
Sacramento River
Folsom South Canal
Legend
Dams/ Pumping Plants
Hatcheries
CVP Canals
Hydrology
N
0
5
10 Miles

Delta



Stanislaus


NEW MELONES LAKE
NEW MELONES DAM
TULLOCH DAM
GOODWIN DAM
Knights Ferry
Orange Blossom Bridge
Stanislaus River
Ripon
Vernalis
San Joaquin River
Legend
Dams/ Pumping Plants
Temperature or Dissolved Oxygen Compliance
Hydrology
N
0
5
10 Miles

Coastal Extent of the Action Area

Status of Species and Critical Habitat

Sacramento River winter-run Chinook salmon

- Endangered - High risk of extinction

Central Valley spring-run Chinook salmon

- Threatened - Moderate risk of extinction

California Central Valley steelhead

- Threatened – likely to become endangered in foreseeable future

Southern DPS Green Sturgeon

- Threatened – moderate risk of extinction

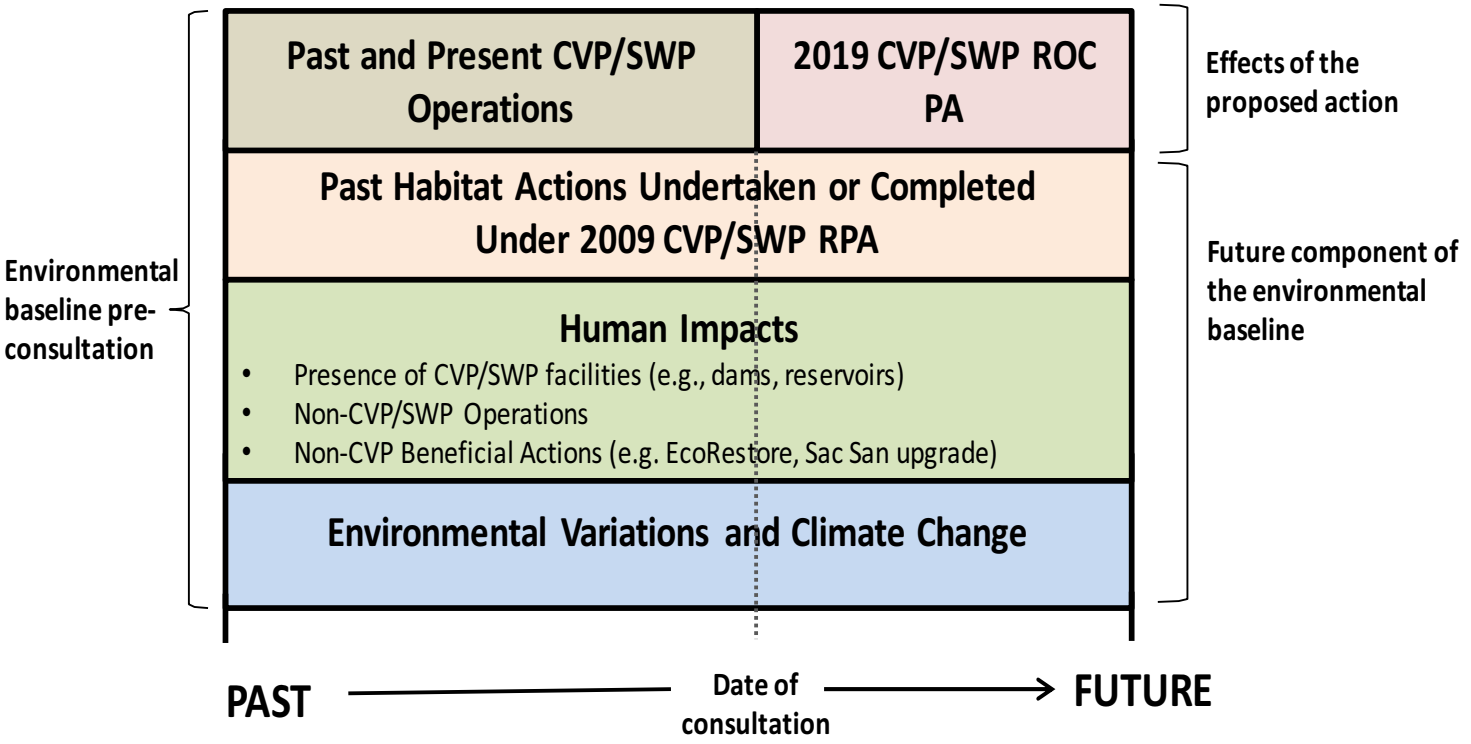
Critical Habitat – all 4 anadromous fish species

- High quality habitat very limited
- All PBFs significantly degraded

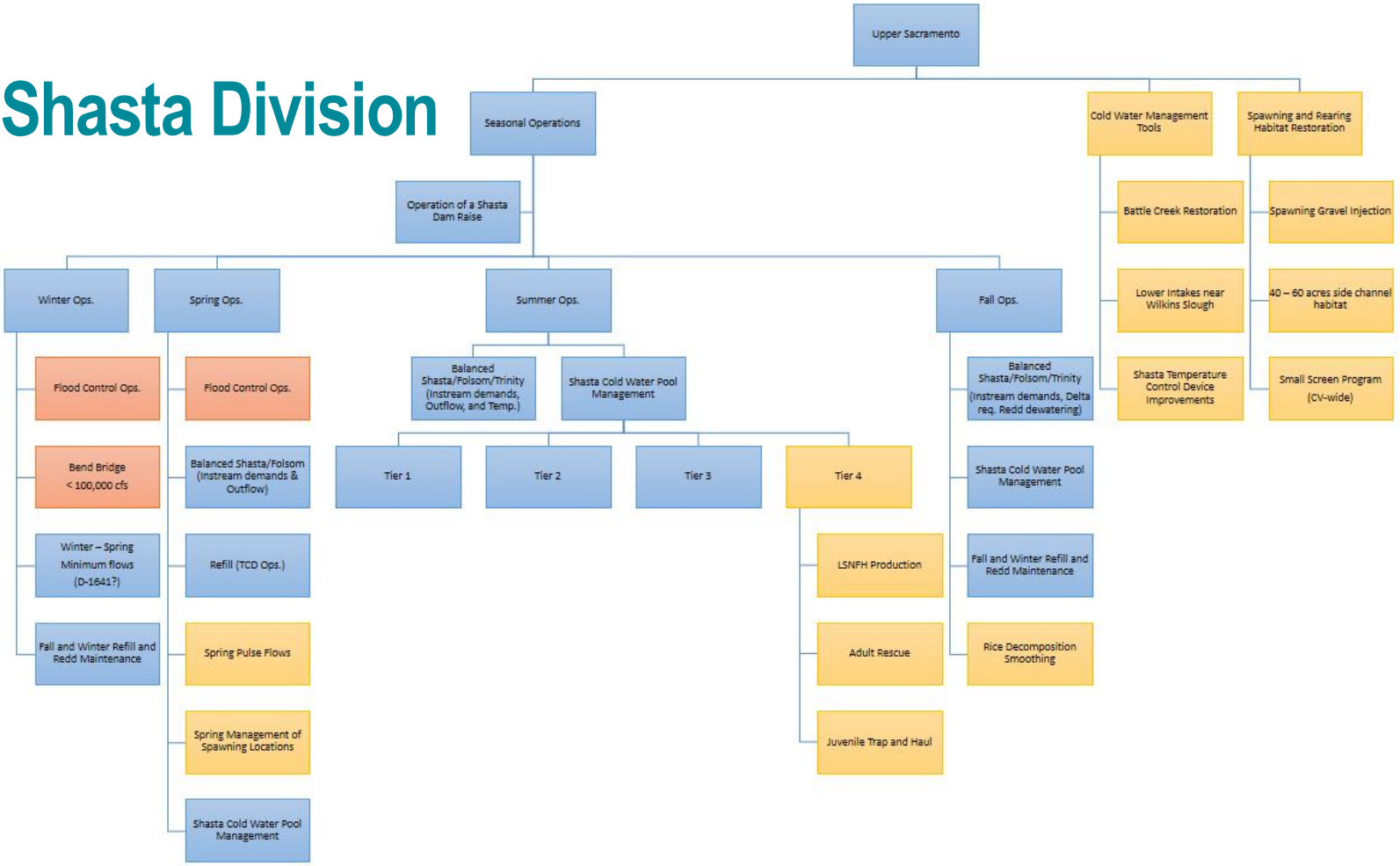
Southern Resident Killer Whale

- Endangered – Danger of extinction

Environmental Baseline



Shasta Division



Significant Effects to Individuals: Winter-run

Action Component	Stressor/Factor	Life Stage (Location)	Life Stage Timing (Work Window Intersection)	Individual Response and Rationale of Effect	Severity of Stressor	Proportion of Population Exposed	Frequency of Exposure	Magnitude of Effect	Weight of Evidence
2.5.2.1.3.1 Tier 1 (Shasta Cold Water Pool Mgmt.)	Water Temperature	Eggs/Fry (Keswick Dam - CCR gauge)	May - October (May 15 - October)	Temperatures higher than 53.5°F would cause a decrease in egg survival.	Lethal	Medium (23.3% of days >53.5°F)	Medium (68% of years)	High	High: Supported by multiple scientific and technical publications that include quantitative models specific to the region and species.
2.5.2.1.3.1 Tier 2 (Shasta Cold Water Pool Mgmt.)	Water Temperature	Eggs/Fry (Keswick Dam - CCR gauge)	May - October (May 15 - October)	Temperatures higher than 53.5°F would cause a decrease in egg survival.	Lethal	Medium (33.1% of days >53.5°F)	Low (17% of years)	High	High: Supported by multiple scientific and technical publications that include quantitative models specific to the region and species.
2.5.2.1.3.1 Tier 3 (Shasta Cold Water Pool Mgmt.)	Water Temperature	Eggs/Fry (Keswick Dam - CCR gauge)	May - October (May 15 - October)	Temperatures higher than 53.5°F would cause a decrease in egg survival.	Lethal	Medium (65% of days >53.5°F)	Low (7% of years)	High	High: Supported by multiple scientific and technical publications that include quantitative models specific to the region and species.
2.5.2.1.3.1 Tier 4 (Shasta Cold Water Pool Mgmt.)	Water Temperature	Eggs/Fry (Keswick Dam - CCR gauge)	May - October (May 15 - October)	Temperatures higher than 53.5°F would cause a decrease in egg survival.	Lethal	Large (86% of days >53.5°F)	Low (7% of years)	High	High: Supported by multiple scientific and technical publications that include quantitative models specific to the region and species.
2.5.2.1.4.1 Fall and Winter Refill and Redd Maintenance	To build storage for the subsequent year class	Juveniles (Upper Sacramento River)	July - December (October, November)	Decreased month-to-month flows restringing in stranding and decreased floodplain inundation and side-channel habitat.	Lethal	Medium (<50% of the population)	Low (20% of years)	High	Medium: Supported by technical publications specific to the region and species. Quantitative results include WUA analysis and month-to-month floodplain inundation.
2.5.2.2 Operation of a Shasta Dam Raise	NA	NA	NA	None. Reinitiation triggers apply	NA	NA	NA	NA	NA
2.5.2.3.3.1.1 LSNFH Production (tier 4 intervention)	Hatchery effects (minimization for Water Temperatures)	Adults (Upper Sacramento River)	December - August (May - August)	Covered under the USFWS 2016 HGMP	Lethal	Uncertain. High (?)	Low (7% of years)	Uncertain, High	High: Multiple scientific and technical publications covering the influence of hatchery production on wild populations.
2.5.2.3.3.1.3 Juvenile Trap and Haul (tier 4 intervention)	Monitoring, Maintenance, Research Studies, etc. (minimization for Water Temperatures)	Juveniles (Upper Sacramento River)	July - December (uncertain)	Uncertain. Programmatic action component. Increased stress and mortality related to capture and handling.	Lethal	Uncertain. High (?)	Low (7% of years)	Uncertain, High	Low: (Programmatic action component) very little information available

Significant Effects to Individuals: Spring-run

Action Component	Stressor	Life Stage (Location)	Life Stage Timing (Work Window Intersection)	Individual Response and Rationale of Effect	Severity of Stressor	Proportion of Population Exposed	Frequency of Exposure	Magnitude of Effect	Weight of Evidence
2.5.2.1.3.1 Tier 1 (Shasta Cold Water Pool Mgmt.)	Water Temperature	Eggs/Fry (Keswick Dam - BSF gauge)	August - December (August - October)	Temperatures higher than 53.5°F would cause a decrease in egg survival.	Lethal	Large (76% of days >53.5°F)	Medium (68% of years)	High	Medium: Supported by multiple scientific and technical publications, however not specific to the region and species.
2.5.2.1.3.1 Tier 2 (Shasta Cold Water Pool Mgmt.)	Water Temperature	Eggs/Fry (Keswick Dam - BSF gauge)	August - December (August - October)	Temperatures higher than 53.5°F would cause a decrease in egg survival.	Lethal	Large (80% of days >53.5°F)	Low (17% of years)	High	Medium: Supported by multiple scientific and technical publications, however not specific to the region and species.
2.5.2.1.3.1 Tier 3 (Shasta Cold Water Pool Mgmt.)	Water Temperature	Eggs/Fry (Keswick Dam - BSF gauge)	August - December (August - October)	Temperatures higher than 53.5°F would cause a decrease in egg survival.	Lethal	Large (97% of days >53.5°F)	Low (7% of years)	High	Medium: Supported by multiple scientific and technical publications, however not specific to the region and species.
2.5.2.1.3.1 Tier 4 (Shasta Cold Water Pool Mgmt.)	Water Temperature	Eggs/Fry (Keswick Dam - BSF gauge)	August - December (August - October)	Temperatures higher than 53.5°F would cause a decrease in egg survival.	Lethal	Large (99.6% of days >53.5°F)	Low (7% of years)	High	Medium: Supported by multiple scientific and technical publications, however not specific to the region and species.
2.5.2.1.4.1 Fall and Winter Refill and Redd Maintenance	Spawning Habitat Availability, Flow Conditions, Loss of Riparian and Instream Cover, Loss of River Morphology	Redds (Upper Sacramento River)	August - December (October, November)	Increased habitat carrying capacity (WUA) Decreased month-to-month flows causing possible stranding and decreased floodplain inundation and side-channel habitat.	Sub-lethal, Lethal	Large	High (Yearly)	High	High: Supported by multiple scientific and technical publications specific to the region and species. Quantitative results include WUA analysis and month-to-month floodplain inundation.
2.5.2.3.3.1.3 Juvenile Trap and Haul (tier 4 intervention)	Monitoring, Maintenance, Research Studies, etc. (minimization for Water Temperatures)	Juveniles (Upper Sacramento River)	November - April (Uncertain),	Uncertain. Programmatic action component.	Lethal	Uncertain	Low (7% of years)	Uncertain, High	Low: (Programmatic action component) very little information available as to how this action component would be implemented or as to its effects.

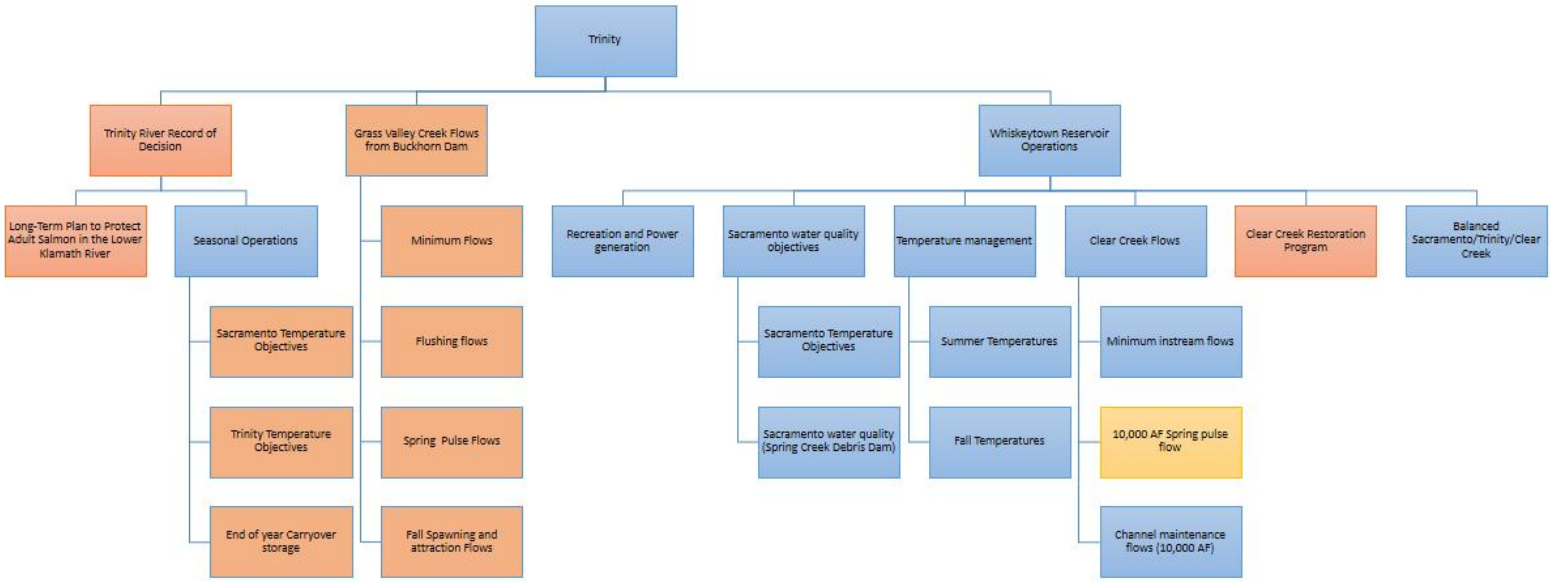
Significant Effects to Individuals: Steelhead

Action Component	Stressor	Life Stage (Location)	Life Stage Timing (Work Window Intersection)	Individual Response and Rationale of Effect	Severity of Stressor	Proportion of Population Exposed	Frequency of Exposure	Magnitude of Effect	Weight of Evidence
2.5.2.1.4.1 Fall and Winter Refill and Redd Maintenance	Spawning Habitat Availability, Flow Conditions, Loss of Riparian Habitat and Instream Cover, Loss of Natural River Morphology and Function	Migrating, Spawning Adults (Upper Sacramento River)	August - December (October, November)	Decreased month-to-month flows resulting in possible dewatering and stranding as decreased floodplain inundation and side-channel habitat isolated	Lethal	Medium (33% - 42% of Redds potentially dewatered)	Low (20% of years)	High	Medium: Supported by select technical publications specific to the region and species. Quantitative results include average spawning flows to proposed minimum flows.

Significant Effects to Individuals: Green Sturgeon

Action Component	Stressor	Life Stage (Location)	Life Stage Timing (Work Window Intersection)	Individual Response and Rationale of Effect	Severity of Stressor	Proportion of Population Exposed	Frequency of Exposure	Magnitude of Effect	Weight of Evidence
2.5.2.3.3.1.3 Juvenile Trap and Haul (tier 4 intervention)	Monitoring, Maintenance, Research Studies, etc. (minimization for Water Temperatures)	Juveniles (Upper Sacramento River)	May - August (Uncertain)	Uncertain. Programmatic action component to be implemented in Tier 4 years when river conditions are unsuitable for Juvenile rearing (WR only	Lethal	Uncertain	Low (7% of years)	Uncertain, (High?)	Low

Trinity Division
Clear Creek



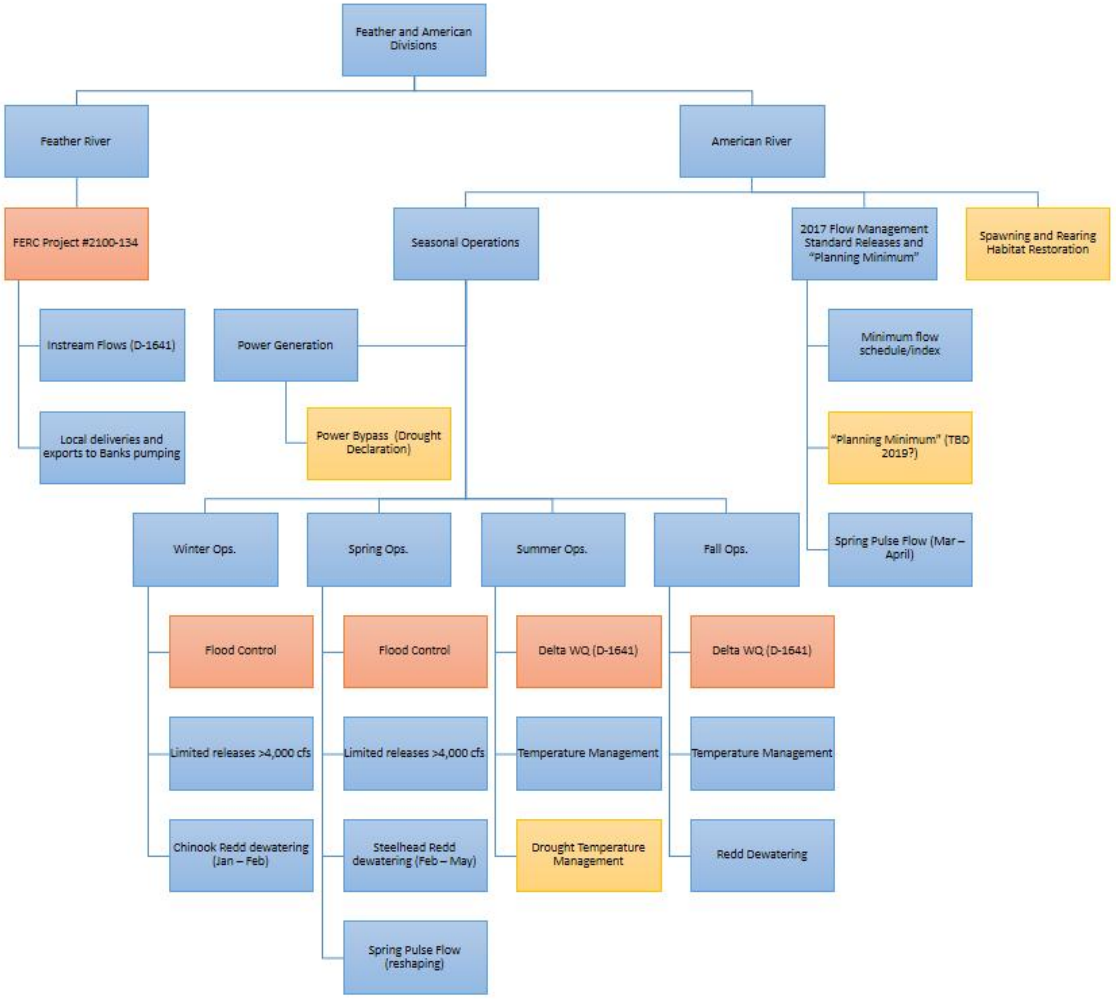
Significant Effects to Individuals: Spring-run

Action Component	Stressor	Life Stage (Location)	Life Stage Timing (Work Window Intersection)	Individual Response and Rationale of Effect	Severity of Stressor	Proportion of Population Exposed	Frequency of Exposure	Magnitude of Effect	Weight of Evidence
Clear Creek Summer Temp (60 F or less June 1-Sept 15) and Fall temp (56 F or less Sept 15-Oct 31) to compliance point at river mile 11	Water Temperature: Water warmer than compliance. Increased risk downstream of compliance point and in critical year types.	Holding and spawning adult spring-run river mile 18 to 3	June-Sept 15	Exposure to MDT >60 F cause stress, reduced fecundity, prespawn mortality, reduced life history diversity. Variable depending on holding locations and exceedence rate.	Sub-lethal and Lethal	Medium	Medium	Medium-High	Medium: temperature monitoring data, effects on current populations.
Clear Creek Summer Temp (60 F or less June 1-Sept 15) and Fall temp (56 F or less Sept 15-Oct 31) to compliance point at river mile 11	Water Temperature: Water warmer than compliance point. Increased risk downstream of point and in critical year types.	Spawning spring-run adults and egg/alevins river mile 18 to 3	Sept 15-Oct	Exposure to MDT > 56F causes reduced fecundity, stress, disease prespawn mortality, introgression with fall run during spawning	Sub-lethal and Lethal	Medium	Medium	Medium-High	Medium: temperature monitoring data, effects on current populations.
Clear Creek Summer Temp (60 F or less June 1-Sept 15) and Fall temp (56 F or less Sept 15-Oct 31) to compliance point at river mile 11	Water Temperature, Spawning Habitat Availability: Temperature compliance point location.	Holding and spawning adult spring run below compliance point river mile 11 to 3	June-Oct	Exposure to MDT >60 F causes reduced fecundity, stress, disease prespawn mortality, intergression with fall run during spawning	Sub-lethal and Lethal	Medium	Medium	Medium-High	High, water temperature monitoring, field observations
Clear Creek Summer Temp (60 F or less June 1-Sept 15) and Fall temp (56 F or less Sept 15-Oct 31) to compliance point at river mile 11	Water Temperature: Suboptimal water temperature criteria for spawning.	Spawning spring-run adults and egg/alevins river mile 18 to 3	Sept-Oct	56 F is to be suboptimal for survival of incubating eggs	Sub-lethal and Lethal	Large	Medium	Medium-High	Medium, temperature monitoring, field observations

Significant Effects to Individuals: Steelhead

Action Component	Stressor	Life Stage (Location)	Life Stage Timing (Work Window Intersection)	Individual Response and Rationale of Effect	Severity of Stressor	Proportion of Population Exposed	Frequency of Exposure	Magnitude of Effect	Weight of Evidence
Geomorphic flows	Flow Conditions	Spawning adult steelhead. Egg /alevin.	Jan-April	Redd scour, infiltration of fines. Steelhead Redds normally exist in these conditions.	Sub-lethal and Lethal	High	Medium	Medium-High	Medium

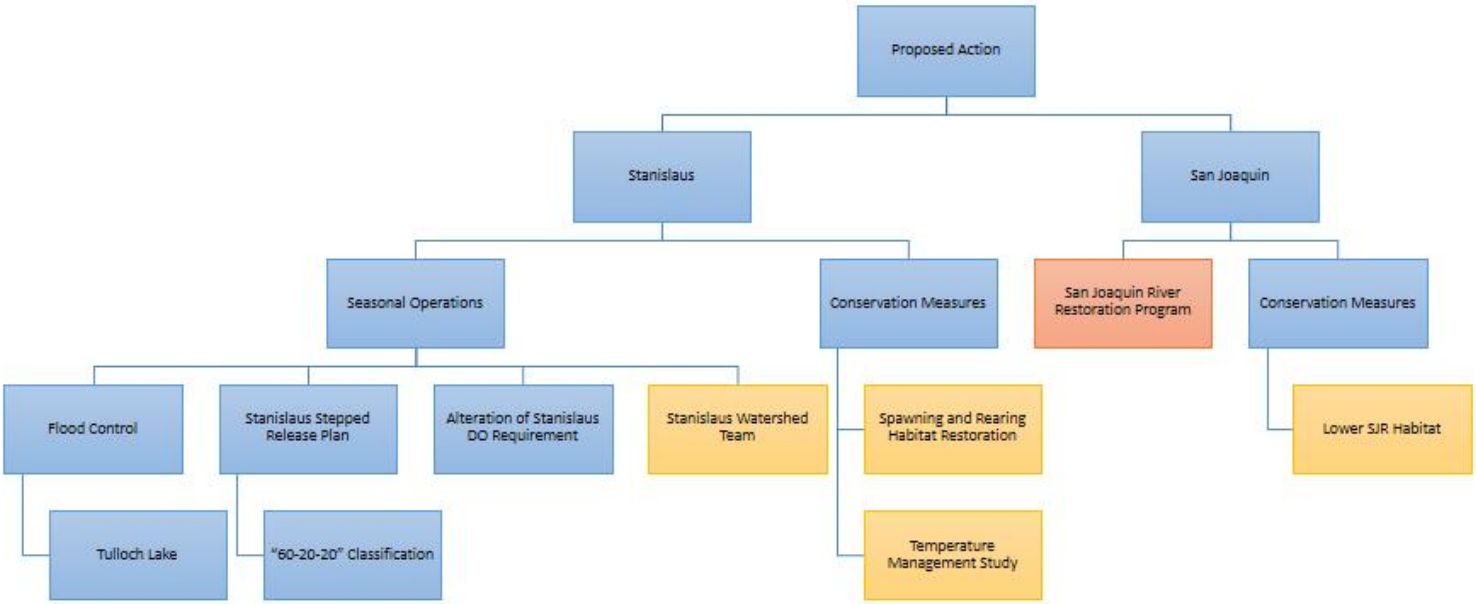
Feather and American River Divisions



Significant Effects to Individuals: Steelhead

Action Component	Stressor	Life Stage (Location)	Life Stage Timing (Work Window Intersection)	Individual Response and Rationale of Effect	Severity of Stressor	Proportion of Population Exposed	Frequency of Exposure	Magnitude of Effect	Weight of Evidence
Seasonal Operations	Folsom/Nimbus releases – flow fluctuations	Spawning Primarily upstream of Watt Ave. area	Late-Dec. - early Apr	Redd dewatering and isolation prohibiting successful completion of spawning	lethal	small	medium	high	high
Nimbus Hatchery Management	Nimbus Hatchery – hatchery O. mykiss spawning with natural-origin steelhead	Spawning Primarily upstream of Watt Ave. area	Late-Dec. - early Apr.	Reduced genetic diversity. Garza and Pearse (2008) showed that genetic samples from the population spawning in the river and the hatchery population were "extremely similar".	sublethal	small	high	high	High, HSRG Report, Draft HGMP, Garza and Pearse (2008)
Seasonal Operations	Water temperatures warmer than life stage requirements, particularly occurring upstream of Watt Ave. during June through September	Juvenile rearing Primarily upstream of Watt Ave. area	Year-round	Physiological effects - increased susceptibility to disease (e.g., anal vent inflammation) and predation. Visible symptoms of thermal stress in juvenile steelhead are associated with exposure to daily mean water temperatures above 65°F (Water Forum 2005a). With the exception of 2005, from 1999 through 2007, daily mean water temperatures at Watt Avenue from August through September were warmer than 65°F for approximately 81 percent of the days, and during 2001, 2002, 2004, 2006, and 2007, water temperatures were often over 68°F (figure 30a). Modeled long-term average water temperatures at Watt Avenue from June through September under the proposed Project (including 2025 climate change simulation) range from approximately 66°F to 70°F (ROC LTO BA).	sublethal	high	high	high	high

East Side Division



Significant Effects to Individuals (Stan): Steelhead

Action Component	Stressor	Life Stage (Location)	Life Stage Timing (Work Window Intersection)	Individual Response and Rationale of Effect	Severity of Stressor	Proportion of Population Exposed	Frequency of Exposure	Magnitude of Effect	Weight of Evidence
Seasonal operations and Stepped Release Plan	Contaminants (particularly dormant sprays) from land uses made possible by operations	Juvenile rearing Goodwin Dam to Orange Blossom	Year round	Reduced food supply; suppressed growth rates, etc…	Sublethal and indirectly lethal via predation	Medium	High	Medium to High	Medium
Seasonal operations and Stepped Release Plan	Lack of overbank flow to inundate rearing habitat	Juvenile rearing Goodwin Dam to Orange Blossom	Year round	Reduced food supply; suppressed growth rates; starvation; loss to predation; poor energetics; indirect stress effects, smaller size at time of emigration;	Sublethal and indirectly lethal via predation	Medium	High	Medium to High	Medium
Seasonal operations and Stepped Release Plan	Reduction in rearing habitat complexity due to reduction in channel forming flows	Juvenile rearing Goodwin Dam to Orange Blossom	Year round	Reduced food supply; suppressed growth rates; starvation; loss to predation; poor energetics; indirect stress effects, smaller size at time of emigration;	Sublethal and indirectly lethal via predation	Medium	High	Medium to High	Medium
Seasonal operations and Stepped Release Plan	End of summer water temperatures warmer than life history stage requirements	Juvenile rearing Goodwin Dam to Orange Blossom	Year round, most acute July-September	Metabolic stress; starvation; loss to predation; indirect stress effects, poor growth;	Sublethal and indirectly lethal via predation	Medium	Medium	Medium to High	Medium
Seasonal operations and Stepped Release Plan	End of summer water temperatures warmer than life history stage requirements	Juvenile rearing Goodwin Dam to Orange Blossom	Year round, most acute July-September	Metabolic stress; starvation; loss to predation; indirect stress effects, poor growth;	Sublethal and indirectly lethal via predation	Medium	Medium	Medium to High	Medium to High
Seasonal operations and Stepped Release Plan	Predation by non-native fish predators because rearing habitat is lacking	Juvenile rearing and out-migration Stanislaus River	All year with increase Feb-May	Juvenile mortality; Reduced juvenile production	Lethal	Medium	High	High	Medium
Seasonal operations and Stepped Release Plan	Suboptimal flow (March – June)	Smolt emigration Stanislaus River	Jan. – Jun.	Failure to escape river before temperatures rise at lower river reaches and in Delta; thermal stress; misdirection, higher risk of predation	Sublethal and indirectly lethal via predation	Medium	High	Medium to High	Medium

Significant Effects to Individuals (Stan): Spring-

Action Component	Stressor	Life Stage (Location)	Life Stage Timing (Work Window Intersection)	Individual Response and Rationale of Effect	Severity of Stressor	Proportion of Population Exposed	Frequency of Exposure	Magnitude of Effect	Weight of Evidence
Seasonal operations and Stepped Release Plan	Water temperatures	Spawning Goodwin Dam to Knights Ferry	Aug-Oct	Egg mortality, Embryonic deformities	Lethal	Large	High	High	Medium
Seasonal operations and Stepped Release Plan	Spawning habitat	Egg incubation and emergence Goodwin Dam to Knights Ferry	Aug-Feb	Reduced suitable spawning habitat; Spawning habitat not likely limited during spawning, but fall-run may superimpose redds before spring-run fry emergence	Lethal	Medium	Medium	High	Low
Seasonal operations and Stepped Release Plan	Excessive fines in spawning gravel resulting from lack of overbank flow	Egg incubation and emergence Goodwin Dam to Knights Ferry	Aug-Feb	Egg mortality from lack of interstitial flow; egg mortality from smothering by nest-building activities of CV steelhead or fall-run; suppressed growth rates	Lethal	Medium	Medium	High	Medium
Seasonal operations and Stepped Release Plan	Water temperatures	Egg incubation and emergence Goodwin Dam to Knights Ferry	Aug-Feb	Egg mortality, Embryonic deformities	Sublethal and Lethal	Large	High	High	Medium
Seasonal operations and Stepped Release Plan	Contaminants from land uses made possible by operations	Juvenile rearing Goodwin Dam to Orange Blossom Bridge	Nov-May for YOY; year-round for yearling	Reduced food supply; suppressed growth rates; smaller size at time of emigration, starvation; predation; poor energetics	Sublethal and indirectly lethal via predation	Medium	High	Medium to High	Low
Seasonal operations and Stepped Release Plan	Lack of overbank flow to inundate rearing habitat	Juvenile rearing Goodwin Dam to Orange Blossom Bridge	Nov-May for YOY; year-round for yearling	Reduced food supply; suppressed growth rates; starvation; loss to predation; poor energetics; indirect stress effects, smaller size at time of emigration;	Sublethal and indirectly lethal via predation	Large	High	High	Medium
Seasonal operations and Stepped Release Plan	Reduction in rearing habitat complexity due to reduction in channel forming flows	Juvenile rearing Goodwin Dam to Orange Blossom Bridge	Nov-May for YOY; year-round for yearling	Reduced food supply; suppressed growth rates; starvation; loss to predation; poor energetics; indirect stress effects, smaller size at time of emigration;	Sublethal and indirectly lethal via predation	Large	High	High	Medium

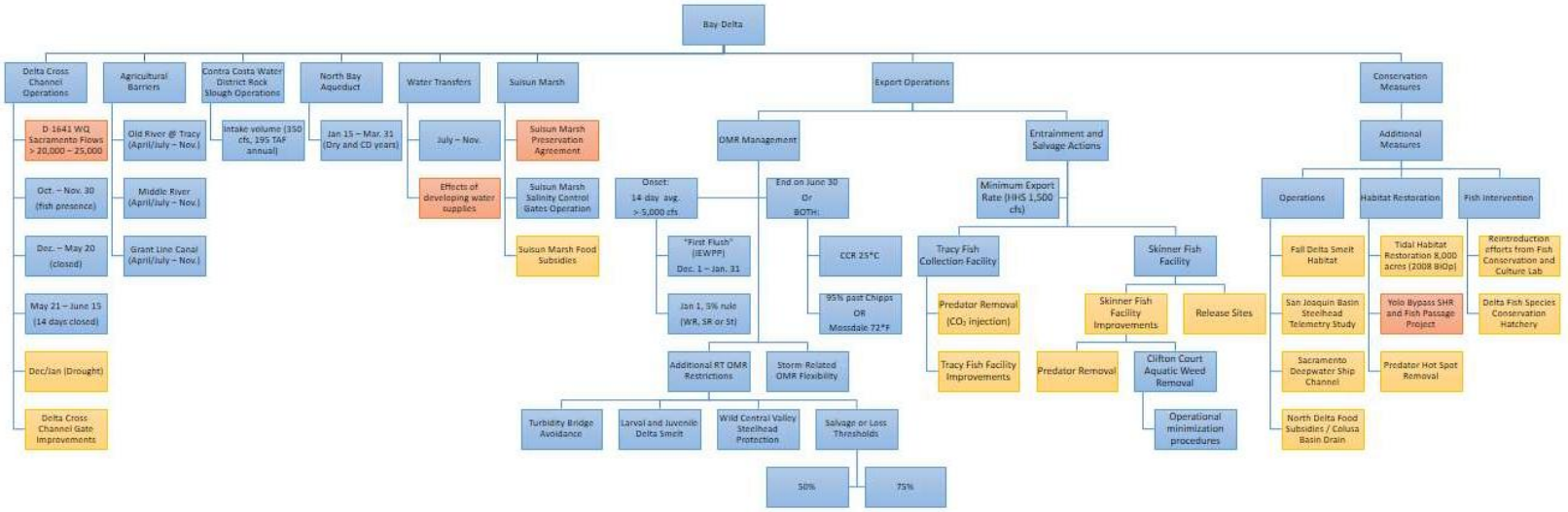
Significant Effects to Individuals (SJ): Steelhead

Action Component	Stressor	Life Stage (Location)	Life Stage Timing (Work Window Intersection)	Individual Response and Rationale of Effect	Severity of Stressor	Proportion of Population Exposed	Frequency of Exposure	Magnitude of Effect	Weight of Evidence
PA Conditions	Contaminants (particularly dormant sprays) from land uses made possible by operations	Juvenile rearing Confluence of Stanislaus to Mossdale	Dec-May	Reduced food supply; suppressed growth rates; smaller size at time of emigration, starvation; indirect: loss to predation; poor energetics;	Sublethal and indirectly lethal via predation	Medium	High	Medium to High	Low
PA Conditions	Lack of overbank flow to inundate rearing habitat	Juvenile rearing Confluence of Stanislaus to Mossdale	Dec-May	Reduced food supply; suppressed growth rates; starvation; loss to predation; poor energetics; indirect stress effects, smaller size at time of emigration;	Sublethal and indirectly lethal via predation	Medium	High	Medium to High	Medium
PA Conditions	Reduction in rearing habitat complexity due to reduction in channel forming flows	Juvenile rearing Confluence of Stanislaus to Mossdale	Dec-May	Reduced food supply; suppressed growth rates; starvation; loss to predation; poor energetics; indirect stress effects, smaller size at time of emigration;	Sublethal and indirectly lethal via predation	Medium	High	Medium to High	Medium
PA Conditions	Springtime water temperatures warmer than life history stage requirements, primarily March-May	Juvenile migration Confluence of Stanislaus to Mossdale	Dec-May	Metabolic stress; starvation; loss to predation; indirect stress effects, poor growth;	Sublethal and indirectly lethal via predation	Medium	Medium	Medium to High	Medium to High
PA Conditions	Predation by non-native fish predators because rearing habitat is lacking	Juvenile out-migration Confluence of Stanislaus to Mossdale	Feb-Jun	Juvenile mortality; Reduced juvenile production	Lethal	Medium	High	High	Medium
PA Conditions	Suboptimal flow	Juvenile out-migration Confluence of Stanislaus to Mossdale	Feb - Jun	Failure to escape river before temperatures rise at lower river reaches and in Delta; thermal stress; misdirection, higher risk of predation	Sublethal and indirectly lethal via predation	Medium	High	Medium to High	Medium

Significant Effects to Individuals (SJ): Spring-run

Action Component	Stressor	Life Stage (Location)	Life Stage Timing (Work Window Intersection)	Individual Response and Rationale of Effect	Severity of Stressor	Proportion of Population Exposed	Frequency of Exposure	Magnitude of Effect	Weight of Evidence
PA Conditions	Water temperatures warmer than life history stage requirements, primarily in June-September	Adult migration Confluence of Stanislaus to Mossdale	Mar-Sep	Failure to enter tributary before temperatures rise at lower river reaches; thermal stress; mortality	Sublethal and Lethal	Medium	High	Medium to High	Medium
PA Conditions	Contaminants	Juvenile rearing Confluence of Stanislaus to Mossdale	Dec-May	Reduced food supply; suppressed growth rates; smaller size at time of emigration, starvation; indirect: loss to predation; poor energetics; indirect stress effects.	Sublethal and indirectly lethal via predation	Medium	High	Medium to High	Low
PA Conditions	Lack of overbank flow to inundate rearing habitat	Juvenile rearing Confluence of Stanislaus to Mossdale	Dec-May	Reduced food supply; suppressed growth rates; starvation; loss to predation; poor energetics; indirect stress effects, smaller size at time of emigration;	Sublethal and indirectly lethal via predation	Medium	High	Medium to High	Medium
PA Conditions	Reduction in rearing habitat complexity due to reduction in channel forming flows	Juvenile rearing Confluence of Stanislaus to Mossdale	Dec-May	Reduced food supply; suppressed growth rates; starvation; loss to predation; poor energetics; indirect stress effects, smaller size at time of emigration;	Sublethal and indirectly lethal via predation	Medium	High	Medium to High	Medium
PA Conditions	Springtime water temperatures warmer than life history stage requirements	Juvenile rearing Confluence of Stanislaus to Mossdale	Dec-May	Metabolic stress; starvation; loss to predation; indirect stress effects, poor growth;	Sublethal and indirectly lethal via predation	Medium	High	Medium to High	Medium

Delta Division



Significant Effects to Individuals: Winter-run

Action Component	Stressor/Factor	Life Stage (Location)	Life Stage Timing (Work Window Intersection)	Individual Response and Rationale of Effect	Severity of Stressor	Proportion of Population Exposed	Frequency of Exposure	Magnitude of Effect	Weight of Evidence
DCC Gate operations -	Routing	Juveniles - Sacramento River - Delta	Juvenile migration and rearing - Oct - April	increased mortality due to routing into the delta interior with lower survival rates	lethal	medium - gates open from Oct 1 through Nov 30, typically closed Dec 1 through Jan 31. Closed Feb 1 through May 20. Estimated 50 % of juvenile WR population emigrates by the end of January	low. DCC gates infrequently operated in December and January	Medium	High - There are a number of publications regarding the relative survival in various North Delta and Central Delta migratory routes; conclusions supported by modelling results.
DCC Gate operations -	Altered Hydrodynamics downstream of DCC location	Juveniles - Sacramento River - Delta	Juvenile migration and rearing - Oct - April	Increased mortality when gates are open due to changes in routing or transit time	minor to lethal	High - opening of gates reduces the proportion of riverine reaches adjacent to the DCC location.	High	High	High - There are a number of publications regarding the relative survival in various North Delta and Central Delta migratory routes; conclusions supported by modelling results.
CVP/SWP South Delta Exports	Altred hydrodynamics in south Delta/ routing	Juveniles - Sacramento River - Delta	Juvenile migration and rearing - Oct - April	Mortality or decreases in condition due to migratory delays in response to altered hydrodynamics	Sub-lethal to lethal	Medium -	High- continual exports	Medium	Medium to High - effects of hydrodynamics well studied and modelled. Effects of hydrodynamics on salmonid migrations in south Delta less certain.
CVP/SWP South Delta Exports	Entrainment and loss at the south Delta export facilities	Juveniles - Sacramento River - Delta	Juvenile migration and rearing - Oct - April	Loss is approximately 35% at the CVP and 84% at the SWP fish salvage facilities	Sub-lethal to lethal	small	high	Medium - sustained high frequency exposure on small proportion of population	High - Numerous studies have evaluated the efficiency of the screening facilities, predation, as well as survival through the facilities

Significant Effects to Individuals: Spring-run

Action Component	Stressor	Life Stage (Location)	Life Stage Timing	Individual Response and Rationale of Effect	Severity of Stressor	Proportion of Population Exposed	Frequency of Exposure	Magnitude of Effect	Weight of Evidence
DCC Gate operations -	Altered Hydrodynamics downstream of DCC location	Juveniles - Sacramento River -Delta	Juvenile migration and rearing - Dec - May	Increased mortality when gates are open due to changes in routing or transit time through interactions with changes in river flow and tidal influence downstream of DCC location and gate operations	minor to lethal	High - opening of gates reduces the proportion of riverine reaches adjacent to the DCC location; closing of gates extends the riverine reaches farther downstream. Entire season of emigration occurs with gates in either open or closed position.	High	High	High - There are a number of publications regarding the relative survival in various North Delta and Central Delta migratory routes; conclusions supported by modelling results.
CVP/SWP South Delta Exports	Entrainment and loss at the south Delta export facilities	Juveniles - Delta	Juvenile migration and rearing - Dec - May	Loss is approximately 35% at the CVP and 84% at the SWP fish salvage facilities	Sublethal to lethal	small	high	Medium - sustained high frequency exposure on small proportion of population	High - Numerous studies have evaluated the efficiency of the screening facilities, predation, as well as survival through the facilities
South Delta Agricultural Barriers	transit times	Juveniles - Sacramento River -Delta	Juvenile migration and rearing - Dec - May	Delayed migration and increased transit times with potential for increased mortality due to increased exposure to predators	Sublethal to lethal	medium - includes SJR experimental population	high	Medium-high	Medium - several studies have indicated that the barriers increase transit time through the south Delta and increase predation risks. Timing of spring-run in the south Delta channels is well documented by salvage records.

Significant Effects to Individuals: Steelhead

Action Component	Stressor	Life Stage (Location)	Life Stage Timing	Individual Response and Rational of Effect	Severity of Stressor	Proportion of Population Exposed	Frequency of Exposure	Magnitude of Effect	Weight of Evidence
DCC Gate operations	Routing	Juveniles-Sacramento River-Delta	Juvenile migration and rearing – Nov – June	increased mortality due to routing into the delta interior with lower survival rates	sublethal - lethal	medium - gates open from Oct 1 through Nov 30, typically closed Dec 1 through Jan 31. Closed Feb 1 through May 20. Estimated 25% to 50% of juvenile SH population emigrates by the end of January.	low. DCC gates infrequently operated in December and January	High	High - There are a number of publications regarding the relative survival in various North Delta and Central Delta migratory routes; conclusions supported by modelling results.
DCC gate operations	Transit times	Juveniles - Sacramento River - Delta	Juvenile migration and rearing - Nov - June	Increased mortality due to increased migration times with concurrent increased exposure to predators	sublethal to Lethal	medium - gates open from Oct 1 through Nov 30, typically closed Dec 1 through Jan 31. Closed Feb 1 through May 20. Estimated 25% to 50% of juvenile SH population emigrates by the end of January.	low. DCC gates infrequently operated in December and January	High	Medium to High - Multiple publications on relative survival of Chinook salmon in North Delta and Central Delta routes but not steelhead; routing and transit time conclusions supported by modelling
DCC gate operations	Altered Hydrodynamics downstream of DCC location	Juveniles - Sacramento River - Delta	Juvenile migration and rearing - Nov - June	Increased mortality due to changes in routing or transit time through interactions with changes in river flow and tidal influence downstream of DCC location and gate operations	Minor to lethal	High - opening of gates reduces the proportion of riverine reaches adjacent to the DCC location, closing of gates extends the riverine reaches farther downstream. Entire season of emigration occurs with gates in either open or closed position.	High	High	High - There are a publications on relative survival of Chinook salmon, but not steelhead in various North Delta and Central Delta migratory routes; hydrodynamic conclusions supported by modelling and physical testing results.
CVP/SWP South Delta Exports	Entrainment and loss at the south Delta export facilities	Juveniles - Delta	Juvenile migration and rearing - Nov - June	Loss is approximately 35% at the CVP and 84% at the SWP fish salvage facilities	Sublethal to lethal	small (overall CCV population), medium to large for SJR baisn steelhead)	high	Medium - sustained high frequency exposure on small proportion of population	High - Numerous studies have evaluated the efficiency of the screening facilities, predation, as well as survival through the facilities

Significant Effects to Individuals: Green Sturgeon

- No Medium to High or Highly Ranked Effects

Significant Effects: Southern Resident Killer Whales

- Overall, the productivity of CV Chinook salmon, especially the dominant fall-run population, appears to be decreasing over time.
- There are fewer measures under the PA to minimize the impacts of operations on the non-ESA listed populations.
- The potential benefits of restoration activities that have been proposed are uncertain at this time.
- For ESA-listed Chinook salmon ESUs in the Central Valley, we conclude that population level effects for ESA-listed species and critical habitats overall under the PA are significant across multiple VSP parameters, including abundance.
- Reductions and limitations in the abundance of Chinook available as prey as a result of the PA will increase over time.

Integration and Synthesis: Winter-run

Step	Apply the Available Evidence to Determine if…	True/False	Action
A	The proposed action is not likely to produce stressors that have direct or indirect adverse effects on the environment	True	End
		False	Go to B
B	Listed individuals are not likely to be exposed to one or more of those stressors or one or more of the direct or indirect consequences of the proposed action	True	NLAA
		False	Go to C
C	Listed individuals are not likely to respond upon being exposed to one or more of the stressors produced by the proposed action	True	NLAA
		False	Go to D
D	Any responses are not likely to constitute "take" or reduce the fitness of the individuals that have been exposed	True	NLAA
		False	Go to E
E	Any reductions in individual fitness are not likely to reduce the viability of the populations those individuals represent	True	NLJ
		False	Go to F
F	Any reductions in the viability of the exposed populations are not likely to reduce the viability of the species	True	NLJ
		False	LJ

Key Findings

- DCC Gates

Integration and Synthesis: Spring-run

Step	Apply the Available Evidence to Determine if…	True/False	Action
A	The proposed action is not likely to produce stressors that have direct or indirect adverse effects on the environment	True	End
		False	Go to B
B	Listed individuals are not likely to be exposed to one or more of those stressors or one or more of the direct or indirect consequences of the proposed action	True	NLAA
		False	Go to C
C	Listed individuals are not likely to respond upon being exposed to one or more of the stressors produced by the proposed action	True	NLAA
		False	Go to D
D	Any responses are not likely to constitute "take" or reduce the fitness of the individuals that have been exposed	True	NLAA
		False	Go to E
E	Any reductions in individual fitness are not likely to reduce the viability of the populations those individuals represent	True	NLJ
		False	Go to F
F	Any reductions in the viability of the exposed populations are not likely to reduce the viability of the species	True	NLJ
		False	LJ

Key Findings

- DCC Gates open more frequently, increasing entrainment into South Delta
- Modeled Old and Middle River flows (OMR flows) will be approximately 3,500 to 4,000 cfs more negative during April and May in wetter water year types with the elimination of the I:E ratio.
- OMR flows are modelled to not be positive at any time (monthly average/ exceedance plots).

Water Year Type	CVP/SWP Salvage			
	PA	COS	PA-COS	% change
Wet	86,606	42,532	44,074	104
Above Normal	59,660	23,056	36,604	159
Below Normal	11,679	5,815	5,864	101
Dry	24,118	13,885	10,233	74
Critical	12,473	7,628	4,845	64

Integration and Synthesis: Steelhead

Step	Apply the Available Evidence to Determine if…	True/False	Action
A	The proposed action is not likely to produce stressors that have direct or indirect adverse effects on the environment	True	End
		False	Go to B
B	Listed individuals are not likely to be exposed to one or more of those stressors or one or more of the direct or indirect consequences of the proposed action	True	NLAA
		False	Go to C
C	Listed individuals are not likely to respond upon being exposed to one or more of the stressors produced by the proposed action	True	NLAA
		False	Go to D
D	Any responses are not likely to constitute "take" or reduce the fitness of the individuals that have been exposed	True	NLAA
		False	Go to E
E	Any reductions in individual fitness are not likely to reduce the viability of the populations those individuals represent	True	NLJ
		False	Go to F
F	Any reductions in the viability of the exposed populations are not likely to reduce the viability of the species	True	NLJ
		False	LJ

Integration and Synthesis: Green Sturgeon

Step	Apply the Available Evidence to Determine if…	True/False	Action
A	The proposed action is not likely to produce stressors that have direct or indirect adverse effects on the environment	True	End
		False	Go to B
B	Listed individuals are not likely to be exposed to one or more of those stressors or one or more of the direct or indirect consequences of the proposed action	True	NLAA
		False	Go to C
C	Listed individuals are not likely to respond upon being exposed to one or more of the stressors produced by the proposed action	True	NLAA
		False	Go to D
D	Any responses are not likely to constitute "take" or reduce the fitness of the individuals that have been exposed	True	NLAA
		False	Go to E
E	Any reductions in individual fitness are not likely to reduce the viability of the populations those individuals represent	True	NLJ
		False	Go to F
F	Any reductions in the viability of the exposed populations are not likely to reduce the viability of the species	True	NLJ
		False	LJ

Key Findings

- The fecundity of the population has been low and that the population is expected to continue to decline in the future if the population dynamics of the population (survival and fecundity) do not improve.

Integration and Synthesis: SRKW

Step	Apply the Available Evidence to Determine if…	True/False	Action
A	The proposed action is not likely to produce stressors that have direct or indirect adverse effects on the environment	True	End
		False	Go to B
B	Listed individuals are not likely to be exposed to one or more of those stressors or one or more of the direct or indirect consequences of the proposed action	True	NLAA
		False	Go to C
C	Listed individuals are not likely to respond upon being exposed to one or more of the stressors produced by the proposed action	True	NLAA
		False	Go to D
D	Any responses are not likely to constitute "take" or reduce the fitness of the individuals that have been exposed	True	NLAA
		False	Go to E
E	Any reductions in individual fitness are not likely to reduce the viability of the populations those individuals represent	True	NLJ
		False	Go to F
F	Any reductions in the viability of the exposed populations are not likely to reduce the viability of the species	True	NLJ
		False	LJ

Key Findings

- Recent information indicates that fecundity is low and that the population is expected to continue to decline in the future if survival and fecundity do not improve.
- Chinook salmon are increasingly prominent and dominant components of available Chinook salmon prey resources as Southern Residents head south along the range.
- Under the PA, our analysis conclude that SRKWs will continue to be exposed to decreased abundance of CV Chinook salmon as a result of the PA and limited by the overall low rates of juvenile Chinook salmon survival.
- The PA is expected to diminish VSP parameters and increase extinction risk of ESA-listed units.
- The prospect for persistent and escalating risks of reduced survival and reproductive success continuing indefinitely in the future reduce the likelihood of survival and recovery of this species.