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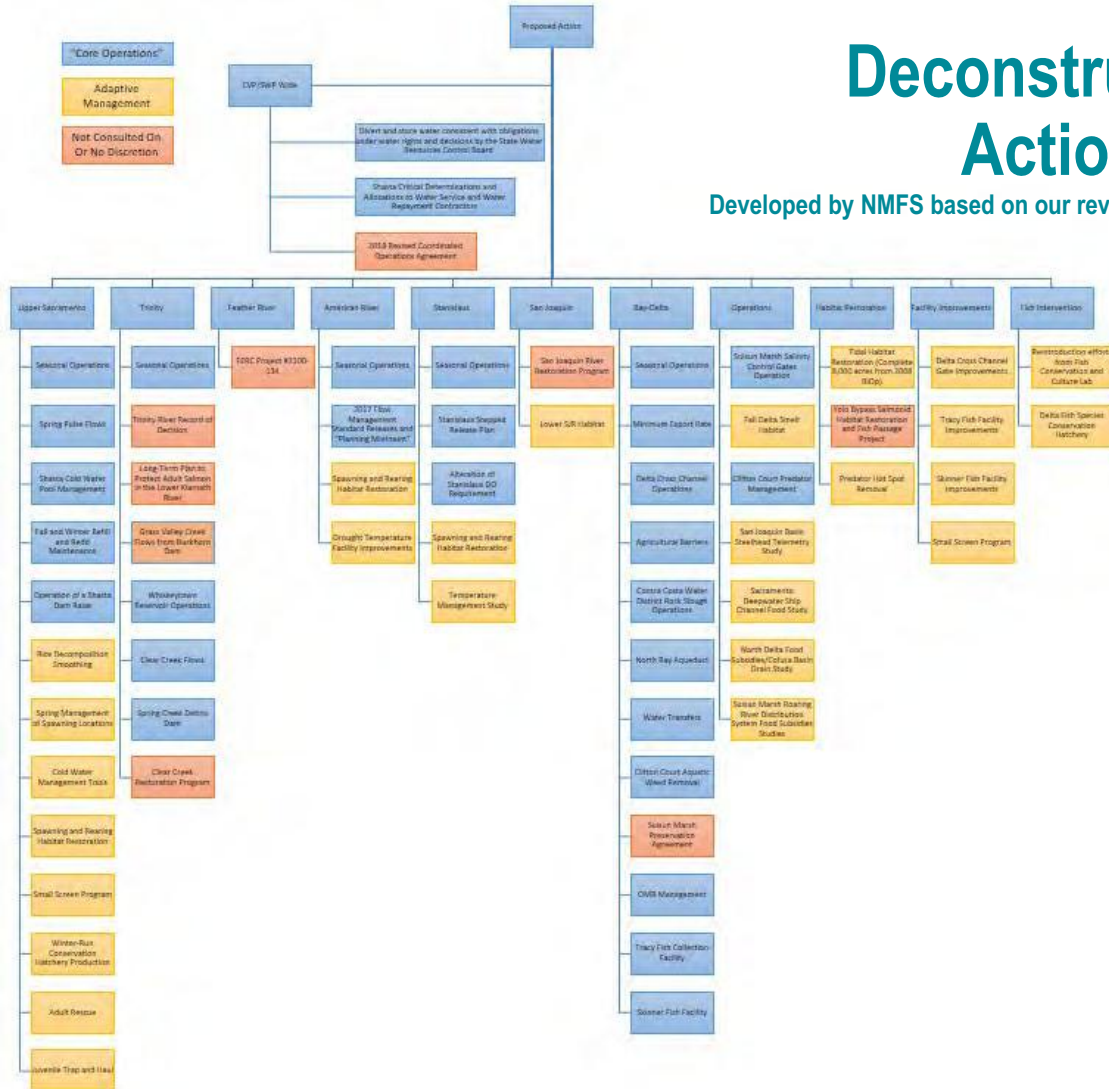
# ROC on LTO BiOp and Preliminary Effects Analysis Briefing “Cracking the ROC”

Barry Thom Briefing  
April 30, 2019



# Deconstructed Action

Developed by NMFS based on our review of the Proposed Action



## Action Components – As proposed by Reclamation

Core Operations	Scheduling (Formerly called Adaptive Management)	Collaborative Planning (Formerly called Adaptive Management)
The action is part of the Core Water Operations of the CVP and SWP	Agencies and water users provide recommendations to Reclamation on scheduling and shaping specific flow actions	Agencies and water users work collaboratively to define, plan, and implement an action.
e.g., OMR Management	e.g., American River Pulse Flows	e.g., Stanislaus River Spawning and Rearing Habitat Restoration
“Site-Specific” Although many components described programmatically	“Site-Specific” Although mostly described programmatically	“Programmatic” Although there are areas where we have enough information to quantify effects

# Overview of the System and Action Area

Action Area for SRKW: All nearshore coastal waters within their range in California, Oregon, and Washington, not including Puget Sound



Action Area for salmonids and green sturgeon: All reservoirs and river systems in the divisions covered in the biop; the Delta; Suisun Marsh; San Francisco Bay

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# Species and Critical Habitat

## Sacramento River winter-run Chinook salmon and Critical Habitat

- Endangered

## Central Valley spring-run Chinook salmon and Critical Habitat

- Threatened

## California Central Valley steelhead and Critical Habitat

- Threatened

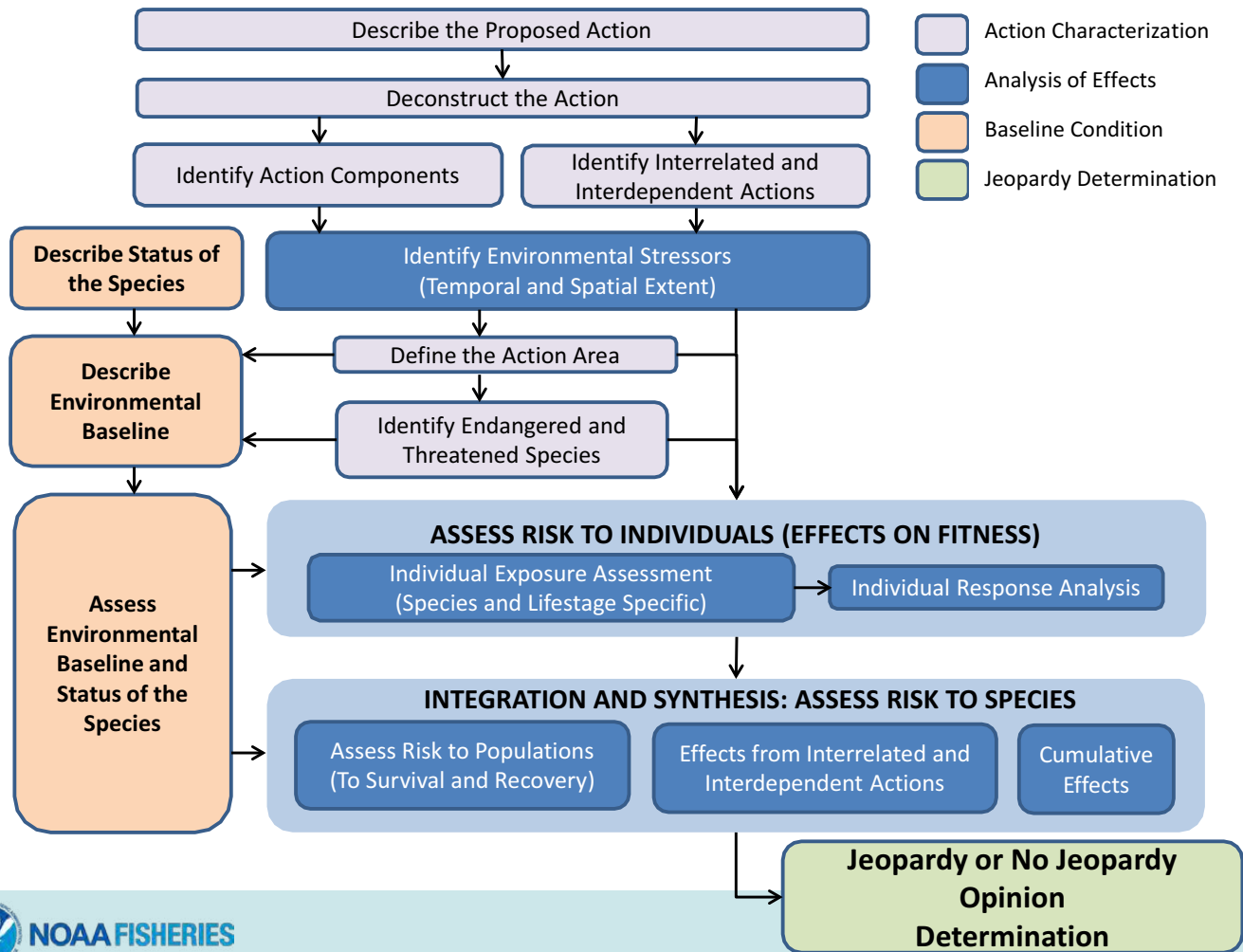
## Southern DPS Green Sturgeon and Critical Habitat

- Threatened

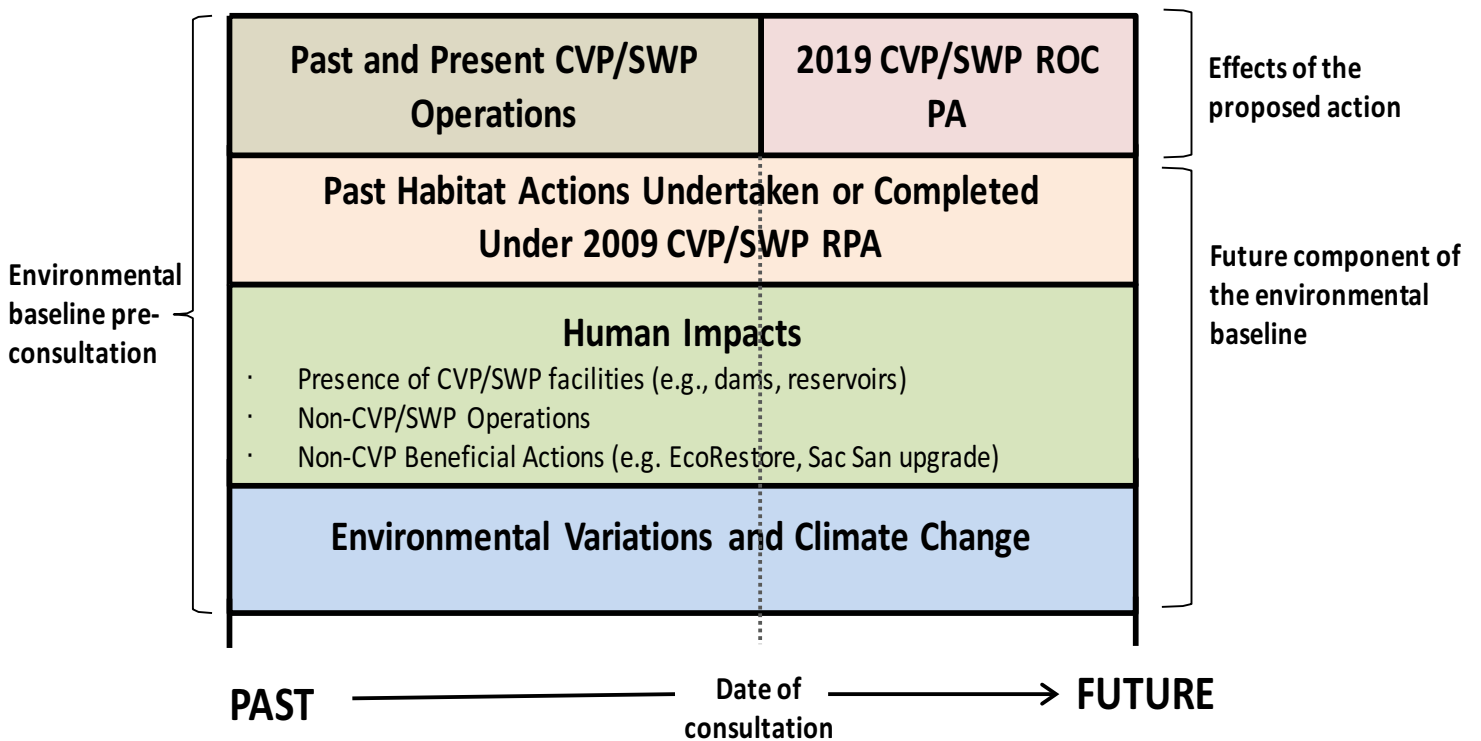
## Southern Resident Killer Whale

- Endangered

# General Approach Model (Species)



# Environmental Baseline



# Shasta Division

- Winter-run
- Spring-run
- Steelhead
- Green Sturgeon

# Trinity Division: Clear Creek

- Spring-run
- Steelhead



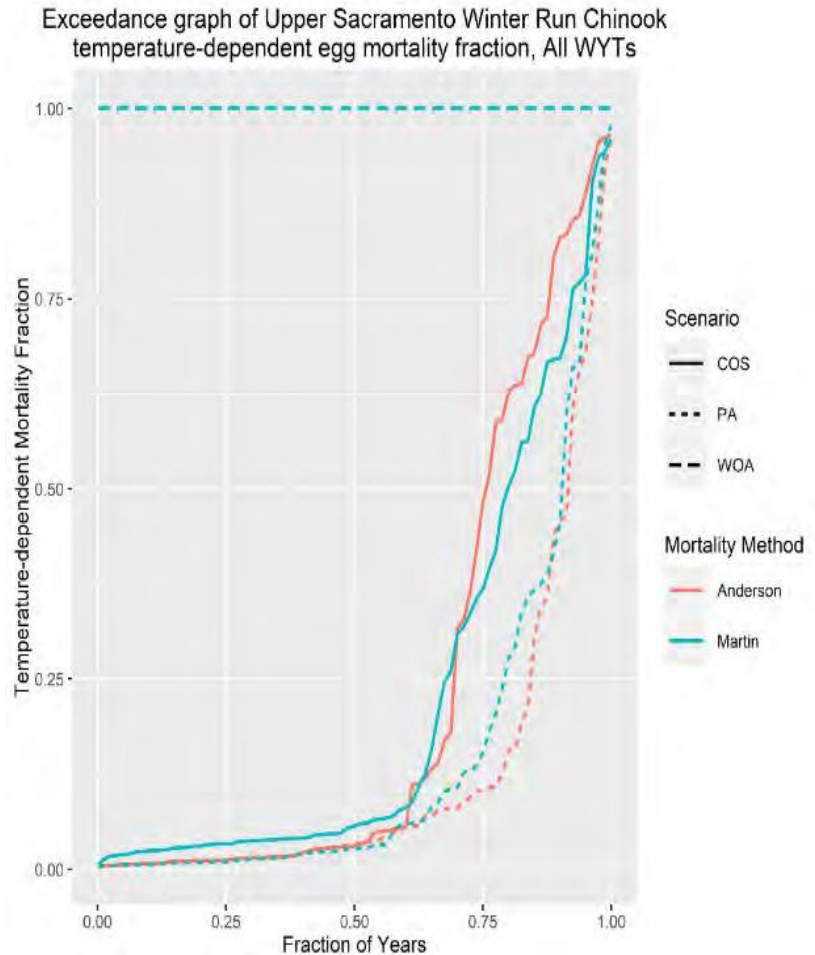


# Shasta Division: Action Components

Core Operations	Scheduling	Collaborative Planning
Seasonal Operations	Spring Pulse Flow	Spring Management of Spawning Locations
Shasta Cold Water Pool Management		Cold Water Management Tools (e.g., Battle Creek Restoration, Intake Lowering near Wilkins Slough, Shasta TCD Improvements)
Fall and Winter Refill and Redd Maintenance		Spawning and Rearing Habitat Restoration
Rice Decomposition Smoothing		Small Screen Program
Operations with Shasta Dam Raise		Winter-Run Conservation Hatchery Production
		Adult Rescue
		Juvenile Trap and Haul

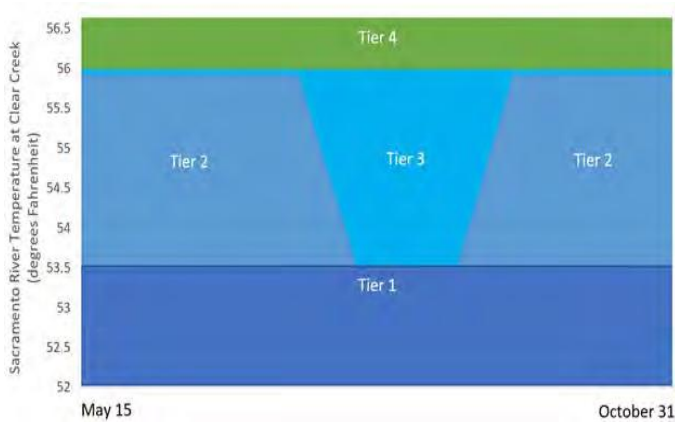
# Shasta Uncertainties

- The description of the PA (e.g., lack of detail in action component explanation)
- The characterization of current operations, COS, and the PA in physical modeling
- The characterization of biological processes in biological modeling (e.g., Anderson hatch model is novel and untested)
- The likelihood that actual operations will adhere to the proposed operations either as modeled or as described in the PA. Moving between Tiers

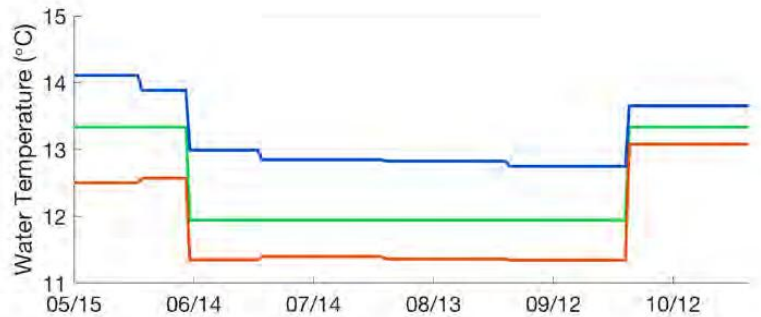


# Figures Depicting Shasta Uncertainties

Depiction of temperature target operations according to Reclamation's Tiered approach. From ROC LTO BA

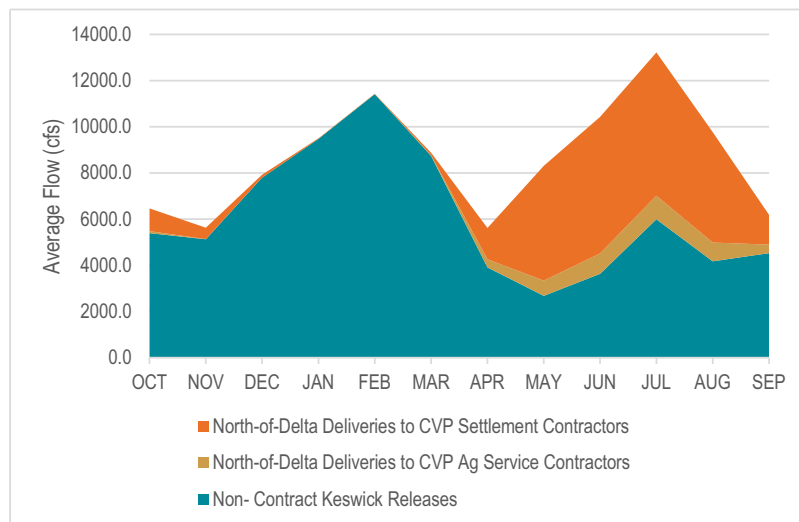


Characterization of Tier 2 CCR daily average temperature backstop (green line) using historical data. Provided by NMFS SWFSC

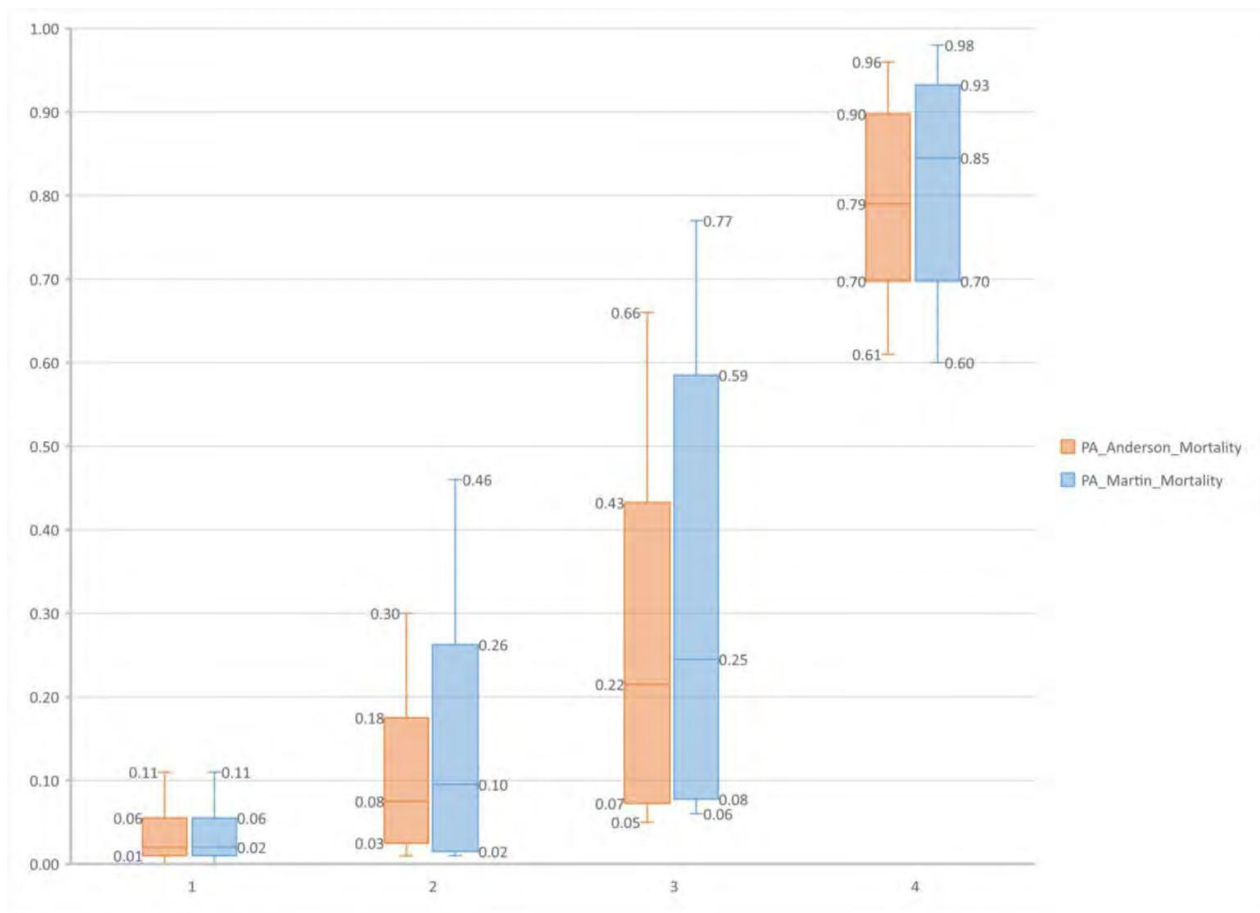


# Figures Depicting Shasta Uncertainties

**Proportion of monthly flows below Keswick, as either north-of-Delta deliveries to CVP Settlement Contractors, North-of-Delta deliveries to CVP Agricultural Service Contractors, or Non-Contract Keswick releases.**



# Temperature-dependent egg mortality by Tier



# Significant Shasta 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
Tiers 1-4: Shasta Cold Water Pool Management	Water Temperature	Eggs/Fry (Keswick Dam - CCR gauge)	May - October (May 15 - October)	Temperatures > 53.5°F decrease egg survival	Lethal	1: Medium (23.3% of days) 2: Medium (33.1% of days) 3: Medium (65% of days) 4: Large (86% of days)	1: Medium (68% of years) 2: Low (17% of years) 3: Low (7% of years) 4: Low (7% of years)	High	High: Supported by multiple scientific and technical publications that include quantitative models specific to the region and species.
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 cause stranding and decreased floodplain inundation, side-channel habitat.	Lethal	Medium (<50% of the population)	Low (20% of years)	High	Medium
Operation of a Shasta Dam Raise	NA	NA	NA	None. Reinitiation triggers apply	NA	NA	NA	NA	NA



# Delta Division: Action Components

Core Operations	Scheduling	Collaborative Planning
Seasonal Operations	N/A	San Joaquin Basin Steelhead Telemetry Study
Minimum Export Rate		Sacramento Deepwater Ship Channel Food Study
Delta Cross Channel Operations		North Delta Food Subsidies/Colusa Basin Drain Study
Agricultural Barriers		Tidal Habitat Restoration
Contra Costa Water District Rock Slough Operations		Predator Hot Spot Removal
North Bay Aqueduct		Delta Cross Channel Gate Improvements
Water Transfers		Tracy Fish Facility Improvements
Clifton Court Aquatic Weed Removal		Skinner Fish Facility Improvements
OMR Management		Small Screen Program
Tracy Fish Collection Facility Operations		
Skinner Fish Facility Operations		
Clifton Court Predator Management		



# Significant Delta Effects to Individuals: Winter-run

Action Component	Stressor/Factor or	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	Variable Low to high. 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 -	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	Altered 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	High	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 Experts	Entrainment and loss at the south Delta export facilities	Juveniles - Delta	Juvenile migration and rearing - Dec - May	Loss is approximately 65% of entrained fish 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 65% of entrained fish at the CVP and 84% at the SWP fish salvage facilities	Sublethal to lethal	small (overall CCV population), medium to large for SJR basin 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
Increased Exports	Entrainment and loss at the south Delta export facilities	Juveniles - Delta	SJ Basin Steelhead Emigration April-May	Higher export levels, increased negative OMR flows  No HORB/IE	Sublethal to lethal	Majority of SJ Basin Steelhead	High	High	High – 6-year study, draft report

# Significant Effects to Individuals: Green Sturgeon

- No Medium to High or Highly Ranked Effects

## Delta Uncertainties

- Lack of trigger thresholds for spring-run and steelhead for the OMR.
- Effectiveness of proposed OMR management actions. Instead of being protective, proposal leads to more risk and loss.
- Impacts of increased April and May export levels. The effects may not be as straightforward as modeled, and may be compounded by the changes in the local hydrodynamics created by the increase in exports.
- Vulnerability of San Joaquin River steelhead to the effects of no I:E ratio, no HORB during the emigration period.
- Many elements of the PA description are vague. 6,000 acres of tidal habitat: we don't know where this will occur, what the success metrics will be, and how we will monitor effectiveness. Also, unclear how "risk assessments" will work for implementing protective actions and how or if NMFS will be involved.

# Coastal Extent of the Action Area

- Southern Resident Killer Whales



## 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 proposed restoration activities that have been proposed are uncertain at this time and most are actually in the Environmental Baseline (previously consulted on)
- 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.

# Clear Creek: Action Components

Core Operations	Scheduling	Collaborative Planning
Seasonal Operations	Clear Creek Geomorphic and Spring Attraction Pulse Flows	N/A
Whiskeytown Reservoir Operations		
Clear Creek Minimum Flows		
Spring Creek Debris Dam		

# Significant Clear Ck. 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, prespawm 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 prespawm 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 prespawm 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 Clear Ck. 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

## Clear Creek Uncertainties

- Ability to meet water temperature criteria during the spring-run spawning period (based on results from current monitoring data and modeling).
- That proposed pulse flows/mechanical channel maintenance will provide adequate geomorphic benefit to maintain habitat. This is based on lack of details in PA of mechanical maintenance, and water year type restrictions.
- If water temperature regime is appropriate for driving anadromy in *O.mykiss* population.

# American Division

- Steelhead



# American Division: Action Components

Core Operations	Scheduling	Collaborative Planning
Seasonal Operations	American River Pulse Flows	Spawning and Rearing Habitat Restoration
2017 Flow Management Standard Releases and "Planning Minimum"		Drought Temperature Facility Improvements
		Nimbus Fish Hatchery HGMP

# Significant American 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 and predation. Visible symptoms of thermal stress in juvenile steelhead are associated with exposure to daily mean water temperatures above 65°F . 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).	sublethal	high	high	high	high

## American River Division Uncertainties

- Reliance on an undefined planning minimum (i.e. end-of December storage), and undefined future operations and resultant water temperatures
- Adherence to the planning minimum and effectiveness in meeting temp standards
- The level of detail provided in the BA for the “Drought Temperature Management” measure

# East-side Division: Stanislaus and Lower San Joaquin

- Steelhead
- Spring-run



# East-side Division (Stan): Action Components

Core Operations	Scheduling	Collaborative Planning
Seasonal Operations	Stanislaus River Pulse Flows	Spawning and Rearing Habitat Restoration
Stanislaus River Stepped Release Plan		Temperature Management Study
Alteration of Stanislaus DO Requirement		

## Stanislaus Uncertainties

- Evaluation of temperature-related effects:** Model outputs of monthly average temperature not directly comparable with 7DADM-based temperature suitability criteria. The approach underestimates adverse effects to species.
- Feasibility of restoration targets:** Proposed 4,500 tons of gravel per year and 50 acres of floodplain and side-channel rearing habitat by 2030 unlikely given recent rate of restoration over past 10 years.

# 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

# East-side Division (SJ): Action Components

Core Operations	Scheduling	Collaborative Planning
N/A	N/A	Lower San Joaquin River Habitat

## San Joaquin Uncertainties

- **Regulatory requirements at Vernalis:** Because of the SWRCB’s efforts to update the Bay Delta Water Quality Control Plan, there is uncertainty about what Vernalis flow and Vernalis Electrical Conductivity (EC) requirements will be in January 2020, when the opinion takes effect.



# 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

# 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

- One remaining population at high risk
- High level of biological uncertainty
- PA is expected to result in concerning levels of egg mortality:
  - 5-6% for 68% of years (Tier 1)
  - 12-15% for 17% of years (Tier 2)
  - 28-34% for 7% of years (Tier 3)
  - 79-81% for 7% of years (Tier 4).
- No commitment to stay within a Tier
- No commitment to build Shasta storage
- Entrainment Index 7-38% higher at Delta pumping facilities
- DCC open 10 additional days Dec-Jan all years
- LCM abundance is 3% higher under COS but CRR is 0.5% higher in the PA
- The PA is likely to reduce the abundance and diversity VSP parameters (and habitat quality)

# Integration and Synthesis: Spring-run

## Key Findings

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

- 2 out of 3 wild populations at high risk, declining trend
- DCC Gates open more frequently (Dec-Jan), 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.
- Clear Creek spawning and holding temperatures often exceeded management approach not current scientific standard.
- OMR flows are modeled to not be positive at any time (monthly average/ exceedance plots).
- PA components are expected to appreciably reduce the abundance and diversity VSP parameters for spring-run populations (and habitat quality).

Water Yeartype	Predicted loss under PA	Predicted loss under COS	PA-COS	% change
Wet	270,759	125,972	144,788	115
Above Normal	199,562	75,124	124,438	166
Below Normal	43,781	20,859	22,922	110
Dry	88,278	48,347	39,931	83
Critical	42,325	23,917	18,408	77

# 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

## Key Findings

- DPS at moderate risk of extinction
- DCC Gates open more frequently (Dec-Jan), 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.
- Differential survival is 20% between HORB in vs. out between 3800cfs-5,000cfs at ernalis
- OMR flows are modeled to not be positive at any time (monthly average/ exceedance plots).
- OMR flows and steelhead density triggers are not protective of the Southern Sierra Diversity Group
- PA components are expected to appreciably reduce the abundance VSP parameter for steelhead populations of the Sacramento River and San Joaquin River basin

# 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

- Single population at moderate risk
- Green sturgeon presumably have access to suitable spawning and incubation areas on the Sacramento River under all conditions (e.g., droughts)
- Low and medium magnitude impacts from PA and only a small portion of the population are likely to experience mortality or substantial injury
- Overall, the PA is not expected to exert any additional selective pressures on green sturgeon and the diversity VSP parameter of the population is expected to remain unchanged

# 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

- Species is at a high risk of extinction
- Recent information indicates that fecundity is low and that the population is expected to decline in the future.
- Chinook salmon are dominant components of available Chinook salmon prey.
- Under the PA, SRKWs will continue to be exposed to a decreasing abundance of CV Chinook salmon during sensitive time period (winter-spring)
- 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.