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Summary of Scientific Certainty Regarding San Joaquin Basin Chinook Salmon

Prepared for State Water Resources Control Board
Phase II Comprehensive Review Workshops
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On behalf of the
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SPRING FLOWS

Scientific Certainty: High

- ***High, unmanaged spring flood flows (above 18,000 cfs), can increase smolt survival through the Delta.***
- ***Without the Head of Old River [Physical] Barrier in place, no significant relationship exists between spring flows in the managed range (below 7,000 cfs) and smolt survival through the Delta.***
- ***Flow related science relied upon by the SWRCB's Technical Report (2012) are flawed, have been discredited, are not the best available science, and should not be used as primary justification to modify flow objectives.***

Key Supporting Science

Existing scientific evidence does not support the conclusion that late winter and spring flow (February to June) in the San Joaquin River is the "primary limiting factor" to smolt survival and subsequent abundance.

- The VAMP independent scientific review panel determined that "simply meeting certain flow objectives at Vernalis is unlikely to achieve consistent rates of smolt survival through the Delta" (Dauble et al., 2010).
- NMFS (2009) states that "flows below approximately 5,000 cfs have a high level of variability in the adult escapement returning 2.5 years later, indicating that factors other than flow may be responsible for the variable escapement returns. Flows above approximately 5,000 to 6,000 cfs begin to take on a linear form and adult escapement increase in relation to flow."
- Baker and Morhardt 2001 indicates that there are no data points between 11,000-18,000 cfs, so there is no ability to identify a linear trend beginning at 5,000 cfs. Also, Baker and Morhardt (2001) state "when only the data below 10,000 cfs are considered, there appears to be a negative relationship between flow and smolt survival."
- "The complexities of Delta hydraulics in a strongly tidal environment, and high and likely highly variable predation, appear to affect survival rates more than flow, by itself, and complicate the assessment of flow effects of on survival rates." (Dauble et al. 2010).
- Choice of emigration route may be more important to survival than flow (Perry et al. 2010).
- The VAMP Peer Review (Dauble et. al 2010) indicates that consideration should be given regarding the role of Delta survival for the smolt life stage in the larger context of the entire life cycle of the fall-run Chinook (i.e., life cycle model), including survival in the upper watershed, the Bay and the ocean and fry rearing in the Delta.

The SWRCB's Technical Report's (2012) conclusion that higher spring flows result in increased adult abundance is based almost exclusively on analyses that are flawed and have been discredited (e.g., DFG 2005, 2010a; Mesick et al 2007; Mesick 2009), as well as similar non-peer-reviewed analyses (e.g., various Mesick documents, AFRP 2005, TBI & NRDC 2010a-c).

- The DFG's San Joaquin River Fall-run Chinook Salmon Population Model (SJRFRCS Model) (DFG 2005, DFG 2010a) has been found to be flawed through both peer and professional reviews (Demko et. al 2010).
- Mesick, TBI & NRDC 2010a-c and AFRP 2005 references have not been peer-reviewed and their analyses are the same/similar to those used in DFG's SJRFRCS Model.
- At least two Mesick documents have been rejected previously by FERC (2009a-b) due to
    - the "fallacy of focusing entirely on flow" and failure to consider the influence of other possible limiting factors (Tuolumne River Limiting Factors Analysis; Mesick et al. 2007); and
    - failing to consider other Central Valley populations, the effects of hatchery introductions on Tuolumne River Chinook salmon, and other potential factors (Tuolumne River Risk of Extinction Analysis; Mesick 2009).
- No factors other than flow were investigated in a rigorous fashion in the models suggesting a causal relationship between spring flow and adult returns.
- Bay Delta Conservation Program and Delta Stewardship Council are not using these analyses and an independent review panel recently recommended that NMFS develop a life cycle model for CV salmonids to examine water management and Biological Opinion Reasonable and Prudent Actions (Rose et. al. 2011).

FLOODPLAIN

Scientific Certainty: High

- ***Floodplains with characteristics like those shown to provide benefits to Chinook salmon (i.e., large, continuous expanses of shallow-water habitat) cannot be created through managed flows in the San Joaquin Basin.***
- ***Juvenile steelhead are not are not likely to use floodplains and thus would not benefit from floodplain inundation, regardless of the season.***

Scientific Certainty: Deficient

- ***Benefits of floodplain habitat on Chinook abundance have not been quantified.***

Key Supporting Science

Floodplains in the San Joaquin Basin have different characteristics than the Yolo and Cosumnes and will not provide similar salmon growth and survival benefits.

- Floodplains in the Yolo and Cosumnes bypasses consist of virtually one large, continuous expanse of mostly shallow-water habitat; while the San Joaquin Basin consists of several disconnected, smaller areas of largely deep-water habitat (oxbow features). This deep-water habitat is similar to isolated pond habitats in the Yolo Bypass where alien fish dominate and no Chinook salmon were found (Feyrer et al. 2004).
- San Joaquin Basin inundation zones estimated by the cbec analysis (cbec 2010) represent the maximum area available under a range of flows, not the quality of that habitat for salmon (i.e., depth and velocities). Even though these estimates are a best-case scenario and include areas which would not be considered beneficial to rearing salmon (i.e., deep ox-bows), the total area is still dwarfed in comparison to the Yolo Bypass or Cosumnes Preserve.
- Growth differences between juveniles rearing in floodplains versus in-river were found after a two-week period (Jeffres et al. 2008). There is no data that supports the conclusion that similar benefits occur if rearing is less than a two-week inundation period.
- Increased growth on floodplains is likely related to several factors including warmer water temperatures resulting from shallower depths and greater surface area than found in-river, as well as lower velocities and better food sources (Sommer et al. 2001). Shallow water floodplain habitat is not prevalent in the San Joaquin Basin.

<u>Juvenile steelhead are not likely to use floodplains and thus would not benefit from floodplain inundation, regardless of the season.</u>

- Juvenile steelhead are not likely to use floodplains known to rear in floodplain habitats to any great degree at any time of year (Bustard and Narver 1975, Swales and Levings 1989, Keeley et al. 1996, Feyrer et al. 2006, Moyle et al. 2007).

<u>Floodplain rearing may help increase the size/weight of Chinook outmigrants, but has not been shown to increase the *abundance* of outmigrants or the *number of adult returns*.</u>

- No clear evidence that juvenile floodplain rearing increases adult recruitment.

<u>Floodplain inundation in the San Joaquin River tributaries only visually inferred from flow-area graphs by DFG (2010).</u>

- Wetted surface area increases more quickly between 3,000-5,000 cfs (Merced) and between 4,000-6,000 cfs (Tuolumne) indicating greater increases in width, which suggests bank overtopping or floodplain inundation; Stanislaus did not have a well-defined floodplain in the 100-10,000 cfs flow range examined (DFG 2010b, SWRCB Technical Report 2012).

<u>Tributary floodplain inundation thresholds exceed the SWRCB's Technical Report (2012) maximum monthly tributary target flows.</u>

- Maximum monthly target flows (i.e., median unimpaired) specified for each tributary in the SWRCB's Technical Report (2012) are 2,500 cfs for the Stanislaus River; 3,500 cfs for the Tuolumne River; and 2,000 cfs for the Merced River.
- Assuming minimum thresholds to begin inundating floodplains are 3,000 cfs for the Merced and Stanislaus Rivers, and 4,000 cfs for the Tuolumne River, all three of these minimums exceed the maximum flows proposed in the SWRCB's Technical Report (2012).

SWRCB's Technical Report (2012) emphasizes the need for creating more floodplain in the San Joaquin Basin through higher flows, but "floodplain habitat" is not defined nor quantified for the San Joaquin Basin.

- The attributes of "floodplain habitat," such as depth, velocity, cover, and water temperature, are not defined.
- No information/data is presented as to how much floodplain habitat exists in the San Joaquin Basin, how much could be gained at various flows, or what the benefit to Chinook salmon would be.

FLOW QUANTITY AND TIMING

Scientific Certainty: High

- ***Under specific conditions, salmon migration can be temporarily stimulated through flow management.***

Scientific Certainty: Deficient

- ***The benefit of temporary migratory stimulation on the survival of Chinook fry or smolts through the tributaries, lower San Joaquin River, and Delta is uncertain.***
- ***The importance of attraction flows to spawning migration and subsequent spawning success is uncertain.***

Key Supporting Science

Juvenile Chinook migration out of the upper tributaries is ***temporarily*** stimulated by changes in flow, but long duration pulse flows do not "flush" fish out of the tributaries.

- Juvenile Chinook migration can be stimulated by changes in flow, but the effect is short lived (few days) (Demko et al. 2001, 2000, 1996; Demko and Cramer 1995).

Higher flows increase fry (but not necessarily parr or smolt) survival in the tributaries; benefits to adult escapement are uncertain.

- Stanislaus River flows have a strong positive relationship with migration survival of Chinook fry, but weak associations with parr and smolt survival (Pyper and Justice 2006).
- Smolt survival (CWT) studies conducted by CDFG at flows ranging from 600 cfs to 1500 cfs and at 4,500 cfs have shown that smolt survival is highly variable and not improved by higher flows in the Stanislaus River (SRFG 2004; CDFG unpublished data).
- Smolt survival indices in the San Joaquin River from the Merced River downstream to Mossdale indicate little relationship to flow (TID/MID 2007).
- The contribution of fry emigrants (Feb/March) to total salmon production in the San Joaquin Basin is uncertain (Baker and Morhardt 2001; SRFG 2004; SJRGA 2008; Pyper and Justice 2006).

Fall flow pulses ***temporarily*** stimulate upstream migration of Chinook salmon into San Joaquin Basin tributaries, but no evidence that attraction flows are needed.

- Prolonged, high-volume fall pulse flows are not warranted, since equivalent stimulation of adult migration may be achieved through modest pulses (Pyper and others 2006).
    - Relatively modest pulse-flow event (increase of ~200 cfs for 3 days) was found to stimulate migration, but only for a short duration (increased for 2-3 days).
- Migration rate and timing are not dependent upon flows, exports, water temperature or dissolved oxygen concentrations (Mesick 2001; Pyper and others 2006).
- No evidence that low flows (1,000 to 1,500 cfs) in the San Joaquin River are an impediment to migration (Mesick 2001).

Flow does not explain low Delta survival of juvenile Chinook observed since 2003, so more flow is not likely the solution.

- Flood flows of approximately 10,000 cfs and 25,000 cfs during outmigration in 2005 and 2006 did not increase survival near levels when flows were moderately high (5,700 cfs) in 2000 (SJRGA 2007b).
- Since recent smolt survival has been far lower than it was historically, models based on historical data are not representative of recent conditions and should not be used to predict future scenarios (VAMP Technical Team 2009).

WATER TEMPERATURE

Scientific Certainty: High

- ***Water temperatures in the San Joaquin River and South Delta are controlled by air temperatures.***
- ***Releases from tributary reservoirs will not impact water temperatures in the San Joaquin River or South Delta.***
- ***San Joaquin River restoration flows will adversely affect water temperatures from the confluence of the Merced River downstream.***

Scientific Certainty: Deficient

- ***Salmon and steelhead survival benefits of releasing large quantities of water to decrease water temperatures in the tributaries are uncertain.***

Key Supporting Science

The dominant factor influencing water temperature is ambient air temperatures, not flow.

- Ambient air temperature is the primary factor affecting water temperature; by the end of May, water temperatures at Vernalis range between 65°F and 70°F regardless of flow levels between 3,000 cfs and 30,000 cfs. (SRFG 2004)

There is no evidence that water temperatures are unsuitable for adult Chinook upstream migration

- DFG demonstrated that pre-spawn mortality is quite low (i.e., 0%-4.5%) and appears to be density, not water temperature, dependent (Guignard 2005 through 2008).
- No associations between adult migration timing and conditions for water temperature, dissolved oxygen (DO), or turbidity (Pyper et. al 2006; Mesick 2001).
- San Francisco Bay water temperatures over 65°F in September when fish are migrating (CDEC; various stations) and water temperatures at Rough and Ready Island (RRI) are typically above 70°F during early migration season.

There is no evidence that water temperatures for juvenile rearing and migration need to be colder or maintained through June.

- Nearly all juvenile Chinook migrate prior to May 15, and <1% migrate after May 31, except in wet and above normal water years. 90-99% of non ad-clipped salvaged *O. mykiss* are encountered between January and May depending on water year type.
- Existing 7 Day Average Daily Maximum water temperatures are generally ≤68ºF (20°C) in the San Joaquin River and the eastside tributaries through May 15.

The restoration of the San Joaquin River upstream of the Merced River (San Joaquin River Restoration Program; SJRRP) will adversely affect water temperatures in the lower San Joaquin River during the spring and fall.

- The lower San Joaquin River downstream of the Merced River confluence is identified as temperature impaired (USEPA 2010). According to water temperature modeling conducted by AD Consultants, SJRRP flows will be the same as the ambient temperature (SJRGA 2007a).

Releases from tributary reservoirs will not impact water temperatures in the San Joaquin River or South Delta.

- Increasing flows from the tributaries will not decrease water temperatures in the mainstem San Joaquin River downstream of the Merced confluence (SJRGA 2007a).

DISSOLVED OXYGEN

Scientific Certainty: High

- ***Low dissolved oxygen concentrations are limited to the DWSC and are the result of anthropogenic manipulation of channel geometry.***
- ***Existing DO concentrations do not impact salmon and steelhead migration.***

Key Supporting Science

Low dissolved oxygen (DO) concentrations are limited to the Deep Water Ship Channel (DWSC), and are the result of anthropogenic manipulation of channel geometry.

- The eastside rivers (Tuolumne, Stanislaus and Merced) discharge high-quality Sierra Nevada water which has low planktonic algal content and oxygen demand, and are not a major source of oxygen demand contributing to the low DO problem in the DWSC (Lee and Jones-Lee 2003).
- DO concentrations in the DWSC can be ameliorated by installation of the Head of Old River Barrier (Brunell et al. 2010).

Existing DO concentrations do not impact salmon and steelhead migration.

- Contrary to Hallock et al. (1970) indicating adult migration is prevented under low DO, migration has been observed at DO < 5mg/L (Pyper and others 2006). Adult upstream migration rate and timing is not dependent on DO concentrations (Pyper and others 2006).
- Smolt survival experiments indicate that juvenile salmon survival is not correlated with existing DO concentrations (SRFG 2004; SJRGA 2002 and 2003). Salmon and steelhead migrate in the upper portion of the water column where DO concentrations are highest (Lee & Jones-Lee 2003).

FOOD

Scientific Certainty: High

- ***Salmon and steelhead are not impaired by food availability in the San Joaquin Basin.***
- ***Projected food production from inundated areas will be realized in short inundation periods.***

Key Supporting Science

Out-migrating Chinook smolts are not food-limited during their 3-15 day migration through the lower San Joaquin River below Vernalis and the South Delta.

- The SWRCB's Technical Report (2012) provides evidence that, in other systems, unregulated rivers have more and better food resources than regulated rivers. However, the report does not provide any evidence that increasing flows in an already highly degraded system has the capability to return primary and secondary production quantity and quality to its pre-regulated state.
- Based on acoustic VAMP studies in 2008, Holbrook et al. (2009) found that smolts took 3-15 days (median 6-9 days) for migration through the lower San Joaquin River and South Delta, therefore the demand for food production over such a short duration is questionable.
- Increases in primary and secondary production due to restoration or changes in management likely occur over longer periods of time, rather than by short-term pulse flows.

CONTAMINANTS

Scientific Certainty: Moderate

- ***Influence of higher flows on contaminant concentrations is variable; dilution may occur in some instances but increase in others.***
- ***Providing a percent of unimpaired flows may increase contaminant concentrations.***

Key Supporting Science

No evidence supports the idea that higher inflows reduce contaminant concentrations.

- The SWRCB's Technical Report (2012, p. 3-29) states, "Higher inflows also provide better water quality conditions by reducing temperatures, increasing dissolved oxygen levels, and ***reducing contaminant concentrations***" but does not provide any references or further discussion to support this statement.
- The SWRCB's Technical Report (2012) may infer that higher flows act to dilute suspended contaminants. However, the influence of higher flows on contaminant concentrations is variable; dilution may occur in some instances but increases may occur in others.

Unimpaired flows may increase contaminant concentrations.

- High flows can increase contaminant concentrations through resuspension of contaminants in sediments (McBain and Trush, Inc 2002). These resuspended contaminants can enter the food web and have longer residence times in rivers and estuaries than water (Bergamaschi et al. 1997).
- Pesticides and herbicides were found in every sample of surface water sites along the

San Joaquin River and in the Old River before, during and after the VAMP month-long pulse flow and some contaminants increased throughout these three periods (Orlando and Kuivila 2005).

- "Perhaps the greatest risks to potential restoration actions within the San Joaquin River study reaches relate to uncertainties regarding remobilization of past deposits of […] pesticides, i.e., DDT and mercury" (McBain and Trush 2002).

TRANSPORT OF SEDIMENTS, BIOTA AND NUTRIENTS

<u>**Scientific Certainty: High**</u>

- ***Transport of sediment, biota, and nutrients benefits are closely linked to the availability and connectivity of floodplain habitat, and cannot be expected in a highly modified system such as the San Joaquin Basin.***

<u>**Key Supporting Science**</u>

<u>Transport benefits from floodplain habitat are not realized in the South Delta and lower San Joaquin River because the majority of the floodplain in the lower San Joaquin River has been eliminated or is isolated behind levees.</u>

- Transport of sediment, biota, and nutrients is directly related to the floodplains of a river-floodplain complex, which has nearly been eliminated from the lower San Joaquin River and its tributaries (cbec 2010; Williams 2006).
- "[F]ormer floodplains now behind manmade levees will remain isolated from the river, assuming no long-term changes in flood stages or flood protection policy" (Junk et al. 1989).
- "In unaltered large river systems with floodplains […], the overwhelming bulk of the riverine animal biomass derives directly or indirectly from production within the floodplains and not from downstream transport of organic matter produced elsewhere in the basin" (Junk et al. 1989).
- The FPC focuses on the lateral exchange of water, nutrients and organisms between the river channel <u>and</u> the <u>connected</u> floodplain. The <u>floodplain</u> is considered as an <u>integral</u> part of the system (Junk and Wantzen 2003).

<u>Transport of sediment, biota, and nutrients differs between the large river-floodplain systems described by Junk et al. (1989) and the anthropogenic, leveed river channels of the South Delta.</u>

- Under natural conditions, sediments would be downstream from upper tributaries, but dams limit natural sediment inputs such as gravels (Schoellhamer et al. 2007).
- Human activities (mining, urbanization and agriculture) have increased erosion and the supply of fine river sediments (Schoellhamer et al. 2007).
- Schoellhamer et al. (2007) states that the present day modified system, "would tend to

transport more sediment to the Delta because 1) the flood basins were a sink for fine sediments, and 2) the leveed channels will experience greater bed shear stress because more flow is kept in the channel. . . It follows that levee setbacks and floodplain restoration would tend to decrease sediment supply to the Delta by promoting floodplain deposition along upstream reaches."

- Sediment inputs into the South Delta from the San Joaquin River are the result of increases in suspended sediments from run-off events and are generally not associated with managed flow pulses (SJRG 2004).

VELOCITY

Scientific Certainty: High

- ***No significant relationship exists between mean smolt migration time and San Joaquin River flow.***

Key Supporting Science

No evidence that higher spring flows "facilitate transport."

- The SWRCB's Technical Report (2012) did not define "facilitate transport so it is unclear by what mechanisms spring flows may facilitate transport of smolts, what the benefits are, and how the benefits may be influenced by factors such as flow level, duration, turbidity, etc. The SWRCB's Technical Report (2012) may be suggesting that increased flows result in increased ***velocity***, which may lead to decreased juvenile salmonid travel time through the region, thus 'facilitating transport'.

"It seems intuitively reasonable that increased flows entering the Delta from the San Joaquin River at Vernalis would decrease travel times and speed passage, with concomitant benefits to survival. The data, however, show otherwise" (Baker and Morhardt 2001).

- No significant relationships at the 95% confidence level between mean smolt migration times from three locations (one above and two below the HORB to Chipps Island) and San Joaquin River flow (average for the seven days following release), but
- Smolt migration rate increases with **size** of released smolts (Baker and Morhardt 2001).

Juvenile salmonids are actively swimming, rather than moving passively with the flow, as they migrate towards the ocean (Cramer Decl., Case 1:09-cv-01053-OWW-DLB Document 167, Peake McKinley 1998).

- Movements of juvenile salmonids depend on their species and size, water temperature and local hydrology, and many other factors (Cramer Decl., Case 1:09-cv-01053-OWW-DLB Document 167).

- Baker and Morhardt (2001) provide an example of a study which compared the speed of smolt passage to that of tracer particles (particle tracking model - PTM), "in which 80% of the smolts were estimated to have been recovered after two weeks, but only 0.55% of the tracer particles were recovered after two months."
- Chinook released at Mossdale traveled to Chipps Island 3.5 times faster than the modeled particles (Cramer Decl., Case 1:09-cv-01053-OWW-DLB Document 167).

<u>Results from VAMP studies (using acoustic tags) have generally shown short travel times between reaches, suggesting active swimming.</u>

- In 2009, mean travel times were reported for each reach, and all were under 2.5 days (SJRGA 2009).

<u>Increased flows may slightly increase velocity near the boundary of the Delta, but do not substantially increase velocity through the Delta.</u>

- Velocities at the Head of Old River may increase by about 1 ft/s with an additional 6,000 cfs San Joaquin River flow, but additional flow provides little to no change IN velocity (<0.5 ft/s) at other stations in the South Delta (Paulsen et al. 2008).

PHYSICAL HABITAT

<u>Scientific Certainty: High</u>

- ***Physical habitat has been substantially reduced by non-flow measures (e.g., land reclamation activities, levees).***
- ***Shallow water rearing habitat (important for almost all native fish), has virtually been eliminated from the Delta.***
- ***Restoring the Delta and mainstem San Joaquin River shallow water habitat cannot be accomplished through flow management.***
- ***Non-native species thrive in the highly altered San Joaquin Basin.***

<u>Key Supporting Science</u>

<u>Physical habitat for San Joaquin Basin and Delta native fishes has been substantially reduced and altered.</u>

- Diverse habitats historically available in the Delta have been simplified and reduced by development of the watershed (Lindley et al. 2009).
- Spawning and rearing habitat have been severely reduced, total abundance and salmon diversity reduced from past alterations (McEvoy, 1986; Yoshiyama et al., 1998, 2001; Williams 2006).
- Major change in system is loss of shallow rearing habitat (Lindley et al. 2009).
- 95% of wetlands/floodplains lost to levee construction and agricultural conversion since the mid 1800s (TBI 2003, Williams 2006).
- Only ~10% of historical riparian habitat remains, with half of the remaining acreage

disturbed or degraded (Katibah 1984).
- Shallow water habitats are essentially non-existent since the "current configuration of largely rip-rapped, trapezoidal channels in the Delta provides little habitat for covered species and contributes to a high degree of predation." (Essex 2009).

Levees and off-channel oxbows restrict ability to create shallow water habitat with increased flows.

- The primary purpose of levees is to provide flood protection and prevent high flows from entering adjacent floodplains. There are approximately 443 miles of levees in the lower San Joaquin River downstream of the Stanislaus River confluence and South Delta.
- Inundation of off-channel oxbows creates deep water instead of shallow water habitat.

Habitat alterations are linked with invasive species expansions.

- *Egeria densa* (Brazilian waterweed) expansion has increased habitat and abundance of largemouth bass and other invasive predators (Baxter et al. 2008).
- Current habitat structure benefits exotic predators more than natives (Brown 2003).

Habitat influences growth, survival and reproduction.

- Estuaries provide important rearing habitat for Chinook; salmon fry in Delta grew faster than in river (Healey 1991, Kjelson et al. 1982).
- Shallow water habitats support high growth of juvenile Chinook (Sommer et al. 2001; Jeffres et al. 2008; Maslin et al. 1997, 1998, 1999; Moore 1997). However, as mentioned above, there is little presently available.

Water quality aspect of habitat is highly variable.

- Variability in habitat likely causes regional differences in relationship between Delta smelt abundance and water quality (Baxter et al. 2008).
- Reduced pumping lowered salinity in Western Delta (as desired), but led (unexpected) result of increased salinity in Central Delta (Monsen et al. 2007).

Improving habitat for increased abundance of native fishes.

- Habitat quantity, quality, spatial distribution and diversity must be improved to promote life history diversity that will increase resilience and stability of salmon populations (Lindley et al. 2009).

GEOMORPHOLOGY

Scientific Certainty: High

- ***Managed flow range is insufficient to provide channel mobilizing flows in the San Joaquin River Basin.***
- ***In leveed systems, true channel mobilization flows are not possible because of flood control.***

Scientific Certainty: Deficient

- ***Releasing large quantities of water for channel mobilizing flows in the tributaries for uncertain benefits to salmon and steelhead.***

Key Supporting Science

Under natural conditions, channel formation and maintenance is directly influenced and modified by flow; however, the morphology of leveed rivers cannot be modified by flow (Jacobson and Galat 2006).

- The "five critical components of the ["natural," i.e., unaltered by humans] flow regime that regulate ecological processes in river ecosystems are the magnitude, frequency, duration, timing, and rate of change of hydrologic conditions (Poff et al. 1997, Poff and Ward 1989, Richter et al. 1996, Walker et al.1995).
- In [a highly modified] a system, flow-related factors like timing of floods, water temperature, and turbidity may be managed; but, in absence of a "naturalized morphology, or flow capable of maintaining channel-forming processes, the hydrologic pulses will not be realized in habitat availability."

Due to land use changes, higher flows do not necessarily provide the channel maintenance that would occur under natural conditions.

- In leveed systems, true channel mobilization flows are not possible because of flood control. In fact, higher flows can result in increased detrimental incision in upstream tributary areas (like the Stanislaus River) where existing riparian encroachment is armored and cannot be removed by high flow events, limiting "river migration and sediment transport processes" (Kondolf et al. 2001, page 39).
- Urban and agricultural developments have encroached down to the 8,000 cfs line, "effectively limiting the highest flows to no more than the allowable flood control" (i.e., 8,000 cfs, Kondolf et al. 2001).
- Where flood pulses are not available to provide maintenance of channel habitat, "mimicking certain geomorphic processes may provide some ecological benefits" (Poff et al. 1997) [e.g., gravel augmentation, stimulate recruitment of riparian trees like cottonwoods with irrigation].

In the absence of floodplain connectivity, the functions attributed to higher "pulse flows" cannot be achieved.

- Historically, the San Joaquin River was a channel connected with its floodplain. Flood pulses in the winter and spring would have provided the beneficial functions of floodplains identified by Junk et al. (1989) and by Junk and Wantzen (2003). However, anthropomorphic changes in the lower river (e.g., levees), particularly below Vernalis (the focus of the 2012 Technical Report), have substantially reduced this floodplain connectivity and the region can no longer be considered a "large river-floodplain system."

HEAD OF OLD RIVER BARRIER

Scientific Certainty: High

- ***Salmon smolt survival can be increased through installation of the Head of Old River Barrier (HORB).***

Key Supporting Science

Operation of a rock barrier at the Head of Old River improves salmon smolt survival through the Delta by 16-61% (Newman 2008).

- HORB reduces entrainment into Old River from more than 58% to less than 1.5%.
- Physical (rock) HORB increases San Joaquin River flow.
- Installation of the HORB doubles through-Delta survival by directing juvenile salmonids through the San Joaquin River mainstem (compared to the Old River route, NMFS 2012).

In the absence of a rock barrier at the Head of Old River, a statistically significant relationship between San Joaquin River flow and salmon survival does not exist (Newman 2008).

- HORB cannot be installed or operated during high flow events
  - Temporary rock barrier requires flows less than 5,000 cfs for installation and flows less than 7,000 cfs for operation (SJRTC 2008).

Head of Old River Barrier Predation and "Hot Spots".

- Mean predation rate at HORB was 27.5% in 2009 and 23.5% in 2010.
- 2007 telemetry tracking found that 20% of released fish were potentially consumed by predators at three "hot spots": Stockton Water Treatment Plant, Tracy Fish Facility trashracks and Old River / San Joaquin River split.

PREDATION

Scientific Certainty: High

- ***Predation by non-native species (especially striped bass)) is a major impediment to salmon smolt survival through the lower San Joaquin River and Delta more than river flow.***
- ***Evidence from other basins (i.e., Columbia) indicates that predation can be easily and cost-effectively reduced.***

Key Supporting Science

The VAMP review panel concluded that "high and likely highly variable impacts of predation appear to affect survival rates more than the river flow" (Dauble et al. 2010).

- All fishery agencies have acknowledged that striped bass are a major stressor on Chinook populations in the Central Valley and recovery will not occur without significant reduction in their populations and/or predation rates (DFG 2011).

Recent San Joaquin Basin VAMP studies conducted from 2006–2010 provide direct evidence of high predation rates on Chinook salmon in the lower San Joaquin River and South Delta.

- In 2007, 20% of released fish were potentially consumed by predators at three "hotspots" (Stockton Treatment Plant, Tracy Fish Facility trashracks, and the HOR).
- In 2009, mortality rates (likely due to predation) between Durham Ferry and the HOR ranged from 25.2% to 61.6% (mean 40.8%), and predation rates at HOR ranged from 11.8% to 40% (mean 27.5) (Bowen et al. 2009).
- In 2010, mortality rates (likely due to predation) between Durham Ferry and the HOR ranged from 2.8% to 20.5% (mean 7.8%) and predation rates at HOR ranged from 17% to 37% (mean 23.5%) (Bowen and Bark 2010).

Reducing striped bass predation on juvenile Chinook is the simplest, fastest, and most cost-effective means of increasing outmigration survival.

- High predation occurs at "hot spots," which can be the focus of a control program.
- Encouraging increased angling pressure on salmonid predators has successfully increased the number of adult returns in other basins on the West Coast (Radtke et al. 2004).
- Columbia River predator suppression program has cut predation on juvenile salmonids by 36% (Porter 2011).
- California Fish and Game Commission (CFGC 2012) rejected DFG's recommendation to amend striped bass sport fishing regulations, which included increasing bag limits and decreasing size limits.

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INDEX TO DOCUMENTS SUBMITTED
SAN JOAQUIN TRIBUTARIES AUTHORITY
SWRCB WORKSHOP 2
SEPTEMBER 14, 2012

FILE NAME	FILE DESCRIPTION	DATE PRODUCED
summaryofscientificcertainty.pdf	**Title**: Summary of Scientific Certainty Regarding San Joaquin Basin Chinook Salmon **Prepared for**: State Water Resources Control Board-Phase II Comprehensive Review Workshops Workshop 2, "Bay-Delta Fisheries" to be held October 1-2, 2012 **Prepared by**: Doug Demko, Michael Hellmair, Matt Peterson, Shaara Ainsley, Michele Palmer and Andrea Fuller **On behalf of**: The San Joaquin Tributaries Authority	September 13, 2012
reviewofscientificinformation.pdf	**Title**: Review of Scientific Information Pertaining to SWRCB's February 2012 Technical Report on the Scientific Basis for Alternative San Joaquin River Flow Objectives **Prepared for**: State Water Resources Control Board-Phase II Comprehensive Review Workshops Workshop 2, "Bay-Delta Fisheries" to be held October 1-2, 2012 **Prepared by**: Doug Demko, Michael Hellmair, Matt Peterson, Shaara Ainsley, Michele Palmer and Andrea Fuller **On behalf of**: The San Joaquin Tributaries Authority	September 12, 2012
leidytestimony.pdf	**Title**: A Review and Comparison of Agency Restoration Strategies and Actions of Central Valley Listed Salmon **Prepared for**: State Water Resources Control Board-Phase II Comprehensive Review Workshops Workshop 2, "Bay-Delta Fisheries" to be held October 1-2, 2012 **Prepared by**: George R. "Roy" Leidy **On behalf of**: The Salmon Recovery Group	May 1, 2012

STATE WATER RESOURCES CONTROL BOARD
PUBLIC WORKSHOPS AND REQUEST FOR INFORMATION:
COMPREHENSIVE (PHASE 2) REVIEW
AND UPDATE TO THE BAYDELTA PLAN

Workshop 2: Bay-Delta Fishery Resources

Written Submittal of George R. "Roy" Leidy, AECOM
on behalf of the San Joaquin Tributaries Authority

1. I am a Certified Fisheries Scientist specializing in conservation biology and fish and wildlife management. I have 37 years of technical expertise as a fish and wildlife biologist and regulatory specialist. Currently, I am an aquatic ecologist at AECOM, where my duties include fish and wildlife impact assessments using HEP, WHR and IFIM, wetlands delineations and assessments, endangered species surveys and impact evaluations, HCP/HMP planning, river-reservoir ecosystem modeling, reservoir fisheries management, water quality modeling and toxicological analysis, stream channel stability and watershed assessments, fish passage and screening design, Clean Water Act permitting, and water resources development evaluations.

2. At the request of the Salmon Recovery Group, I reviewed and compared the management goals and actions of the National Marine Fisheries Service, the U.S. Fish and Wildlife Service, and the California Department of Fish and Game with regard to the Central Valley salmon and steelhead populations and drafted a report titled, "A Review and Comparison of Agency Restoration Strategies and Actions for Central Valley Listed Salmonids." This report examines the key management strategies of the three resource agencies by comparing and contrasting each agency's plan for achieving the goal of viable, "naturally" produced salmonid stocks. In addition, this report provides an overview of the organizational management structure under which salmon and steelhead are managed in California and the restoration strategies and actions of each of the three primary management agencies. A true and correct copy of this report is attached hereto as Exhibit 1.

EXHIBIT 1

A Review and Comparison of Agency Restoration Strategies and Actions for

Central Valley Listed Salmonids

Prepared for:

Salmon Recovery Group

AECOM

May 2012

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EXECUTIVE SUMMARY

The National Marine Fisheries Service, the U.S. Fish and Wildlife Service, and the California Department of Fish and Game have the primary on-the-ground responsibility to identify and implement actions that manage Central Valley salmon and steelhead populations. While the ultimate goals of these three agencies are to ensure the viability of salmon and steelhead stocks into the future, their respective "blueprints" for achieving the common goal vary and are often inconsistent. This review examines the key management strategies of the three resource agencies by comparing and contrasting each agency's plan for achieving the goal of viable, "naturally" produced salmonid stocks

This review provides an overview of the organizational management structure under which salmon and steelhead are managed in California and the restoration strategies and actions of each of the three primary management agencies are discussed. A comparison of management actions among agencies is presented, followed by a summary discussion.

None of the three restoration plans reviewed adequately provide a clear and succinct strategy for recovering Central Valley anadromous salmonid stocks to viable and sustainable levels. The principal reason is that these plans were prepared by different agencies for different purposes largely independent of one another. This has lead to numerous inconsistencies and disconnects among the three plans. No plan tells a complete and compelling story that outlines the path to recovery of anadromous salmonids.

Specifically this review finds that one or more of these recovery plans have the following deficiencies:

(1) Lack of specificity as to which anadromous salmonid stock benefits from specific recovery/conservation actions;

(2) Lack of specificity as to which streams the actions apply to;

(3) Failure to include actions for known anadromous salmonid streams;

(4) Failure to identify involved parties or lead agency responsible for recovery actions;

(5) Failure to address some anadromous salmonid stocks;

(6) Inconsistent and variable level of conservation efforts for specific streams;

(7) No evaluations of the population-level benefits of actions generally or by specific stream;

(8) Inconsistent recovery goals among the agencies;

(9) No consistent timeline for implementing or completing conservation actions;

(10) No secure long-term funding sources; and

(11) No integrated performance measures to gauge success/failure of actions.

Only the NMFS plan recognized the enormous restoration measures implemented to date at a cost of over $1 billion. Even after efforts supported by these funds over a long period of time, a significant sustained positive trend in fish populations has not materialized. It would seem appropriate to begin a restoration strategy by recognizing this failure and asking why there has not been sufficient progress in meeting restoration objectives. Questions should address project selection, management structure, funding sources, and quantifiable benefits toward recovery for the various salmonid stocks. The answers to these critical questions should drive, in part, the restoration strategy.

Of the three plans, the NMFS plan is the most thoughtful from a science perspective. The NMFS plan attempts to lay out processes to recover listed anadromous salmonids by following a science-based approach that examines the reasons behind current problems limiting recovery, then proposing actions to address those problems. Even so, the draft of the NMFS plan received 652 comments, many of which focused on coordination and compatibility among agencies. The lack of sufficient coordination among the three resource agencies is a key factor that is apparent when examining all the inconsistencies among plans, including the general lack of agreement among agencies as to what actions should be implemented and by whom.

We recommend that a new science-based and pragmatic restoration strategy be developed that is candid about the opportunities for anadromous salmonid restoration. Once created, the plan should be routinely revised to reflect new information, accomplishments, and failures. If a more comprehensive coordinated approach is not taken, it would appear that the resource agencies will continue developing independent management strategies leaving anadromous salmonid resources at risk.

A REVIEW AND COMPARISON OF AGENCY RESTORATION STRATEGIES AND ACTIONS FOR CENTRAL VALLEY LISTED SALMONIDS (May 2012)

BACKGROUND

There are two federal agencies and one state agency that have the primary on-the-ground responsibility to identify and implement actions that strive to manage Central Valley salmon and steelhead stocks at population levels that will ensure their viability into the future. These agencies are the National Marine Fisheries Service (NMFS), the U.S. Fish and Wildlife Service (USFWS), and the California Department of Fish and Game (CDFG). While the ultimate goals of these three agencies are the same - ensuring the viability of salmon and steelhead stocks - their respective "blueprints" for achieving the common goal vary and are often inconsistent. This review examines the key management strategies of the three resource agencies by comparing and contrasting each agency's plan for achieving the goal of viable, "naturally" produced salmonid stocks into the future.

The review first describes the listing status of Central Valley salmonids, followed by an overview of the organizational management structure under which salmon and steelhead are managed. Next the restoration strategies and actions of each of the three agencies are discussed. Finally, a comparison of management actions among agencies is presented, followed by a summary discussion.

LISTING STATUS OF CENTRAL VALLEY SALMONIDS

Table 1 summarizes the federal Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. 1531 *et seq*.) and California Endangered Species Act (CESA; Fish and Game Code, sections 2050 *et seq*.) listing status of Central Valley salmon and steelhead stocks addressed in this paper. Not all stocks listed or of concern to the federal government are similarly of concern to the state. For example, neither the Central Valley Late Fall-run Chinook Salmon Evolutionarily Significant Unit (ESU) nor the California Central Valley Steelhead Distinct Population Segment (DPS) have any special state status at this time.

PACIFIC SALMON AND STEELHEAD MANAGEMENT OVERVIEW

There are six state and federal agencies involved in managing salmon resources in marine and freshwater environments of California. The authorizing legislation, relationships between agencies, and management processes are discussed for each agency in the following sections. These narratives are summarized overviews that may omit some of the complexity and interaction between and within organizations. The Pacific Fisheries Management Council (PFMC) is discussed first because many of the regulations and management goals originate with the PFMC. The NMFS is discussed second because of its close relationship with the PFMC in both advisory and implementing roles. The Fish and Game Commission of California (Commission) and the CDFG are the third and fourth organizations discussed because they implement many of the freshwater and nearshore marine regulations for both sport and commercial fisheries. The USFWS is the fifth agency discussed because, while they are responsible for assessing progress towards specific management goals, they do not set regulations or actively

Table 1
Listing Status of Central Valley Salmonids.

Species	Current ESA Listing Status	Current CESA Listing Status	Critical Habitat Status	Recovery Plan Status
Sacramento Winter-run Chinook Salmon ESU	Endangered[1] 4 January 1994	Endangered 22 September 1989	Final 16 July 1993	Draft October 2009
Central Valley Spring-run Chinook Salmon ESU	Threatened[2] 16 September 1999	Threatened 5 February 1999	Final 2 January 2006	Draft October 2009
Central Valley Fall-run Chinook Salmon ESU	Species of Concern[3,4] 15 April 2004	None CDFG "Species of Special Concern"	Not Applicable	Not Applicable
Central Valley Late Fall-run Chinook Salmon ESU	Species of Concern[5] 15 April 2004	None	Not Applicable	Not Applicable
California Central Valley Steelhead DPS	Threatened[6] 19 March 1998	None	Final 2 January 2006	Draft October 2009

Notes:

1 The ESU includes all naturally spawned populations of winter-run in the Sacramento River and its tributaries, as well as two artificial propagation programs: winter-run from the Livingston Stone National Fish Hatchery (NFH), and winter-run in a captive broodstock program maintained at Livingston Stone NFH and the University of California Bodega Marine Laboratory.

2 The ESU includes all naturally spawned populations of spring-run in the Sacramento River and its tributaries, including the Feather River, as well as the Feather River Hatchery spring-run program.

3 "Species of Concern" identify species about which NMFS has some concerns regarding status and threats, but for which insufficient information is available to indicate a need to list the species under the ESA.

4 Sacramento and San Joaquin rivers and their tributaries between Keswick Dam and the Merced River.

5 Sacramento and San Joaquin rivers and their tributaries between Keswick Dam and the Merced River.

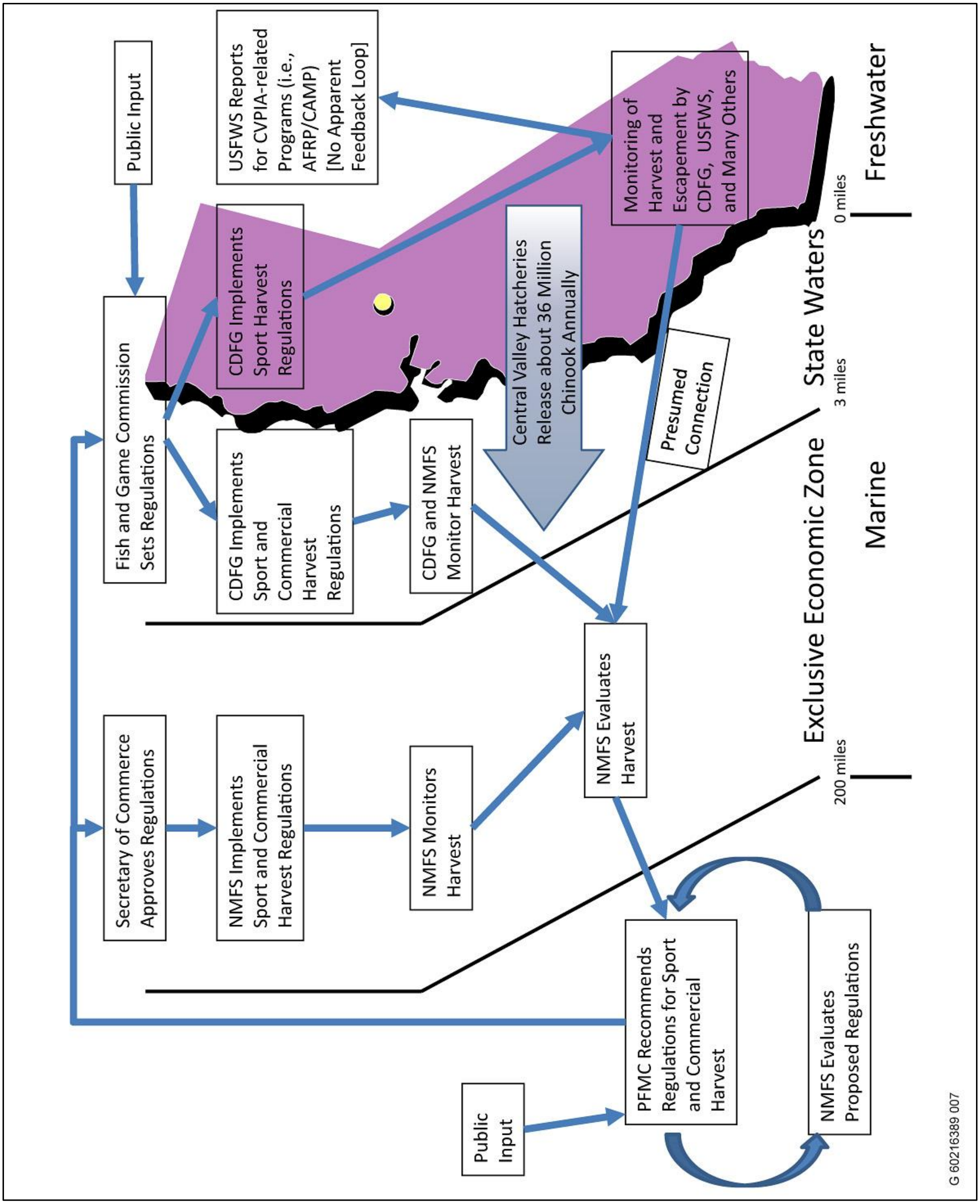
6 The DPS includes all naturally spawned anadromous *O. mykiss* populations (steelhead) below natural and man-made impassable barriers in the Sacramento and San Joaquin rivers and their tributaries, excluding steelhead from San Francisco and San Pablo bays and their tributaries, as well as two artificial propagation programs: the Coleman NFH and Feather River Hatchery steelhead hatchery programs.

manage anadromous fish populations. Finally, the role of the Pacific States Marine Fisheries Commission (PSMFC) is summarized although it has no regulatory or management authority.

PACIFIC FISHERIES MANAGEMENT COUNCIL

AUTHORIZING LEGISLATION

The PFMC was established by the Magnuson-Stevens Fishery Conservation and Management Act of 1976 (Public Law 94-265, as amended). The PFMC has jurisdiction over the exclusive economic zone (EEZ) off Washington, Oregon, and California where they manage salmon fisheries. The EEZ extends from 3 to 200 miles off the coast (Figure 1). The PFMC does not manage any steelhead stocks.



Source: AECOM 2012

Figure 1 **General Management Structure for Chinook Salmon in California**

INTERAGENCY RELATIONSHIPS

Management measures developed by the PFMC are recommended to the Secretary of Commerce through the NMFS. Once approved, management measures are implemented by NMFS. These same recommendations may be adopted by California for state marine waters from 0 to 3 miles offshore.

FISH MANAGEMENT

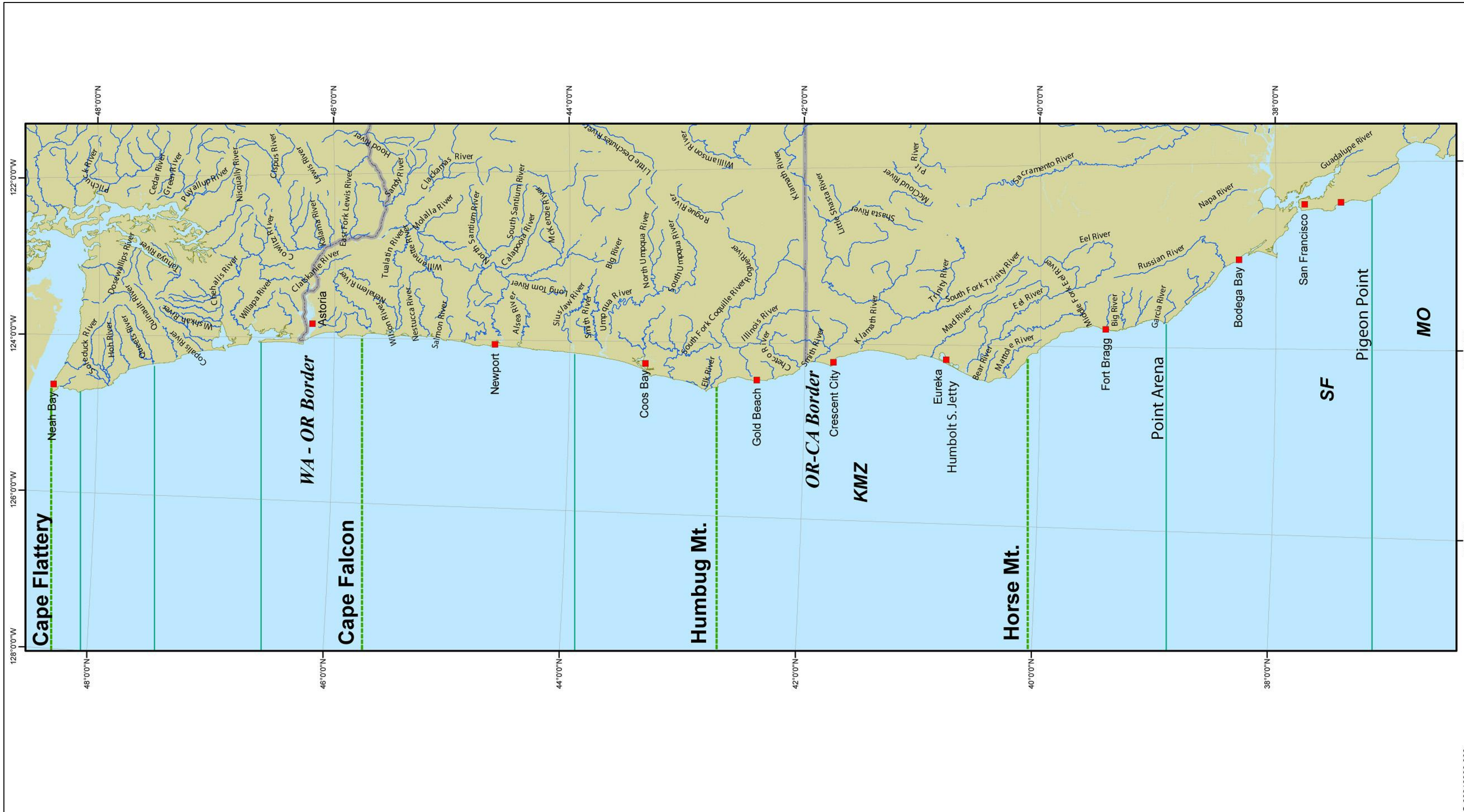
The PFMC manages salmon through the *Salmon Fishery Management Plan* (*FMP*; PFMC 2003). The *only* salmonid species managed are Chinook, coho, and pink salmon (in odd-numbered years). The plan also includes all species listed under the ESA that could be affected by PFMC-managed fisheries. Harvest is allocated between commercial, recreational, tribal, ports, ocean, and inland areas. Conservation objectives are based on achieving *maximum sustained yield* or *maximum sustained production*. Objectives are set through joint coordinated consultation with other state, federal, and tribal managers. These conservation objectives are generally expressed as annual spawner escapement for major salmon stocks or at specific locations.

There are three main subcommittees that assist the PFMC with its work. The Salmon Technical Team summarizes data, conducts population estimates, and evaluates the impacts of PFMC recommendations. The Salmon Advisory Subpanel helps develop the annual management options. The Model Evaluation Workgroup works with the population models to predict effects of harvest on escapement goals and allocations.

SEASON, LIMITS, GEAR RESTRICTIONS, QUOTAS, AND CATCH PROJECTIONS

In their annual preseason reports (e.g., PFMC 2011b), the PFMC recommends seasons, harvest quotas (Table 2), bag and length limits, and gear to be used in the commercial and recreational harvest of salmon.Quotas are set to manage fisheries in defined areas of the ocean that affect a specific stock or stocks of fish (Figure 2). The only quota-based fishery in California is Klamath Management Zone (KMZ) fishery. The PFMC sets catch limits from Humbug Mountain, Oregon south to the Humboldt South Jetty to actively manage fish returning to the Klamath River to ensure that tribal and hatchery escapements are met. Catch projections are calculated by the PFMC and are based on the escapement goals for a particular stock, the population expected within the ocean for a given year, and harvest percentages allowed that would ensure a large enough escapement from the ocean to meet the freshwater escapement goals. The catch projections are used for Central Valley origin fisheries because fish originating from the Central Valley are not managed via the quota system.

The catch projections overlap the quota area fisheries for the KMZ but extend beyond the KMZ to allow harvest of fish outside of this zone. For example, the quota for commercial troll caught Chinook salmon from Humbug Mountain to the Humboldt South Jetty is 6,100 fish compared to the projected commercial troll catch of 7,100 fish which extends south of the Humboldt South Jetty to Horse Mountain (Figure 2). Fish caught in the area between the Humboldt South Jetty and Horse Mountain are presumed to not be Klamath River fish. Coho salmon are managed entirely on the quota system and the only fishery is a recreational fishery from Cape Falcon to the Oregon/California border (Figure 2).



Source: Washington Department of Fish and Wildlife

Figure 2 **PFMC Marine Fisheries Management Zones**

Table 2
Summarized Fishery-specific Harvest Quotas for the 2011 Harvest Seasons.

Fishery	Chinook Quota	Coho Quota
North of Cape Falcon		
Treaty Indian Troll	82,000	42,000
Non-Indian Commercial Troll	61,800	12,800
Recreational	33,700	67,200
North of Cape Falcon Total	105,600	122,000
South of Cape Falcon		
Commercial Troll	6,100	-
Recreational	-	18,000
Total South of Cape Falcon	**6,100**	**18,000**
Source: PFMC 2011b, Table 4		

MANAGEMENT GOALS

Management goals are set in the *FMP* by the PFMC where they are referred to as Conservation Objectives. These objectives are sometimes modified in the preseason reports (e.g., PFMC 2011a). For Central Valley salmon the objectives are as follows:

- For Sacramento fall and late fall-run Chinook between 122,000-180,000 natural and hatchery adult spawners are required (PFMC 2011a);
- For Sacramento spring-run Chinook NMFS ESA standards and recovery plans provide the management goal for this run. The present level (2011) of ocean fishery impacts are limited by measures constraining harvest on Sacramento winter-run and Klamath River fall-run Chinook salmon (PFMC 2011a: 89); and
- Sacramento River winter-run Chinook salmon were originally supposed to show an annual 31 percent increase in adult spawner replacement rate relative to the 1989-1993 replacement rate of 1.35 (PFMC 2003). This goal was revised to comply with the NMFS ESA consultation standard that influences the length and timing of the commercial and recreational fisheries south of Point Arena (PFMC 2011a: 89).

PROCESS FOR REGULATION CHANGES

The PFMC accepts recommendations for changes to ocean fisheries on an annual basis starting when the schedule for the revisions process and upcoming meetings are made available after the November meeting. Public input into the process begins in late February when the previous season's harvest and escapement data are released. The March PFMC meeting includes release of proposed options for the upcoming season. This meeting is followed by public hearings in late March or early April. Final recommendations are made to the Secretary of Commerce for implementation on May 1. Changes in conservation objectives can be made without an amendment to the *FMP* through a federal court order, or if supported by a technical review of the best available scientific information.

NATIONAL MARINE FISHERIES SERVICE

AUTHORIZING LEGISLATION

The Magnuson-Stevens Fisheries Conservation and Management Act (Public Law 94-265) along with the ESA are the federal laws that authorize NMFS's mission. Organized within the Department of Commerce, NMFS manages marine resources and related habitat, including anadromous salmonids. There are two divisions within NMFS that collaborate to manage salmon and steelhead resources in California. The Sustainable Fisheries Division manages the commercial and recreational fisheries for sustainable harvest. It also collects data on fishery operations, administers grant programs, and supports research. The Protected Resources Division is responsible for the conservation and management of endangered species. It develops regulations and management measures to protect and conserve these species. This is the division that conducts ESA-related consultations for actions that may affect listed Central Valley anadromous salmonids.

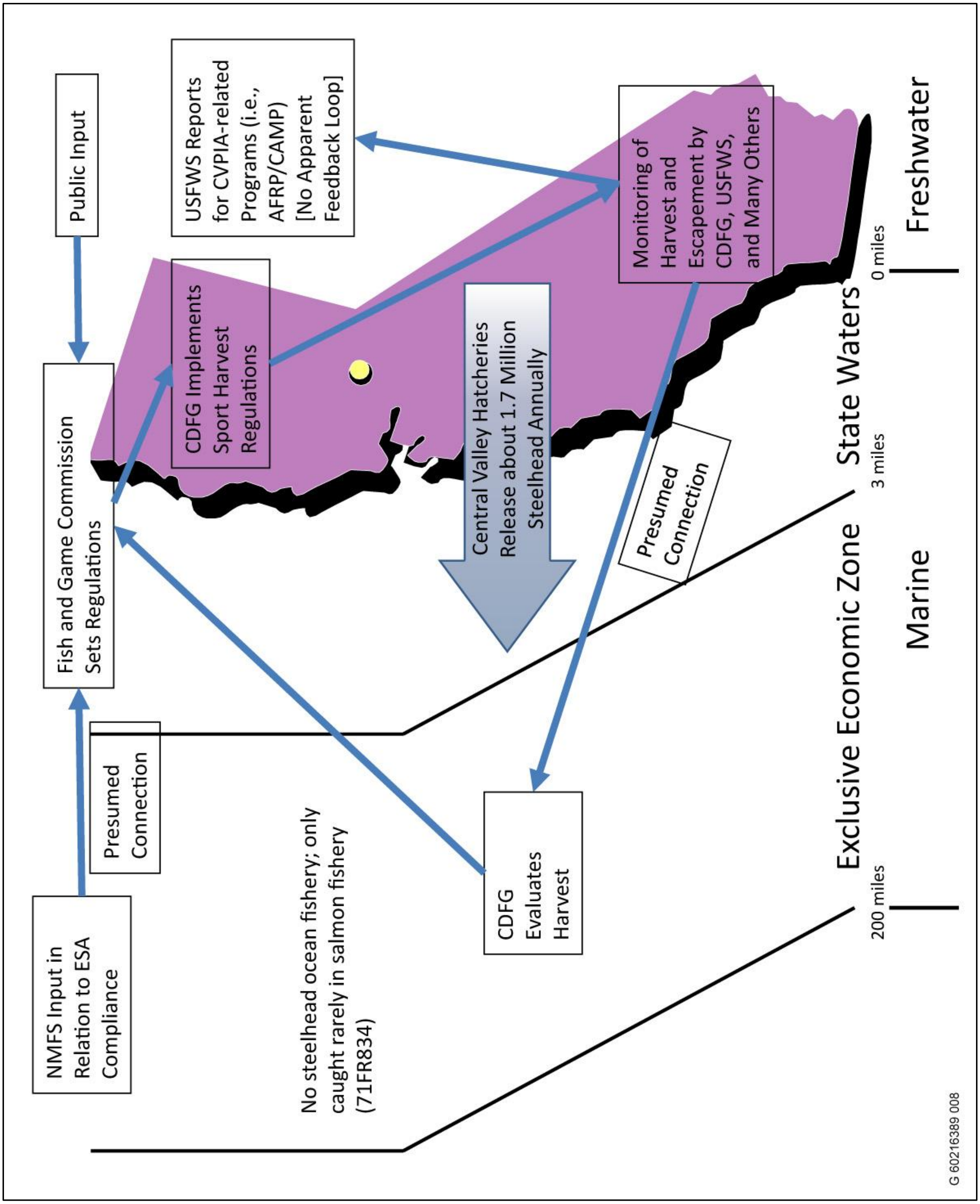
INTERAGENCY RELATIONSHIPS

The relationship between NMFS and the other federal agencies is complex because they work in both advisory and implementation roles (Figures 1 and 3). In the case of Chinook salmon, although the PFMC recommends management actions to the Secretary of Commerce, many of these actions are developed by NMFS for the PFMC. NMFS is also responsible for evaluating the effects of management recommendations and for providing feedback for PFMC's consideration. Once the Secretary of Commerce accepts a set of recommendations, NMFS is responsible for implementing them. In addition, NMFS is both the action and consulting agency for ESA compliance with these regulations. The results of these internal ESA consultations are fed back to the PFMC for implementation to avoid jeopardy and to aid in recovery of ESA-listed species.

Although the specific area of responsibility for NMFS is the EEZ, the Protected Resources Division of NMFS works closely with the State of California on management actions that could affect listed Central Valley anadromous salmonids (Figures 1 and 3).

FISH MANAGEMENT

The NMFS provides primary data tracking and processing, runs numerous population models, and analyzes regulations proposed by PFMC to determine the affects of those regulations on salmon populations. This process applies to non-listed Chinook and coho salmon populations. The ESA-listed species are managed through the recovery planning process. Recovery plans establish the status of the population and the steps required to meet the delisting or down-listing criteria. The recovery plan for winter-run Chinook, spring-run Chinook, and Central Valley steelhead is currently in draft form (NMFS 2009). The public has been provided opportunity to comment on this plan and those comments have been analyzed (NMFS 2010), but a final recovery plan has not yet been produced.



Source: AECOM 2012

Figure 3 **General Management Structure for Steelhead in California**

CALIFORNIA FISH AND GAME COMMISSION AND CALIFORNIA DEPARTMENT OF FISH AND GAME

AUTHORIZING LEGISLATION

The Commission was created by Section 20, Article IV of the California Constitution. Fish and Game Code (FGC) Section 200.5 gives the Commission the authority to regulate taking and possession of fish through sport fishing activities. FGC Section 205 allows the Commission to establish and modify seasons, bag limits, size limits, possession limits, harvest areas, and method of harvest. Other legislation relevant to the management of salmon and steelhead by CDFG includes *The Salmon, Steelhead Trout, and Anadromous Fisheries Program Act of 1988* (California Senate Bill 2261) which mandated an increase in natural fish production. This act is now codified as Sections 6900-6930 of the FGC. Specifically, Section 6902 states that CDFG "…shall develop a plan and a program that strives to double the current natural production of salmon and steelhead trout resources." This goal was to be achieved by the year 2000, but it has yet to be met.

INTERAGENCY RELATIONSHIPS

The Commission and CDFG manage ocean salmon harvest within 3 miles from shore and in freshwater streams of the state (Figures 1 and 3). State regulations generally follow those recommended by the PFMC. Section 316.5 of the FGC states that the Commission may prohibit taking or possession of salmon in the same manner as regulated by federal laws or established by the U.S. Secretary of Commerce. This section gives the Commission authority to have different regulations than those recommended by the PFMC. If a different set of regulations were implemented, CDFG would have to consult with NMFS pursuant to the ESA.

FISH MANAGEMENT

In general, CDFG follows the escapement and harvest goals established by the PFMC and takes steps to ensure that the freshwater harvest conform to the overall PFMC plan (Boydstun 2001). The process for adopting commercial harvest regulations is identified in FGC Section 7650 which states that the state is required to adjust its regulations to ensure that there is no "substantial and adverse effect" on salmon management goals by state regulation. In essence, harvest regulations adopted by the Commission, for both fresh and saltwater, need to conform to the overall management goals established by the PFMC.

MANAGEMENT GOALS

Management goals for salmon populations in California are tied to those established in the *FMP* (PFMC 2003) and the preseason reports (e.g., PFMC 2011a). Increasing naturally produced salmon populations is an important goal of CDFG. As noted previously, FGC Section 6902 states that the CDFG shall work towards a doubling of naturally producing salmon populations. CDFG is required to "…consult with every public agency whose policies or decisions may affect…" the program goal of doubling naturally produced salmon and steelhead in California (FGC Section 6920(b)).

The management of Central Valley steelhead is primarily the responsibility of the Commission and CDFG. All hatchery-produced steelhead are marked by adipose fin clipping prior to release. The Commission sets that harvest regulations for hatchery fish only. Anglers that catch unmarked steelhead must release those fish and only hatchery-marked fish can be harvested in compliance with the state regulations.

PROCESS FOR REGULATION CHANGES

Section 206 of the FGC establishes the process for regulation changes. This involves a series of Commission meetings in August, October, November, and December during which changes to fishing regulations may be considered. In the August meeting, the Commission receives input from staff, other public agencies (e.g., NMFS), and the public about possible changes. In the October and November meetings the Commission holds discussions regarding proposed changes including analysis by staff. By the end of the November meeting the Commission announces the regulations changes they intend to implement. At the December meeting the Commission may hear additional testimony relating to the proposed regulations. At or within 20 days of the December meeting, the Commission must finalize any regulation changes.

U.S. FISH AND WILDLIFE SERVICE

AUTHORIZING LEGISLATION

The Central Valley Project Improvement Act (CVPIA; Public Law 102-572, Title 34) was passed in 1992 and established changes in management of the Central Valley Project that focused on protection, restoration, and enhancement of fish and wildlife. Within the CVPIA, the Comprehensive Assessment and Monitoring Program (CAMP) was authorized by Section 3406(b)(16). The goals of the CAMP are to assess the overall effectiveness of the CVPIA actions and the relative effectiveness of habitat restoration methods. To meet the first goal, the CAMP relies on the Anadromous Fish Restoration Program (AFRP). The AFRP was created by the CVPIA (Section 3406(b)(1)) and charged with a goal of at least doubling the natural production of salmon and steelhead in the Central Valley by the year 2002 based on the estimated long-term average population levels of each stock between 1967 and 1991. The USFWS has the primary responsibility for implementing both the CAMP and AFRP.

INTERAGENCY RELATIONSHIPS

Both the AFRP and CAMP rely on other agencies for a variety of tasks. Perhaps the largest cross-agency pathway is with the Bureau of Reclamation which has substantial management responsibilities (especially those related to management of water) for CAMP as part of the CVPIA. In addition, the CAMP relies on other agencies (e.g., CDFG, California Department of Water Resources, and East Bay Municipal Utility District) for collection of data that is reported by CAMP. The AFRP relies on a host of federal, state, local, and private organizations for project implementation.

FISH MANAGEMENT

The USFWS functions primarily as a monitoring entity when it comes to Central Valley salmon and steelhead. They USFWS collects information as required under the CVPIA, but has no direct management function in relation to harvest quotas or escapement goals. The USFWS can participate in all the public/agency meetings that are held by the PFMC or Commission to set harvest regulations.

Management Goals

As noted, the AFRP was given a goal by the CVPIA of at least doubling the long-term sustainable natural production of salmon and steelhead in the Central Valley (Section 3406(b)(1)). The AFRP production targets are set in the *Final Restoration Plan for the Anadromous Fish Restoration Program* (USFWS 2001). The specific production targets for adult fish are (USFWS 2001: 9):

- Fall and Late fall-run Chinook 818,000;
- Winter-run Chinook: 110,000;
- Spring-run Chinook: 68,000; and
- Steelhead: 13,000.

Process for Regulation Changes

While the USFWS does not implement any harvest-related actions, both the AFRP and CAMP have affects on salmon and steelhead populations. If it were necessary to make change to the AFRP and CAMP, Congressional action would be required.

PACIFIC STATES MARINE FISHERIES COMMISSION

Authorizing Legislation

The PSMFC was formed by a compact entered into in 1947 and subsequently approved by Congress (Public Law 232) with the states of Alaska, Idaho, Washington, Oregon, and California.

Interagency Relationships

The primary goal of the PSMFC is to help resource agencies and the fishing industry sustainably manage Pacific Ocean resources. Although the PSMFC has no regulatory or management authority it provides valuable functions related to fish management along the West Coast. First, it functions as a venue and forum that allows participating members to work on mutual concerns and those that cross state boundaries. Second, it collects and disburses grant funds for states and other organizations where money comes from a variety of state, federal, and other sources. Third, the PSMFC coordinates research and collects and manages data relating to interstate fisheries issues. The PSMFC is also a non-voting member of the PFMC.

AGENCY RESTORATION STRATEGIES AND ACTIONS

The three agencies use different terminologies to describe their respective plans. The USFWS states that its plan is a programmatic-level “restoration” plan that is designed to double the natural production of Central Valley anadromous fish. The NMFS plan is more specialized and focuses only on the “recovery” of listed anadromous salmonids – a subset of Central Valley anadromous fish. The CDFG “conservation” strategy describes Stage 2 restoration actions in the Central Valley. Some of these actions focus on the enhancement of naturally produced anadromous salmonids. While the approaches to each of the three plans vary due to the variety of resources covered, all plans are intended to result in viable and persistent populations of anadromous salmonids in the

Central Valley. Accordingly, this paper uses the terms “restoration,” “recovery,” and “conservation” interchangeably.

RESTORATION STRATEGY OF THE NATIONAL MARINE FISHERIES SERVICE

The Sacramento Office of Protected Resources within the NMFS issued in 2009 a *Public Draft Recovery Plan* (Recovery Plan; NMFS 2009) for the three federally-listed salmonids occurring in the Central Valley. The ultimate goal of any recovery plan is to improve the viability of listed species such that they can be removed from federal protection under the ESA. The Recovery Plan represents NMFS’s expert judgment on how to achieve the delisting goal for three stocks of Central Valley salmonids. As such, it is roadmap that describes the steps, strategies, and actions that must be taken to return the three listed salmonids to viable status, thereby ensuring their long-term (time scales greater than 100 years) persistence and evolutionary potential. Because the NMFS is the federal agency with the primary responsibility of meeting the requirements of the ESA for all listed anadromous fish species, this paper presents in some detail the elements of the Recovery Plan that will be compared later to the parallel actions of the USFWS and CDFG.

RECOVERY PLANS UNDER THE ESA

Section 4(f) of the ESA specifies the content of recovery plans. Specifically, Section 4(f) states:

“(1) RECOVERY PLANS.—The Secretary [Commerce or Interior] shall develop and implement plans hereinafter in this subsection referred to as ‘‘recovery plans’’ for the conservation and survival of endangered species and threatened species listed pursuant to this section, unless he finds that such a plan will not promote the conservation of the species. The Secretary, in development and implementing recovery plans, shall, to the maximum extent practicable—

(A) give priority to those endangered species or threatened species, without regard to taxonomic classification, that are most likely to benefit from such plans, particularly those species that are, or may be, in conflict with construction or other development projects or other forms of economic activity;

(B) incorporate in each plan—

(i) a description of such site-specific management actions as may be necessary to achieve the plan’s goal for the conservation and survival of the species;

(ii) objective, measurable criteria which, when met, would result in a determination, in accordance with the provisions of this section, that the species be removed from the list; and

(iii) estimates of the time required and the cost to carry out those measures needed to achieve the plan’s goal and to achieve intermediate steps toward that goal.

“(2) The Secretary, in developing and implementing recovery plans, may procure the services of appropriate public and private agencies and institutions and other qualified persons. Recovery teams appointed pursuant to this subsection shall not be subject to the Federal Advisory Committee Act.

“(3) The Secretary shall report every two years to the Committee on Environment and Public Works of the Senate and the Committee on Merchant Marine and Fisheries of the House of Representatives on the status of efforts to develop and implement recovery plans for all species listed pursuant to this section and on the status of all species for which such plans have been developed.

“(4) The Secretary shall, prior to final approval of a new or revised recovery plan, provide public notice and an opportunity for public review and comment on such plan. The Secretary shall consider all information presented during the public comment period prior to approval of the plan.

“(5) Each federal agency shall, prior to implementation of a new or revised recovery plan, consider all information presented during the public comment period under paragraph (4).”

It is important to note that the ESA does not mention, nor does it require, that recovery plans must focus only on “naturally” produced species, as opposed to captively bred specimens as are hatchery fish.

HATCHERY-ORIGIN FISH IN ESA LISTING DETERMINATIONS AND RECOVERY PLANNING

There is a common misconception that the NMFS only considers naturally produced fish in its listing determinations and recovery planning. This is not the case. The NMFS issued a final policy on the consideration of hatchery-origin fish in ESA listing determinations for Pacific salmon and steelhead on 28 June 2005 (NMFS 2005; 70 FR 37204).

PREVIOUS ACTIONS BY THE NMFS

In 1978, Congress amended the ESA and provided the current language defining “species.” Specifically, a “species” is defined to include to include “any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature.” Just what constitutes a DPS and thus a “species” under the ESA, was a vexing issue among federal agencies which was not resolved until the NMFS issued its ESU policy on 20 November 1991 (NMFS 1991; 56 FR 58612). In that policy the NMFS determined that a DPS of a Pacific salmon or steelhead species is considered for listing if it meets two criteria:

(1) It must be substantially reproductively isolated from other conspecific (i.e., same species) population units; and

(2) It must represent an important component in the evolutionary legacy of the species.

According to Waples (1991) isolation does not need to be absolute, but must be sufficient to permit evolutionarily important differences to accrue in different populations. The second criterion would be met if the population contributed substantially to the ecological/genetic diversity of the species as a whole. The NMFS hatchery-origin fish policy states (NMFS 2005; 70 FR 37215):

> “A key feature of the ESU concept is the recognition of genetic resources that represent the ecological and genetic diversity of the species. These genetic resources can reside in a fish spawned in a hatchery (hatchery fish) as well as in a fish spawned in the wild (natural fish).”

Given the foregoing criteria, in delineating an ESU considered for listing, the NMFS must identify all components of the ESU, including natural fish and hatchery fish that are part of the ESU. The NMFS evaluates if hatchery fish have a level of genetic divergence relative to the local natural fish that is no more than what occurs within the ESU. Hatchery fish that meet this genetic divergence threshold: (1) are considered part of the ESU; (2) are considered in determining whether or not an ESU should be listed; and (3) are included in any listing of the ESU.

Furthermore, when the NMFS makes status determinations for ESUs, it considers the entire ESU, including hatchery fish if they have been designated part of the ESU. Notably, the NMFS applies the ESU policy in support of the conservation of naturally-spawning salmon and steelhead and the ecosystems upon which they depend. The support of naturally-spawning salmon and steelhead and the ecosystems upon which they depend stems from section 2(b) of the ESA which states, in relevant part (16 U.S.C. 1531(b)):

> "The purposes of this Act [i.e., ESA] are to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved …"

Hatcheries are not part of a natural ecosystem, but can contribute to conserving natural self-sustaining populations if properly managed. Therefore, the emphasis is on naturally produced fish and the ultimate goal is to achieve viable, naturally produced fish that maintain the genetic legacy of the stock without the need for hatchery conservation programs.

At present, when the NMFS makes status determinations for Pacific salmon and steelhead ESUs, there are four factors considered key elements in the status determination: (1) abundance; (2) productivity; (3) genetic diversity; and (4) spatial distribution. The hatchery-origin fish policy states (NMFS 2005; 70 FR 37215):

> "The effects of hatchery fish on the status of an ESU will depend on which of the four key attributes are currently limiting the ESU, and how the hatchery fish within the ESU affect each of the attributes. The presence of hatchery fish within the ESU can positively affect the overall status of the ESU, and thereby affect a listing determination, by contributing to increasing abundance and productivity of the natural populations in the ESU, by improving spatial distribution, by serving as a source population for repopulating unoccupied habitat, and by conserving genetic resources of depressed natural populations in the ESU. Conversely, a hatchery program managed without adequate consideration of its conservation effects can affect a listing determination by reducing adaptive genetic diversity of the ESU, and by reducing the reproductive fitness and productivity of the ESU. In evaluating the effect of hatchery fish on the status of an ESU, the presence of a long-term hatchery monitoring and evaluation program is an important consideration."

In the Central Valley, the NMFS has determined that in addition to naturally spawned fish, two artificial propagation programs: winter-run from the Livingston Stone National Fish Hatchery (NFH), and winter-run in a captive broodstock program maintained at Livingston Stone NFH and the University of California Bodega Marine Laboratory are part of the ESU (Table 1). Similarly, the NMFS has determined in addition to naturally spawned fish, the Feather River Hatchery spring-run Chinook salmon program is part of the ESU (Table 1). No artificially produced Central Valley steelhead are considered part of the Central Valley Steelhead DPS by the NMFS (Table 1). A summary of the history of Central Valley Chinook salmon and steelhead hatcheries and the role of hatchery production in the management of Central Valley salmonids is discussed more fully in Appendix A.

NMFS-DEFINED DIVERSITY GROUPS

The NMFS has identified four Chinook salmon "population groups or salmonid ecoregions" in the Central Valley that were defined based on climatological, hydrological, and geological characteristics. These four groups are termed "diversity groups" in the draft Recovery Plan, and are (Figure 4):

- The *basalt and porous lava diversity group* composed of the upper Sacramento River and Battle Creek watersheds;
- The *northwestern California diversity group* composed of streams that enter the mainstem Sacramento River from the northwest;
- The *northern Sierra Nevada diversity group* composed of streams tributary to the Sacramento River from the east, and including the Mokelumne River; and
- The *southern Sierra Nevada diversity group* composed of streams tributary to the San Joaquin River from the east.

The NMFS has identified six diversity groups for Central Valley steelhead as follows (Figure 5):

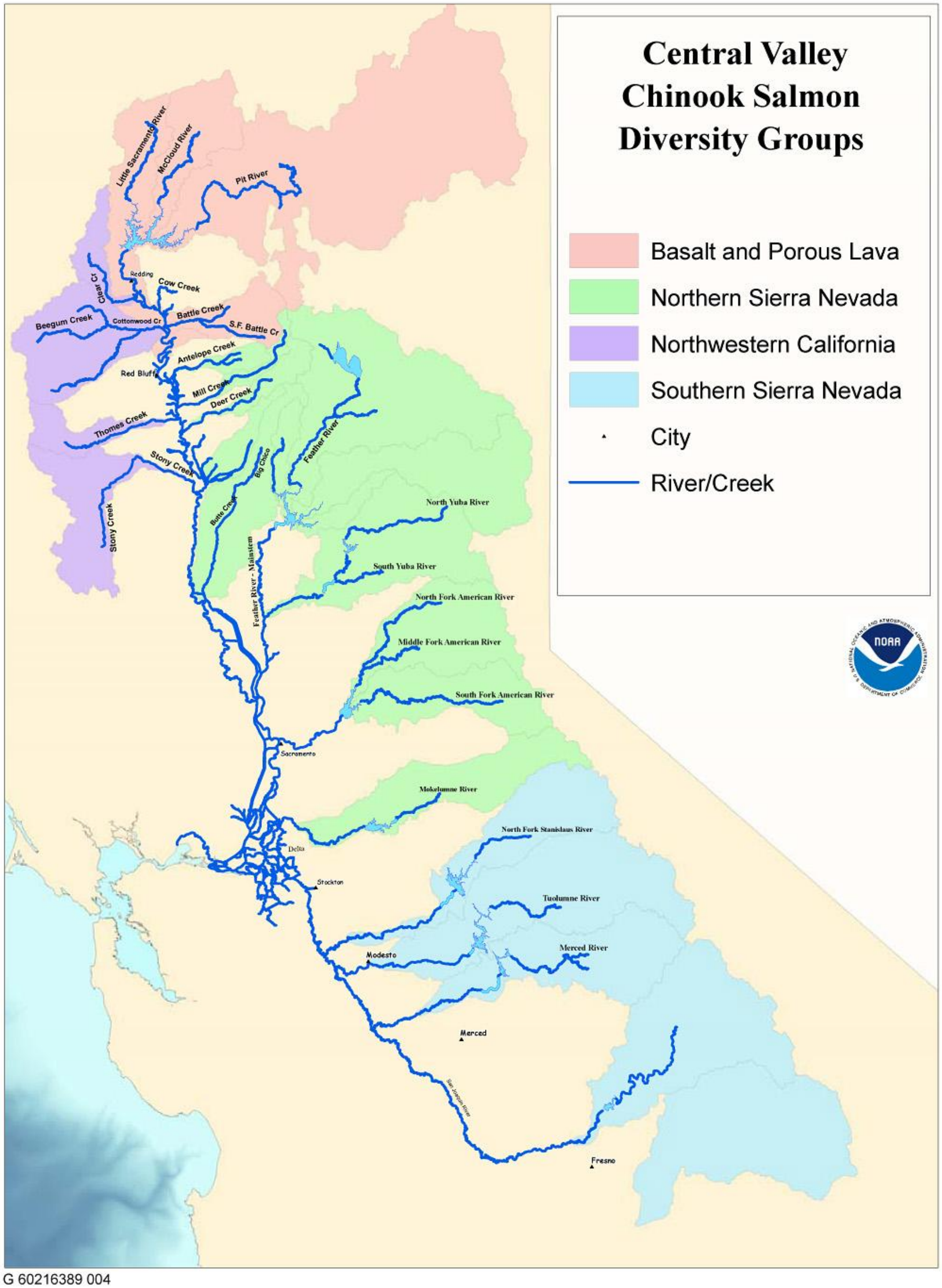
- The *basalt and porous lava diversity group* composed of the upper Sacramento River and Battle Creek watersheds;
- The *northwestern California diversity group* composed of streams that enter the mainstem Sacramento River from the west;
- The *northern Sierra Nevada diversity group* composed of streams tributary to the Sacramento River from the east, and including the Cosumnes River;
- The *southern Sierra Nevada diversity group* composed of streams tributary to the San Joaquin River from the east, including the Mokelumne River;
- The *central western diversity group* composed of streams in the Coast Range on the westside of the San Joaquin Valley; and
- The *Suisun Bay tributaries diversity group* composed of streams tributary to Suisun Bay.

Without explanation, the central western and Suisun Bay diversity groups are not discussed further in the draft Recovery Plan.

STRATEGY ELEMENTS

The near-term strategy to recovery identified by the NMFS includes these elements:

- Secure all extant populations;
- Begin collecting distribution and abundance data for steelhead in habitats accessible to anadromous fish;
- Minimize straying from hatcheries to natural spawning areas;



Source: NMFS 2009

Figure 4 Diversity Groups for the Sacramento River Winter-run Chinook Salmon and Central Valley Spring-run Chinook Salmon ESUs in the Central Valley Domain.

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Source: NMFS 2009

Figure 5 Diversity Groups for the Central Valley Domain Steelhead DPS in the Central Vally Domain

- Conduct critical research on fish passage above rim dams, reintroductions, and climate change; and
- List salmonids ESUs that are likely to be conservation-reliant (i.e., continued conservation management is likely to be required).

The long-term strategy identified by NMFS includes these elements:

- Ensure that every extant diversity group has a high probability of persistence;
- Until all ESU viability criteria have been achieved, no population should be allowed to deteriorate in its probability of persistence;
- High levels of recovery should be attempted in more populations than identified in the diversity group viability criteria because not all attempts will be successful;
- Individual populations within a diversity group should have persistence probabilities consistent with a high probability of diversity group persistence; and
- Within a diversity group, the populations restored/maintained at viable status should be selected to: (1) allow for typical meta-population processes; (2) allow for typical evolutionary processes, including the retention of the genetic diversity; and (3) minimize the susceptibility to catastrophic events.

Just how these near and long-term strategy elements translate into specific objectives and criteria is discussed next.

RECOVERY GOALS, OBJECTIVES, AND CRITERIA IDENTIFIED BY THE NMFS

As stated previously, the goal of the NMFS Recovery Plan is to remove Sacramento River winter-run Chinook salmon ESU, Central Valley spring-run Chinook salmon ESU, and Central Valley steelhead DPS from the federal list of endangered and threatened wildlife. The draft Recovery Plan identifies recovery priorities for currently occupied watersheds (Table 3).

In addition to the recovery priorities for occupied watersheds, the NMFS draft Recovery Plan also identifies reintroduction priorities for Central Valley watersheds (Table 4).

The criteria for delisting salmonids are also presented in the draft Recovery Plan. At the ESU/DPS level each Diversity Group must meet the following criteria:

- Winter-run Chinook Salmon
    - Three populations in the Basalt and Porous Lava Flow Diversity Group at low risk of extinction (3 populations x 2,500 fish[1] = 7,500 fish).
- Spring-run Chinook Salmon
    - One population in the Northwestern California Diversity Group at low risk of extinction (2,500 fish).

[1] Population levels were established by the Central Valley Technical Recovery Team and described by Lindley et al. (2007).

Table 3
Recovery Priorities for Central Valley Watersheds Currently Occupied by Listed Salmonids.

Diversity Group	Watershed/Population	Species	Recovery Focus[1]
Northwestern California	Clear Creek	Spring-run	Core 1
		Steelhead	Core 1
	Cottonwood/Begum Creek	Steelhead	Core 2
		Spring-run	Core 2
	Thomes Creek	Steelhead	Core 2
		Spring-run	Core 3
Basalt and Porous Lava	Upper Sacramento River (Keswick to Red Bluff)	Winter-run	Core 1
		Spring-run	Core 2
		Steelhead	Core 2
	Cow Creek	Steelhead	Core 2
	Redding Area Tributaries	Steelhead	Core 2
	Battle Creek	Spring-run	Core 1
		Steelhead	Core 1
Northern Sierra Nevada	Antelope Creek	Steelhead	Core 1
		Spring-run	Core 2
	Mill Creek	Spring-run	Core 1
		Steelhead	Core 1
	Deer Creek	Spring-run	Core 1
		Steelhead	Core 1
	Big Chico Creek	Steelhead	Core 2
		Spring-run	Core 3
	Butte Creek	Spring-run	Core 1
		Steelhead	Core 2
	Lower Feather River	Spring-run	Core 2
		Steelhead	Core 2
	Lower Yuba River	Spring-run	Core 1
		Steelhead	Core 1
	Bear River	Spring-run	Core 3
		Steelhead	Core 3
	Lower American River	Steelhead	Core 2
	Cosumnes River	Steelhead	Core 3
	Lower Mokelumne River	Steelhead	Core 3
Southern Sierra Nevada	Calaveras River	Steelhead	Core 1
	Lower Stanislaus River	Steelhead	Core2

Table 3 Recovery Priorities for Central Valley Watersheds Currently Occupied by Listed Salmonids.			
Diversity Group	**Watershed/Population**	**Species**	**Recovery Focus[1]**
	Lower Tuolumne River	Steelhead	Core 2
	Lower Merced River	Steelhead	Core 2

Notes:

[1] Core 1 populations are those populations identified as having the highest priority for recovery action implementation. These populations must meet the recovery criteria for low risk of extinction.

Core 2 populations must have the potential to reach the biological recovery criteria for moderate risk of extinction and are of secondary importance in recovery efforts.

Core 3 populations may be present on an intermittent basis and are characterized as being dependent on other nearby independent populations for their existence, but are not expected to exceed the abundance criteria for high risk of extinction.

Source: NMFS 2009, Table 3-1

- Two populations in the Basalt and Porous Lava Flow Diversity Group at low risk of extinction (2 populations x 2,500 fish = 5,000 fish).
- Three populations in the Northern Sierra Diversity Group at low risk of extinction (3 populations x 2,500 fish = 7,500 fish).
- Two populations in the Southern Sierra Diversity Group at low risk of extinction (2 populations x 2,500 fish = 5,000 fish).
- Maintain Core 2 populations at moderate risk of extinction (Table 3).

► Central Valley Steelhead

- Two populations in the Northwestern California Diversity Group at low risk of extinction (2 populations x 2,500 fish = 5,000 fish).
- Two populations in the Basalt and Porous Lava Flow Diversity Group at low risk of extinction (2 populations x 2,500 fish = 5,000 fish).
- Three populations in the Northern Sierra Diversity Group at low risk of extinction (3 populations x 2,500 fish = 7,500 fish).
- Two populations in the Southern Sierra Diversity Group at low risk of extinction (2 populations x 2,500 fish = 5,000 fish).
- Maintain Core 2 populations at moderate risk of extinction (Table 3).

Table 4 Reintroduction Priorities for Central Valley Watersheds for Listed Salmonids.			
Diversity Group	**Watershed/Population**	**Species**	**Focus for Recovery[1]**
Basalt and Porous Lava	Little Sacramento River	Winter-run	Primary
		Spring-run	Primary
		Steelhead	Primary
	McCloud River	Winter-run	Primary
		Spring-run	Primary
		Steelhead	Primary
	Battle Creek	Winter-run	Primary
Northern Sierra Nevada	North Fork Feather River	Spring-run	Secondary
		Steelhead	Secondary
	Upper Yuba River	Spring-run	Primary
		Steelhead	Primary
	Upper American River	Spring-run	Secondary
		Steelhead	Primary
	Cosumnes River	Steelhead	Secondary
	Upper Mokelumne River	Steelhead	Secondary
Southern Sierra Nevada	Upper Stanislaus River	Steelhead	Secondary
	Upper Tuolumne River	Steelhead	Secondary
	Upper Merced River	Steelhead	Secondary
	San Joaquin River (Friant to Merced)	Spring-run	Primary

Notes:

[1] Primary priority watersheds have a high potential to support spawning populations of anadromous fish.
Secondary priorities have a moderate potential to support spawning populations of anadromous fish.

Source: NMFS 2009, Table 3-2

At the population level the draft Recovery Plan lists these delisting criteria (Core 1 and Core 2 combined):

- "For a population to be considered at low risk of extinction (i.e., <5 percent chance of extinction within 100 years), the population viability assessment must demonstrate that risk level or all of the following criteria must be met:
  - The effective population size must be >500 or the population size must be >2,500;
  - The population growth rate must show that a decline is not apparent or probable;
  - There must be no apparent or minimal risk of a catastrophic disturbance occurring; and

- Hatchery influence must be low, as determined by levels corresponding to different amounts, durations and sources of hatchery strays."

In summary, the draft Recovery Plan envisions the establishment of a number of populations of each listed salmonid within specific geographic areas (Diversity Groups) that have a low risk (<5 percent) of extinction over the long-term (100 years). Numerically, each population must exceed 2,500 adult fish. Using the criteria presented in the draft Recovery Plan delisting could occur when Core 2 populations have only a moderate risk of extinction and Core 1 populations achieve the following:

- Winter-run Chinook Salmon
    - Three populations at low risk of extinction with each population having a *minimum* population size of 2,500 fish (7,500 fish total for all populations).
- Spring-run Chinook Salmon
    - Nine populations at low risk of extinction with each population having a *minimum* population size of 2,500 fish (22,500 fish total for all populations).
- Central Valley Steelhead
    - Nine populations at low risk of extinction with each population having a *minimum* population size of 2,500 fish (22,500 fish total for all populations).

RECOVERY ACTIONS

NMFS states in the draft Recovery Plan:

> "Many complex and inter-related biological, economical, social, and technological issues must be addressed in order to recover anadromous salmonids in the Central Valley. Policy changes at the Federal, State, and local levels will be necessary to implement many of the recovery actions. For example, without substantial strides in habitat restoration, fish passage, and changes in water use, recovery will be difficult if not impossible."

The specific recovery actions for listed Central Valley salmonids identified by the NMFS in its draft Recovery Plan are summarized in tables in Appendices B through E. For each *Priority 1 Recovery Action*, the NMFS provides an estimate of the duration of the action, for example, "year 1 through year 10." NMFS provides for most actions, but not all, a 5-year cost estimate for implementation. Also, for each action, the NMFS lists involved parties, although it is not clear which party, if any, is the lead action agency.

RESTORATION STRATEGY OF THE CALIFORNIA DEPARTMENT OF FISH AND GAME

The CDFG's restoration strategy for Central Valley salmonids has its foundation in the CALFED Bay-Delta Program (CALFED) and the Ecosystem Restoration Program Plan (ERPP) *Volume III: Strategic Plan for Ecosystem Restoration* (ERP; CALFED 2000). Under the ERP, CDFG issued a draft *Conservation Strategy for Restoration of the Sacramento-San Joaquin Delta Ecological Management Zone and the Sacramento and San*

Joaquin Regions in July 2011 (Conservation Strategy; CDFG 2011). The draft was developed by CDFG; however, the draft states that the final version of this strategy is to be developed in consultation with the USFWS and NMFS who, along with the CDFG, are collectively known as the ERP Implementing Agencies.

The CDFG draft Conservation Strategy describes the ERP priorities and actions for Stage 2 of the CALFED Bay-Delta Program. The Conservation Strategy is stated to provide the rationale for restoration actions specific to the Delta Ecological Management Zone (EMZ) and the Sacramento Valley and San Joaquin Valley regions (CDFG 2011). The document states:

> "The Conservation Strategy serves as an update to the ERP Strategic Plan and follows the principle of a single-blueprint for ecosystem restoration and species recovery in accordance with the principals of ecosystem-based management. Having a single-blueprint is a key ingredient for a successful and effective restoration program. This single-blueprint is the vehicle for ensuring coordination between all resource management, conservation, and regulatory actions affecting the Bay-Delta ecosystem . . ."

The document states that the ERP Implementing Agencies (i.e., CDFG, USFWS, and NMFS) will use the ERP Stage 2 Conservation Strategy during the period from 2011 to 2030. Further, it states that the Conservation Strategy is intended "as a guide to the types and locations of restoration actions, it is not a prescription for restoration actions at any specific site." The focus area of the strategy extends from Shasta Dam on the Sacramento River in the north to Friant Dam on the San Joaquin River to the south, and includes the Delta westward to North San Francisco Bay and Suisun Marsh.

The Conservation Strategy is presented by geographic area:

- Sacramento-San Joaquin Delta EMZ;
- Sacramento Valley Region; and
- San Joaquin Valley Region.

Within each of these areas the Conservation Strategy identifies *Stage 2 Actions* to address restoration issues that have been grouped into broad categories:

- Ecosystem Processes;
- Habitats;
- Stressors; and
- Species.

The actions related to anadromous salmonids are summarized in tables in Appendices B through E.

The Conservation Strategy also discusses, by geographic area, the strategy's relationship to other planning efforts in each geographic area.

Implementation of the Conservation Strategy rests on:

- The continued coordination of the ERP Implementing Agencies managers with the Delta Stewardship Council;

- Integration of the Conservation Strategy into the planning efforts of the Delta Stewardship Council and the Delta Conservancy;
- Sustained funding of actions and ecosystem restoration activities; and
- The incorporation of uncertainty and adaptive management into planning, doing, evaluating, and responding to actions.

The Conservation Strategy includes a listing of ERP Strategic Goals and Objectives (Appendix B of the strategy) and for each goal and its subset of objectives ERP Performance Measures are identified (Appendix D of the strategy). While the performance measure targets and measure metrics are frequently listed as “to be determined,” some key targets are identified. For example:

ERP GOAL 3. Maintain and/or enhance populations of selected species for sustainable commercial and recreational harvest, consistent with the other ERP strategic goals.

- **Objective 3-1.** Enhance fisheries for salmonids, white sturgeon, Pacific herring, and native cyprinid fishes.
- **Performance Measure 3-1.1a.** Progress towards maintaining population, or doubling established baseline (prescribed in the CVPIA for anadromous fish).
- **Targets.** 990,000 all races of Chinook salmon; 13,000 steelhead.
- **Metric.** To be determined.

No information is included in the Conservation Strategy identifying the lead agency for any restoration action, specific timelines for action implementation, or the projected costs of action implementation.

RESTORATION STRATEGY OF THE U.S. FISH AND WILDLIFE SERVICE

The *Final Restoration Plan for the Anadromous Fish Restoration Program* (Restoration Plan; USFWS 2001) is the oldest of the agency plans considered in this evaluation. Many of its restoration actions have been completed; however, those actions are not distinguished herein from those actions yet to be implemented. As has been stated previously, the CVPIA created the AFRP with the goal of making all reasonable efforts to double natural production of anadromous fish in the Central Valley. Out of the AFRP the USFWS developed the Restoration Plan. While the Restoration Plan is described as a programmatic-level document, it includes numerous site-specific recovery actions and evaluations. The geographic coverage of the Restoration Plan encompasses most of the Central Valley, including the Sacramento-San Joaquin Delta. The Restoration Plan excludes the San Joaquin River between Friant Dam and Mendota Pool pursuant to the CVPIA.

In developing the Restoration Plan the USFWS went through a process to prioritize watersheds based on their capacity to increase fish production. Recovery actions were prioritized based on the action’s ability to promote natural processes leading to greater fish production. A process for implementing the recovery actions and for inter-agency cooperation was identified. An adaptive management approach was adopted to address scientific uncertainty. The USFWS’s Restoration Plan does not include detailed narrative descriptions of why particular actions are necessary, but it rather presents a series of tables that state the action, what parties are likely to be involved, and what priority level the action is (i.e., low, medium, or high). No information on the projected cost or timeline for each action is included.

Those actions in the Recovery Plan related to the recovery of anadromous salmonids are summarized in tables in Appendices B through E.

COMPARISON OF AGENCY SALMONID MANAGEMENT ACTIONS

While there are numerous local, state, and federal agencies and organizations that have a direct role in the conservation of listed salmonids in the Central Valley, ranging from non-profit watershed conservancies to the U.S. Bureau of Reclamation, the primary restoration responsibility rests with the NMFS, USFWS, and CDFG. Over the past 20 years numerous plans for salmonid restoration have been issued – largely revisiting the same issues and potential solutions over and over again. Enormous quantities of money have been devoted to conservation measures over this same period of time with mixed results depending on stock monitored, as measured by escapement to spawning. Today, there is no Central Valley anadromous salmonid stock that is not either listed under state or federal endangered species statues or considered as a "species of concern" by one or more agencies.

The primary restoration planning documents relied upon by each of the "big three" agencies were reviewed previously herein. A summary comparison of each agency's restoration actions is provided in Appendices B through E. In comparing actions among agencies keep in mind the following caveats:

- The planning documents were developed at different points in time;
- The USFWS's document is a programmatic restoration plan prepared pursuant to CVPIA; the NMFS's document is a draft recovery plan prepared pursuant to ESA; and the CDFG document is a draft conservation strategy is a guide stemming from CALFED;
- Some of the actions listed particularly in the USFWS and NMFS documents have been completed; and
- The total number of restoration actions among the agencies is variable due, in part, by how specific the restoration plan is (i.e., generalized actions for an entire geographic area versus site-specific actions listed stream-by-stream).

COMPARISON OF THE SIMILARITY OF AGENCY RECOVERY ACTIONS

The total number of restoration actions varies widely among agencies and region, with the USFWS typically identifying many more actions that NMFS and CDFG, particularly in the Sacramento River watershed (Tables 5 and 6). The difference is due, in part, to the tendency of the USFWS restoration plan, even though claiming to be programmatic, to be much more site-specific than the plans of the other two agencies. Even taking this

Table 5
Comparison of the Similarity of Agency Recovery Actions by Geographic Region.

Geographic Location	Total Number of Proposed Recovery Actions			Number of Occurrences When Recovery Actions are Similar Among All Three Agencies	Number of Occurrences When Recovery Actions are Similar Between Two Agencies			Number of Occurrences When Recovery Actions are Unique to Only One Agency		
	NMFS	USFWS	CDFG		NMFS + USFWS	NMFS + CDFG	USFWS + CDFG	NMFS	USFWS	CDFG
Central Valley-wide	19	14	8	2	7	0	0	10	4	0
Sacramento-San Joaquin Delta	14	26	9	2	5	1	0	6	4	3
Sacramento River Watershed	40	177	31	3	21	5	9	11	123	15
San Joaquin River Watershed	10	42	28	5	3	3	2	0	22	17
Total	**83**	**259**	**76**	**12**	**36**	**9**	**11**	**27**	**153**	**35**

Table 6
Relative Agreement Among Agencies on Recovery Actions.

Agency	Total Number of Recovery Actions for Central Valley	Recovery Actions Unique to Agency		Recovery Actions Similar Among All Three Agencies		Recovery Actions Similar Between Two Agencies					
						NMFS		USFWS		CDFG	
		Number	Percent of Total	Number	Percent of Total	Number	Percent of Total	Number	Percent of Total	Number	Percent of Total
NMFS	83	27	32.5	12	14.4	NA	NA	36	43.4	9	10.8
USFWS	259	153	59.1	12	4.6	36	13.9	NA	NA	11	4.2
CDFG	76	35	46.0	12	15.8	9	11.8	11	14.5	NA	NA

comparison limitation into account, the data clearly shows that rarely did all three agencies propose similar to identical restoration actions in comparison with the total number of actions proposed (Table 5). For example, in the Sacramento River watershed, out of the numerous actions identified, the three agencies only identified similar actions five times, and for the entire Central Valley the three agencies were only in agreement 12 times. Those 12 times of agency agreement comprise a small percentage of the total recovery actions identified by any given agency, ranging from 4.6 to 15.8 percent, depending on agency (Table 6).

A substantial proportion of a given agency's recovery actions were unique to that agency (Table 5). For example, the USFWS proposed 153 unique actions out of a total of 259 actions; this was over 59 percent of its total number of actions (Table 6). Similar substantial percentages of unique recovery actions are noted for NMFS and CDFG (Tables 5 and 6).

Also of interest is the frequency with which any two agencies agreed with each other. The NMFS and the USFWS were in agreement on 36 recovery actions, which was 43.4 percent of the total actions proposed by NMFS, but only 13.9 percent of the total actions identified by the USFWS (Tables 5 and 6). It should be noted that the NMFS in its draft Recovery Plan included numerous actions directly from the USFWS's AFRP restoration plan.

The CDFG's recovery actions were consistently out-of-sync with the federal agencies. For example, of the 76 total recovery actions identified by the CDFG, only 11.8 percent of the actions overlapped with actions proposed by the NMFS, and 14.5 percent overlapped with the USFWS (Table 6).

The often substantial disconnect among the three agencies as to what recovery actions are necessary suggest different agency goals and objectives as well as structural problems in inter-agency cooperation or communication. An examination deeper into the differences in the agency recovery documents is revealing.

SPECIFIC INCONSISTENCIES AMONG THE RECOVERY PLANNING DOCUMENTS

A review of Appendices B through E and the text of each agency document reveal specific inconsistencies that impair efficient and effective recovery planning and make the documents not very useful to managers. Essentially, there are three programs that overlap to some degree, but do not seem to take advantage of the benefits of combined and consistent planning. The key issues in comparing the recovery documents with examples follow.

One or more of the three planning documents was found to be inadequate due to:

(1) *Lack of specificity as to which anadromous salmonid stock benefits from specific recovery/conservation actions.*

The NMFS draft Recovery Plan consistently identifies species that benefit from each recovery action (Appendices B through E). The USFWS Restoration Plan is inconsistent in identifying the species that benefit, and the CDFG draft Conservation Strategy is even more inconsistent when identifying species when presenting its Stage 2 Actions.

The USFWS plan in presenting recovery actions frequently uses vague terms (e.g., anadromous fishes, salmonids, juvenile salmon, adult salmonids). Often, no specific anadromous salmonid is identified. The plan assumes the reader must know which stock is being referred to for specific actions.

Example:

> "Provide flows in the Calaveras River of suitable water temperature for all salmonid life stages." (Appendix E. Calaveras River. Action 2)

The CDFG plan has similar omissions to that of the USFWS, but the omissions are more frequent, leading the reader to assume to which stock the benefits accrue.

Example:

> "Improve the efficiency of screening devices on the Yuba River at Hallwood-Cordua and Brophy-South Yuba diversions, and construct screens at Brown's Valley water diversion and other unscreened diversions." (Appendix D. Yuba River. Action 2)

(2) *Lack of specificity as to which streams the actions apply to.*

This issue is typically a problem associated with the CDFG plan wherein the plan frequently presents generic actions. Generic actions are less than informative because they do not tell manager's anything about the scope of the problem, the potential costs to solve the problem, or who the interested parties are. It is also essentially impossible to evaluate the success of generic actions.

Example:

> "Investigate whether individual species' respective range of distribution can be extended or changed, so they may persist in changing future conditions." (Appendix E. Action 1)

(3) *Failure to include actions for known anadromous salmonid streams.*

The USFWS Restoration Plan does an excellent job in presenting site-specific recovery actions. The NMFS Recovery Plan is somewhat less specific, but generally covers most of the same streams as the USFWS plan. The CDFG Conservation Strategy, again due to its overly generic content does not directly address recovery actions in many streams as it should. The specific anadromous salmonid streams unaddressed by NMFS are: Cow Creek, Bear Creek, Cottonwood Creek, Paynes Creek, Elder Creek, Thomes Creek, Stony Creek, Big Chico Creek, Lindo Channel, Mud Creek, Bear River, Dry Creek, Auburn Ravine, Miner's Ravine, and the Cosumnes River.

The specific anadromous salmonid streams unaddressed by CDFG are: Clear Creek, Cow Creek, Bear Creek, Cottonwood Creek, Battle Creek, Paynes Creek, Antelope Creek, Elder Creek, Mill Creek, Thomes Creek, Stony Creek, Deer Creek, Lindo Channel, Mud Creek, Mokelumne River, and the Cosumnes River.

The NMFS plan includes streams upstream of the rim dams, something the two other plans do not directly address. Action items included in the NMFS plan include these streams upstream of the rim dams: Little Sacramento River, McCloud River, Yuba River, American River, Mokelumne River, Stanislaus River, and Tuolumne River.

(4) *Failure to identify involved parties or lead agency responsible for recovery actions.*

Both the NMFS and USFWS recovery plans identify involved parties, with rare exception by NMFS, but neither plan indicates which involved party for a given action is the lead party or action agency. Sometimes the lead is obvious, but not in all cases. The CDFG plan rarely identifies the involved parties or the lead agency.

Example:

> "Design, permit, and construct priority fish screen projects on the Sacramento River." (Appendix D. Sacramento River. Action 4)

Not only is it not known what projects CDFG is thinking of, but neither are the potential involved parties identified.

There is another problem, however, even when the interested parties are identified. There are numerous instances where a unique recovery action identified by one agency places the burden of implementation on another agency or agencies. These other agencies may, or may not, be able to implement the action for a variety of reasons. This is an area that requires inter-agency coordination and communication.

Example:

> "Eliminate sources of chronic sediment delivered to Mill Creek from roads and other near-stream development by out-sloping roads, out-sloping of diversion prevention dips, replacing under-sized culverts and applying other storm proofing guidelines."

Involved Parties: CDFG, U.S. Forest Service (Appendix D. Mill Creek. Action 1.9.2.3 from NMFS 2009)

(5) *Anadromous salmonid stocks not addressed*.

The NMFS Recovery Plan does not address, of course, fall-run or late fall-run Chinook salmon because these stocks are not listed pursuant to the ESA, even though they are both "species of concern." As noted previously, there are many examples, especially in the USFWS and CDFG plans where it is not clear which anadromous fish stocks are benefiting from the recovery action. The USFWS plan commonly does not mention which run of Chinook salmon it is referring to for a specific action. For some streams one agency plan will include an anadromous salmonid stock that is omitted by another agency's action on the same stream.

Example:

> NMFS notes the stocks benefited are spring-run Chinook salmon and steelhead. The CDFG plan only lists Chinook salmon, and generically at that. (Appendix D. Chinook salmon and steelhead. Action 1.9.6.1 from NMFS 2009)

Steelhead are omitted from some streams where they are known to occur, primarily in the CDFG plan.

(6) *Level of conservation efforts for specific streams inconsistent/variable*.

The number of recovery actions is variable among agencies and geographic regions (Table 5). Also, as discussed under inconsistency (3), some anadromous salmonid streams are not even recognized by some plans, leading to a clear bias in recovery planning. Even for those streams recognized by all three agencies as needing recovery actions, the level-of-effort may not be the same. For example, in the Yuba River NMFS identifies 2 recovery actions, the USFWS 12, and CDFG 5 (Appendix D. Yuba River. Various Actions).

(7) *There are no evaluations of the population-level benefits of actions generally or by specific stream.*

While evaluating the population-level benefits of specific actions in concert with other actions on a given stream may be difficult, it seems appropriate to undertake such a benefit/cost analyses. Is it more beneficial to restore spring-run Chinook salmon to Butte Creek or to Battle Creek? Perhaps both are required; however, priorities are important based on the expected return. The NMFS plan identifies *Recovery Focus* levels ranging from Core 1 to Core 3 for currently occupied watersheds, and *Focus for Recovery* levels of Primary or Secondary for reintroduction. Presumably these ratings reflect which streams are likely to provide the most benefit for recovery. It would be desirable to see in the NMFS Recovery Plan these ratings converted to numbers of fish escaping to spawning if the recovery actions are fully successful. Life history model(s) would be needed to provide this information.

Similarly, the USFWS rates its recovery actions from low to high, presumably as a measure of the level of production achieved or priority for implementation. However, both the USFWS and CDFG have an artificial goal of doubling anadromous fishes from baseline levels regardless of whether the goal is realistic. It would be useful to know what both the USFWS and the CDFG project in population growth as measured by escapement to spawning if the recovery actions are successful.

(8) *Recovery Goals Among the Agencies are Not the Same.*

As presented previously in this report, using the criteria presented in the NMFS draft Recovery Plan delisting could potentially occur when Core 2 populations have only a moderate risk of extinction and Core 1 populations achieve certain population sizes. Also as discussed previously, the USFWS Restoration Plan and the CDFG Conservation Plan contain specific targets related to doubling populations.

Ignoring fall and late fall-run Chinook for comparative purposes, it is clear that the minimum the recovery goals for NMFS and the minimum recovery goals for the USFWS and the CDFG are not even remotely the same (Table 7).

Clearly, the restoration goals must be reconciled among the agencies or management conflicts will become substantial problems. It is also important to remember that NMFS's goal is to down-list or de-list populations; a goal that is different and achievable at Chinook salmon population levels less than an arbitrary doubling goal. For steelhead, the arbitrary doubling goal does not even achieve long-term viability of the stock if the NMFS assessment is to be relied upon.

Table 7 Recovery Goals for ESA Listed Species Among Agencies.		
Stock	**Total *Minimum* Population Size Goals By Agency**	
	NMFS	**USFWS/CDFG**
Fall + Late Fall Run Chinook	NA	818,000
Winter-run Chinook	7,500	110,000
Spring-run Chinook	22,500	68,000
Central Valley Steelhead	22,500	13,000
Total	**52,500**	**1,009,000**

(9) *There is no consistent timeline for implementing or completing conservation actions.*

The original timeframe for doubling the baseline Chinook salmon and steelhead stocks under the CVPIA (passed in 1992) was the year 2002. Obvious, that timeline is now irrelevant. The original timeline for CDFG to double salmonid stocks was the year 2000. That timeline is also moot. The current CDFG plan only extends to the year 2030 and there is no goal of doubling stocks by that year, so the timeline appears open-ended. The NMFS plan does address the duration of each proposed action (see Table 8-2 in NMFS plan). The NMFS plan states that recovery of listed stocks could take 50 to 100 years, and some stocks could require human intervention indefinitely. Selected actions are recognized to run 5, 10, 20, or more years. For planning purposes it would be desirable for the agencies to collaborate on a more refined timeline for the next 20 years, recognizing the uncertainties of budgets, staffing, and recovery success will remain hard to anticipate.

(10) *Long-term funding sources need to be secured.*

The CDFG plan briefly discussed the funding of ERP actions but it does not address long-term funding needs. Similarly, the NMFS plan, while recognizing the need for billions of dollars in funding over time, does not discuss strategies for securing such funding. The USFWS plan does not address this problem. For example, section 3406(b) of the CVPIA identified 34 "restoration" activities that the USFWS and U.S. Bureau of Reclamation should undertake. By 2008, 16 years later and over $1 billion in obligated funds, only 7 of 34 restoration activities had been completed.

It would appear prudent to make a concerted inter-agency effort to explore opportunities for long-term, dedicated recovery funding at the state and federal level. Recovery plans that are at the mercy of large-scale economic changes, annual budget vagaries and other factors are at risk of not achieving their long-term goals. Programs that are not implemented appropriately because of funding limitations are inefficient and prone to be ineffective as well. This issue should be addressed in the recovery planning process. It has not been adequately addressed to date.

(11) *There are no integrated performance measures to gauge success/failure of actions.*

Only the CDFG plan addressed the issue of performance measures (CDFG 2011 Table D-1); however, there are many gaps remaining in the document before a complete set of performance measures is determined. Specifically, many of the performance measures identified in the CDFG plan do not yet have performance targets or performance metrics. The work begun by the CDFG should be integrated among all three agencies to develop, as much as feasible, a uniform and agreed to set of standards, targets, and metrics that will measure the progress of the recovery efforts. More work needs to be invested in this area to demonstrate the success of restoration efforts: this is always crucial in seeking funding for continued restoration.

(12) *Limited discussion of inter-agency integration.*

Only the CDFG plan contained a discussion of the role of the ERP Implementing Agencies. The CDFG plan candidly recognized that the implementation of the ERP needed to be more focused to meet the expectations of stakeholders. While projects were identified, budget and staffing issues hampered implementation. The CDFG stated that during Stage 1 just over 25 percent of the funding actually went to restoration projects, the remainder going to other activities. This ratio in funding, if sustained, will certainly adversely impact the recovery efforts because they will be perceived by managers and funding sources as inefficient and ineffective. One approach to correcting this imbalance is to create a process that better integrates inter-agency activities by removing roadblocks to action implementation. Streamlining permitting through programmatic agreements and reducing redundancy in bureaucracy are possible areas for improvement. In any case, much of the foregoing problems discuss in this paper demonstrate that dramatically improved inter-agency communication, coordination, and integration are necessary to tackle the massive restoration requirements in the Central Valley.

CONCLUDING DISCUSSION

While much of the discussion in this paper focuses on problems and conflicts between recovery plans, it is important to recognize that the existing management scheme has not been without its successes. Those successes, however, are limited. Perhaps the biggest success has been that no species have been extirpated and the listing status for all the Central Valley stocks has remained unchanged. In the face of rapid population growth, constrained water supply, recreational and commercial harvest, habitat degradation, and water quality concerns, ensuring that populations have not become more endangered is a worthwhile achievement. However, holding steady does not lead to recovery.

None of the three restoration plans reviewed adequately provide, even at the programmatic level, a clear and succinct strategy for recovering Central Valley anadromous salmonid stocks to viable and sustainable levels. The principal reason for this unfortunate outcome is that these plans were prepared by different agencies for different purposes largely independent of one another. No plan tells a complete and compelling story outlining anadromous salmonid restoration.

Recall that the CDFG's draft Conservation Strategy stated:

> "The Conservation Strategy serves as an update to the ERP Strategic Plan and follows the principle of a single-blueprint for ecosystem restoration and species recovery in accordance with the principals of ecosystem-based management. Having a single-blueprint is a key ingredient for a successful and effective

> restoration program. This single-blueprint is the vehicle for ensuring coordination between all resource management, conservation, and regulatory actions affecting the Bay-Delta ecosystem . . ."

If the Conservation Strategy is the "blueprint," then why is it so inconsistent with NMFS's draft Recovery Plan? The CDFG plan does not even adequately describe restoration measures implemented to date. Only the NMFS plan recognized the enormous restoration measures implemented to date at a cost of over $1 billion. Even after these efforts over a long period of time, a significant upward, sustained trend in fish population numbers has not materialized. It would seem appropriate to begin a restoration strategy by recognizing this failure and asking the question as to why there has not been sufficient progress in meeting the restoration objectives. Are we working on the wrong projects in the wrong places? Is it the management structure that consumes most of the available dollars before they can be directed to on-the-ground actions? Numerous questions should be asked and the answers to these critical questions should drive, in part, the restoration strategy.

Of the three plans, the NMFS plan is the most thoughtful from a science perspective. The NMFS plan attempts to lay out processes to recover listed anadromous salmonids by following a science-based approach that examines the reasons behind current problems limiting recovery, then proposing actions to address those problems. Even so, the draft of the NMFS plan received 652 comments. Many comments focused on coordination and compatibility, including the apparent lack of coordination between NMFS and other regulatory agencies during the development of the plan. The lack of *sufficient* coordination among the three resource agencies is a key factor that is apparent when examining all the inconsistencies among plans, including the general lack of agreement among agencies as to what actions should be implemented and by whom.

The CDFG draft Conservation Strategy is clearly not a "blueprint" for anadromous salmonid restoration. The NMFS "blueprint" does not include all the stocks of anadromous fish imperiled. The older USFWS restoration "blueprint" is out-of-date and should be updated or incorporated into a joint-agency plan.

Clearly, whatever the ERP Implementing Agencies are doing regarding anadromous salmonid restoration has not resulted in a positive trend towards recovery and is therefore inadequate. How this group communicates and coordinates its actions relative to salmonid restoration should be examined and adjusted. To develop a clear mission and a common set of restoration goals, identification of specific objectives, and actions is required. Instead of three inadequate restoration plans, there should be an attempt to prepare one inter-agency plan that recognizes the responsibilities of each agency, but nevertheless outlines a clear recovery strategy for all anadromous salmonid stocks in the Central Valley. Ideally, scientist from all three agencies should be under one organizational "anadromous salmonid restoration umbrella." A new "blueprint" should be developed using the draft Recovery Plan prepared by NMFS as the basis for the recovery strategies. This new "blueprint" should be a comprehensive restoration strategy that integrates the input of stakeholders at all levels of government and the private sector. Putting the best parts of the three existing plans into such a restoration strategy would be useful. Everyone responsible for management of anadromous fish in the Central Valley needs to be on the same page working from the same guiding document, and towards the common goal.

Finally, any new restoration strategy should be science-based, pragmatic, and candid about the opportunities for anadromous salmonid restoration. The plan should be routinely revised to reflect new information, accomplishments, and failures. If the recommended approach is not taken, it would appear that the resource agencies will continue to repeat the same debates into the future leaving the anadromous salmonid resource at risk.

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APPENDIX A

Hatchery Summary

SUMMARY OF CENTRAL VALLEY SALMON AND STEELHEAD HATCHERIES AND THE ROLE THEY PLAY IN THE MANAGEMENT OF CENTRAL VALLEY ANADROMOUS SALMONID STOCKS

The hatcheries operating in the Central Valley raise all runs of Chinook salmon and winter-run Central Valley steelhead (Table A-1). The need for creating hatcheries in the Central Valley is tied to mitigation for anadromous salmonid production lost when dams were constructed that blocked access to historical habitats (Table A-2). Some hatcheries also provide supplementation or enhancement of a population, typically fall-run Chinook salmon, in addition to mitigation for lost production (e.g., Feather River and Mokelumne River; JHRC 2001).

Table A-1
Central Valley Hatchery Production Targets.

Hatchery	Operating Agency[1]	Production Target (fish/year)[2]					
		Chinook Salmon				Central Valley Steelhead	Total Production
		Fall-run	Late Fall-run	Winter-run[3]	Spring-run[4]		
Coleman	USFWS	12,000,000	1,000,000	0	0	600,000	13,600,000
Livingston Stone	USFWS	0	0	250,000 max.	0	0	250,000 max.
Feather River	CDFG	8,000,000	0	0	5,000,000	450,000	13,450,000
Nimbus	CDFG	4,000,000	0	0	0	400,000	4,400,000
Mokelumne	CDFG	5,000,000	0	0	0	250,000	5,250,000
Merced	CDFG	1,000,000	0	0	0	0	1,000,000
Total	USFWS/ CDFG	30,000,000	1,000,000	250,000 max.	5,000,000	1,700,000	37,950,000

Notes:

1 USFWS = U.S. Fish and Wildlife Service.
CDFG = California Department of Fish and Game.

2 Production targets may or may not be met in any given year depending on escapement (run size).

3 Max. = maximum number of fish depending on escapement. This hatchery contribution to winter-run Chinook salmon is counted as part of the evolutionarily significant unit (ESU).

4 This hatchery contribution to spring-run Chinook salmon is counted as part of the ESU.

Winter-run Chinook salmon raised at Livingston Stone National Fish Hatchery (NFH) and spring-run Chinook salmon raised at the Feather River Hatchery are included in the winter-run and spring-run listed ESUs. At these two hatcheries compliance with the ESA is required. Compliance is either achieved through a Section 7 consultation or by approval by NMFS of a hatchery and genetics management plan (HGMP). Either of these two routes will provide the hatchery with an exemption from ESA Section 9 incidental take prohibitions or a biological opinion and incidental take permit.

Table A-2
Hatcheries, Operating Agencies, Purpose and ESA-listed Species Reared at Each Facility in the Central Valley

Hatchery	Operating Agency[1]	Funding Agencies[2]	Purpose[3]	ESA-Listed Species Raised	ESA Compliance Method[4]
Coleman	USFWS	BOR	Mitigation	None	BO (1999) BA (2011)
Livingston Stone	USFWS	BOR	Mitigation	Winter-run Chinook	BO (1999) BA (2011)
Feather River	CDFG	DWR, Salmon Stamp	Mitigation, Enhancement	Spring-run Chinook	Draft HMGP (2009)
Nimbus	CDFG	BOR	Mitigation	Central Valley Steelhead	OCAP BO (2008) Draft HGMP (2007)
Mokelumne	CDFG	EBMUD, Salmon Stamp	Mitigation, Enhancement	Central Valley Steelhead	N/A
Merced	CDFG	Merced ID, DWR	Mitigation	None	N/A

Notes:

1 USFWS = U.S. Fish and Wildlife Service.
CDFG = California Department of Fish and Game.

2 BOR = Bureau of Reclamation, EBMUD = East Bay Municipal Utilities District, Merced ID = Merced Irrigation District, DWR = California Department of Water Resources.

3 From Table 2 in JHRC 2001.

4 BO = Biological Opinion, BA=Biological Assessment, HGMP=Hatchery and Genetics Management Plan, N/A= Not Applicable, Number in parenthesis ( ) is the year of the BO, BA, or HGMP.

The USFWS operates two facilities in the Central Valley that it considers part of the Coleman NFH Complex: Coleman NFH and Livingston Stone NFH (USFWS 2011). Funding for these two facilities is provided by the U.S. Bureau of Reclamation (BOR). Because their operations are linked they are combined in this discussion.

COLEMAN NFH COMPLEX

Coleman NFH was established in 1942 to mitigate for habitat lost by the construction of Shasta and Keswick dams. It was authorized by the Emergency Relief Appropriation Act of 1935 (49 Stat. 115) and the First Deficiency Appropriation Act Fiscal Year 1936 (49 Stat. 1622). Because the water supply at Coleman NFH was too warm to successfully raise the federally-endangered winter-run Chinook salmon, Livingston Stone NFH was built to fulfill this need and is included in the draft Recovery Plan for winter run Chinook salmon (NMFS 2009).

The production goals for the two facilities are:

- 12 million fall-run Chinook salmon (Coleman NFH);
- 1 million late fall-run Chinook salmon (Coleman NFH);
- 250,000 winter-run Chinook salmon (Livingston Stone NFH); and
- 600,000 Central Valley steelhead (Coleman NFH).

There are multiple purposes for these facilities that are linked to the runs of fish raised. The main purpose for rearing fall and late fall-run Chinook salmon is to mitigate for impacted harvest opportunities when of 187 miles salmonid habitat was lost upstream of Shasta Dam.

The USFWS operated these two hatcheries under a biological opinion (BO) that was to expire in December 1999. The USFWS re-initiated consultation with NMFS and updated the biological assessment (BA) which lead to extensions of the BO (USFWS 2011). In July 2011, the USFWS submitted a BA evaluating the effects of facility operations on listed Central Valley salmonids and other threatened and endangered species (USFWS 2011). This assessment was prepared in the format of an HGMP and when approved by NMFS should guide hatchery operations and provide ESA clearance under the 4(d) rules for incidental take of listed species.

According to the BA, fall and late fall-run Chinook salmon are managed to mitigate for lost harvest, both in-river recreational harvest and ocean commercial and sport fisheries (USFWS 2011). Winter-run Chinook salmon are managed as part of the integrated recovery program and returning adults are expected to spawn under natural conditions (USFWS 2011). The steelhead raised by Coleman NFH are not part of the DPS, but are managed in part as mitigation for the Central Valley Project and to support harvest in the Sacramento River and recovery in Battle Creek (USFWS 2011).

FEATHER RIVER HATCHERY

The Feather River Hatchery was built in the 1967 to mitigate for habitat lost by the construction of Oroville Dam (ICF Jones & Stokes 2010). The hatchery's mission was not only mitigation but enhancement of salmon runs (ICF Jones & Stokes 2010; JHRC 2001). This hatchery spawns and rears fall-run Chinook, spring-run Chinook, Central Valley steelhead, and coho. The steelhead produced in this hatchery are not included as part of the Central Valley DPS population (NMFS 1998; 63 FR 13347). The coho are stocked into Lake Oroville as part of the inland coldwater salmon program (ICF Jones & Stokes 2010). This is the only facility that raises spring-run Chinook salmon. Spring-run produced in this hatchery are included as part of the Central Valley spring-run ESU.

The Thermalito Annex is considered part of the Feather River Hatchery (ICF Jones & Stokes 2010). This facility receives Chinook salmon fry from Feather River Hatchery, rears them for a period of time before they are released (ICF Jones & Stokes 2010).

Currently, the California Department of Water Resources (DWR) has a ESA Section 4(d) permit that allows them to operate the fish ladder in such a way that spring-run Chinook salmon can be accurately separated from fall-run Chinook (Cavallo et al. 2009). A draft HGMP has been prepared for the hatchery that if approved by NMFS would allow continued operation of the facility under the newer Section 4(d) regulations (Cavallo et al. 2009). The draft HGMP was scheduled to be submitted to NMFS by mid-January 2012. The hatchery currently operates with the goal of producing 2 million spring-run Chinook smolts (at about 60 fish per pound) annually (Cavallo et al. 2009).

This facility was built with funds from the DWR and the Delta Pumps Fish Protection Agreement and also receives funding from the state Salmon Stamp Program (JHRC 2001). The Salmon Stamp funds support the production of fall-run Chinook salmon intended for recreational and commercial harvest (ICF Jones & Stokes 2010).

NIMBUS HATCHERY

Nimbus Hatchery is located on the American River just downstream of Nimbus Dam. It was constructed at the same time that Folsom Dam was completed in 1955 (Leitritz 1969).

The Nimbus Hatchery was constructed to mitigate for the loss of about 85 percent (Lietritz 1969) of the salmonid habitat above Folsom Lake that was blocked by construction of Folsom and Nimbus dams (Lee and Chilton 2007).

The Nimbus Hatchery raises both fall-run Chinook salmon and Central Valley winter steelhead (Lee and Chilton 2007). The steelhead reared here are not considered part of the Central Valley DPS. The current management goal as identified in the draft HGMP is to annually release 430,000 steelhead at about four fish per pound (Lee and Chilton 2007). There is no goal for returning adults.

Both Folsom and Nimbus dams are federal facilities owned and managed by the BOR. The BOR provides funding to CDFG to operate the Nimbus Hatchery.

MOKELUMNE RIVER FISH HATCHERY

The Mokelumne River Fish Hatchery was built by East Bay Municipal Utilities District (EBMUD) in 1964 and was substantially reconstructed in 2001 (ICF Jones & Stokes 2009). This hatchery was built to offset for the loss of salmon and steelhead spawning and rearing habitat upstream of Camanche Dam. According to the JHRC (2001) the hatchery has both mitigation and enhancement roles. This facility raises fall-run Chinook salmon and Central Valley steelhead. These steelhead are not considered part of the Central Valley steelhead DPS.

According to the 2010 Final Hatchery and Stocking Program EIR/EIS, CDFG has started the HGMP process for all affected hatchery programs (ICF Jones & Stokes 2010, Appendix K). As of January 2012 internal draft HGMPs for Central Valley steelhead and fall-run Chinook salmon programs at the Mokelumne River Fish Hatchery have been prepared; however, they were not yet ready for public distribution.

The hatchery is operated by CDFG with funding provided by the EBMUD for the mitigation portion of the mission and from the state Salmon Stamp Program for the enhancement part of the mission (ICF Jones & Stokes 2010).

MERCED HATCHERY

The Merced River Hatchery went into operation in 1970 to mitigate for habitat lost to salmonids from the construction of Crocker-Huffman, McSwain, and New Exchequer dams. The hatchery is downstream of Crocker-Huffman Dam.

The hatchery is funded in part by Merced Irrigation District (the owner of the upstream dams) and also by an agreement between DWR and CDFG to mitigate for salmon losses at the south Delta water diversion in accordance with the Delta Fish (Four Pumps) Agreement (*aka* Delta Pumping Plant Fish Protection Agreement; JHRC 2001).

The facility currently raises fall-run Chinook salmon with an annual production goal of 1 million fish. Because no federally-listed fish are raised at this facility and there are no Central Valley steelhead present (Vogel 2007), there are no ESA compliance documents needed for its operation and an HGMP has not yet been prepared. An HGMP process was initiated in January 2012.

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APPENDIX B

Comparison of Actions throughout the Central Valley

Appendix B

Comparison of actions identified by federal and state agencies to recover listed Central Valley salmonids throughout the Central Valley.

NMFS (2009)				CDFG (2011)				USFWS			
Species Benefited	**Threat Category**	**Priority 1 Recovery Actions**	**Involved Parties**	**Species Benefited**	**Ecosystem Processes**	**Stage 2 Actions**	**Involved Parties**	**Species Benefited**	**Geographic Location**	**Restoration Actions/Evaluations**	**Involved Parties**
Winter-run Spring-run Steelhead	Harvest, hatchery effects, habitat loss and degradation, and water management	1.2.1 Promote Central Valley resource managers to cooperatively develop and implement an ecosystem based management approach that integrates harvest, hatchery, habitat, and water management, in consideration of ocean conditions and climate change.	CDFG, DWR, NMFS, PFMC, Reclamation, SWRCB, USFWS								
Winter-run Spring-run Steelhead	Habitat loss and degradation	1.2.2 Support programs to provide educational outreach and local involvement in restoration, including programs like Salmonids in the Classroom, Aquatic Wild, Adopt a Watershed, school district environmental camps, and other programs teaching the effects of human land use on anadromous fish survival.	CDFG, DWR, NMFS, PFMC, Reclamation, SWRCB, USFWS					Salmonids Anadromous fish	Central Valley-wide Central Valley-wide	Action 1. Support programs to provide educational outreach and local involvement in restoration, including programs like Salmonids in the Classroom, Aquatic Wild, and Adopt a Watershed and school district environmental camps. Action 2. Develop programs to educate the public about anadromous fish issues, such as the effects of poaching and environmental contaminants, especially contaminants in urban runoff.	Local schools, CDFG, USFWS, NMFS CDFG, USFWS, NMFS, Water Education Foundation, California Teachers Association
Winter-run Spring-run Steelhead	Habitat degradation	1.2.3 Develop a monitoring program to determine the level of entrainment at individual diversions. Prioritize diversions based on this monitoring and screen those that are determined to have the greatest impacts on juvenile survival.	CDFG, DWR, NMFS, USFWS								
Winter-run Spring-run Steelhead	Habitat loss and degradation	1.2.4 Provide additional funding for increased law enforcement to reduce illegal take of anadromous fish, stream alteration, and water pollution and to ensure adequate protection for juvenile fish at pumps and diversions.	CDFG, NMFS					Anadromous fish	Central Valley-wide	Provide additional funding for increased law enforcement to reduce illegal take of anadromous fish, stream alteration, and water pollution and to ensure adequate protection for juvenile fish at pumps and diversions.	CDFG, USFWS, USBR, DWR
Winter-run Spring-run Steelhead	Habitat loss and degradation	1.2.5 Control or relocate the discharge of irrigation return flows and sewage effluent, and restore riparian forests to help provide suitable water temperatures for anadromous salmonids.	ACOE, City and County planners, NMFS, SWRCB, USFWS	Food web Aquatic habitat	Decline in productivity and the aquatic food web Upland areas	Action 3. Determine potential impacts of ammonium and other contaminants of primary productivity. Listed in the Delta narrative. Action 4. Determine contaminant and runoff impacts of agriculture and urban areas, and develop predictions of effects on the ecosystem from future expansion of these land uses. Listed in the Delta narrative.	SWRCB, regional water quality control boards Not stated.	Not stated.	Central Valley-wide	Action 3. Reduce toxic chemical and trace element contamination.	CDFG, USFWS, SWRCB, RWQCBs

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Winter-run Spring-run Steelhead	Habitat loss and degradation	1.2.6 Implement and evaluate actions to minimize and/or eliminate the effects of exotic (non-native invasive) species (plants and animals) on production of anadromous fish.	Department of Boating and Waterways	Food web	Decline in productivity and the aquatic food web	Action 1. Determine how to alleviate the negative impacts of non-native species and contaminant toxicity on the pelagic food web. Listed in the Delta narrative.	Not stated.	Anadromous fish	Central Valley-wide	Evaluation 10. Evaluate the effects of exotic species on production of anadromous fish	IEP agencies
				Ecosystem	Non-native invasive species	Action 1. Continue implementing CDFG's California Aquatic Invasive Species Management Plan to prevent new introductions; limit or eliminate NIS populations; and reduce economic, social, and public health impacts of NIS infestation. Listed in the Delta narrative.	CDFG				
				Ecosystem	Non-native invasive species	Action 3.Continue research and monitoring programs to increase understanding of the invasion process and the role of established NIS in the Delta's ecosystem. Listed in the Delta narrative.	Not stated.				
				Ecosystem	Non-native invasive species	Action 5. Standardize methodology for sampling programs to measure changes in NIS populations over a specific timeframe. Listed in the Delta narrative.	Not stated.				
				Ecosystem	Non-native invasive species	Action 6. Collect and analyze water quality sampling data for correlation analysis between NIS distribution and habitats. Listed in the Delta narrative.	Not stated.				
				Ecosystem	Non-native species	Action 7 Complete an assessment of existing NIS introductions and identify those with the greatest potential for containment or eradication; this assessment also would be used to set priority control efforts. Listed in the Delta narrative.	Not stated.				

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Winter-run Spring-run Steelhead	Habitat loss and degradation	1.2.7 Restore tributaries by evaluating the feasibility of screening or relocating diversions, switching to alternative sources of water for upstream diversions, restoring and maintaining a protected riparian strip, limiting excessive erosion, enforcing dumping ordinance, removing toxic materials or controlling their source, replacing bridge and ford combinations with bridges or larger culverts and installing siphons to prevent truncation of small streams at irrigation canals, and implement actions to address harmful effects.	Caltrans, USFS, SWRCB					Not stated.	Central Valley-wide	Evaluation 11. Encourage the restoration of small tributaries by evaluating the feasibility of screening or relocating diversions, switching to alternative sources of water for upstream diversions, restoring and maintaining a protected riparian strip, limiting excessive erosion, enforcing dumping ordinance, removing toxic materials or controlling their source, replacing bridge and ford combinations with bridges or larger culverts and installing siphons to prevent truncation of small streams at irrigation canals.	CDFG, USFWS, USBR
Winter-run Spring-run Steelhead	Habitat loss	1.2.8 Conduct Central Valley-wide assessment of keystone dams and passage opportunities and implement programs to restore access to properly functioning habitat that was historically available.	CDFG, DWR, NMFS, Reclamation, USFWS, USFS								
Winter-run Spring-run Steelhead	Habitat loss	1.2.9 Evaluate passage at small dams or other anthropogenic obstructions and implement fish passage per NMFS criteria.	CDFG, DWR, NMFS, Reclamation, USFWS, USFS								
Winter-run Spring-run Steelhead	Water management	1.2.10 Increase integration of the State and Federal water projects through shared storage and conveyance agreements.	DWR, Reclamation								
Winter-run Spring-run Steelhead	Water management	1.2.11 Secure agreements with or purchase water rights from landowners and Federal and State agencies to provide additional instream flows.	DWR, Reclamation, county water agencies								
Winter-run Spring-run Steelhead	Hatchery effects	1.2.12 Form a hatchery science review panel to review Central Valley hatchery practices. The panel should address the issues contained within the following six hatchery-related actions.	CDFG, DWR, NMFS, Reclamation, USFWS								
Winter-run Spring-run Steelhead	Hatchery effects	1.2.13 Evaluate impacts of out-planting and broodstock transfers among hatcheries on straying and population structure and evaluate alternative release strategies.	CDFG, DWR, NMFS, Reclamation, USFWS								

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Species Benefited	**Threat Category**	**Priority 1 Recovery Actions**	**Involved Parties**	**Species Benefited**	**Ecosystem Processes**	**Stage 2 Actions**	**Involved Parties**	**Species Benefited**	**Geographic Location**	**Restoration Actions/Evaluations**	**Involved Parties**
Winter-run Spring-run Steelhead	Hatchery effects	1.2.14 Evaluate whether production levels are appropriate and if they could be adjusted according to expected ocean conditions.	CDFG, DWR, NMFS, Reclamation, USFWS								
Winter-run Spring-run Steelhead	Hatchery effects	1.2.15 Evaluate the potential to modify hatchery procedures to benefit native stocks of salmonids and implement beneficial modifications.	CDFG, DWR, NMFS, Reclamation, USFWS					Salmonids	Central Valley-wide	Evaluation 2. Evaluate the potential to modify hatchery procedures to benefit native stocks of salmonids.	CDFG, DWR, USFWS, USBR
Winter-run Spring-run Steelhead	Hatchery effects	1.2.16 Evaluate and avoid potential competitive displacement of naturally produced juvenile salmonids with hatchery-produced juveniles by implementing release strategies for hatchery-produced fish designed to minimize detrimental interactions.	CDFG, DWR, NMFS, Reclamation, USFWS					Juvenile salmonids	Central Valley-wide	Evaluation 3. Evaluate and avoid potential competitive displacement of naturally produced juvenile salmonids with hatchery produced juveniles by implementing release strategies for hatchery produced fish designed to minimize detrimental interactions.	CDFG, DWR, USFWS, USBR
Winter-run Spring-run Steelhead	Hatchery effects	1.2.17 Evaluate and implement specific hatchery spawning protocols and genetic evaluation programs to maintain genetic diversity in hatchery and natural stocks.	CDFG, DWR, NMFS, Reclamation, USFWS					Salmonids	Central Valley-wide	Evaluation 4. Evaluate and implement specific hatchery spawning protocols and genetic evaluation programs to maintain genetic diversity in hatchery and natural stocks.	CDFG, DWR, USFWS, USBR
Winter-run Spring-run Steelhead	Hatchery effects	1.2.18 Evaluate a program to tag and fin-clip all or a significant portion of hatchery-produced fish as a means of collecting better information regarding harvest rates on hatchery and naturally produced fish and effects of hatchery-produced fish on naturally produced fish.	CDFG, DWR, NMFS, Reclamation, USFWS					Salmonids	Central Valley-wide	Evaluation 7. Evaluate a program to tag and fin-clip all or a significant portion of hatchery-produced fish as a means of collecting better information regarding harvest rates on hatchery and naturally produced fish and effects of hatchery-produced fish on naturally produced fish.	CDFG, DWR, USFWS, USBR, NMFS, EBMUD
Steelhead	Lack of data	1.2.19 Implementation of a comprehensive life history monitoring plan for Central Valley steelhead that will result in basin-wide (Sacramento and San Joaquin) estimates of hatchery and wild steelhead population abundance, production diversity, and distribution.	CDFG, NMFS, USFWS					Chinook salmon	Central Valley-wide	Evaluation 1. Evaluate the need to revise harvest regulations to increase spawning escapement of naturally produced Chinook salmon.	CDFG, Pacific Fisheries Management Council, NMFS, USFWS
								Chinook salmon	Central Valley-wide	Evaluation 5. Evaluate the transfer of disease between hatchery and natural stocks.	CDFG, DWR, USFWS, USBR
								Anadromous fish	Central Valley-wide	Evaluation 8. Evaluate the direct and indirect effects of contaminates on production of anadromous fish.	CDFG, USFWS, RWQCBs, SWRCB
								Steelhead	Central Valley-wide	Evaluation 9. Evaluate the ability of streams for which target production	CDFG,

Appendix B Comparison of actions identified by federal and state agencies to recover listed Central Valley salmonids throughout the Central Valley.											
NMFS (2009)				CDFG (2011)				USFWS			
Species Benefited	Threat Category	Priority 1 Recovery Actions	Involved Parties	Species Benefited	Ecosystem Processes	Stage 2 Actions	Involved Parties	Species Benefited	Geographic Location	Restoration Actions/Evaluations	Involved Parties
										levels exists for Chinook salmon but not for steelhead to support natural production of steelhead.	USFWS

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APPENDIX C

Comparison of Actions for the Sacramento-San Joaquin Delta

Appendix C

Comparison of actions identified by federal and state agencies to recover listed Central Valley salmonids in the Sacramento-San Joaquin Delta.

NMFS (2009)				CDFG (2011)				USFWS			
Species Benefited	**Threat Category**	**Priority 1 Recovery Actions**	**Involved Parties**	**Species Benefited**	**Ecosystem Processes**	**Stage 2 Actions**	**Involved Parties**	**Species Benefited**	**Geographic Location**	**Restoration Actions/Evaluations**	**Involved Parties**
Winter-run Spring-run Steelhead	Water management	1.5.1 Develop alternative water operations and conveyance systems that ensure multiple and suitable salmonid rearing and migratory habitats for all Central Valley salmonids and that restore the ecological flow characteristics of the Delta ecosystem.	BDCP agencies and stakeholders								
Winter-run Spring-run Steelhead	Habitat loss and degradation	1.5.2 Large-Scale Habitat Restoration – Identify funding and direct restoration of 80,000 acres of tidal marsh, 130,000 acres of terrestrial grasslands, and 60,000 acres of floodplain habitat. Floodplain habitats should be restored to appropriate elevations using Frequently Activated Floodplain principles and modeling. The habitats should be along primary migration and rearing corridors, and connected in ecologically beneficial ways. This will require separating levee systems from active river and estuary channels, restoring dendritic channel systems in areas where this habitat feature existed historically, and allowing for natural developmental processes to maintain habitats.	ACOE, DWR, Reclamation	Native fish and wildlife Native fish and wildlife	Upland areas Upland areas	Action 1. Acquire land and easement interests for willing sellers in the East and South Delta that will accommodate seasonal floodplain areas, and shifts in tidal and shallow subtidal habitats due to future sea level rise. Action 5. Restore large-scale riparian vegetation along waterways wherever feasible, including opportunities for setback levees.	Not stated. Not stated.	Anadromous fish Anadromous fish	Delta Delta	Evaluation 4. Evaluate potential benefits of and opportunities for increasing salmonid and other anadromous fish production through improved riparian habitats in the Delta. Evaluation 6. Evaluate benefits of and opportunities for additional tidal shallow-water habitat as rearing habitat for anadromous fish in the Delta.	SWP and CVP contactors, The Nature Conservancy, IEP agencies SWP and CVP contactors, The Nature Conservancy, IEP agencies
Winter-run Spring-run Steelhead	Habitat loss and degradation	1.5.3 Integrate the Ecosystem Restoration Program and the Calfed Science Program into an effort to restore the Delta ecosystem. Note: "Calfed Science Program" is under the Delta Stewardship Council and is now called the Delta Science Program as of 3 Feb 2010.	USFWS, Calfed								
Winter-run Spring-run Steelhead	Predation	1.5.4 Implement programs and measures designed to control non-native predatory fish (e.g., striped bass, largemouth bass, and smallmouth bass), including harvest management techniques, non-native vegetation management, and minimizing structural barriers in the Delta, which attract non-native predators and/or that delay or inhibit migration.	CDFG, Sport fish community								

Appendix C

Comparison of actions identified by federal and state agencies to recover listed Central Valley salmonids in the Sacramento-San Joaquin Delta.

NMFS (2009)				CDFG (2011)				USFWS			
Species Benefited	**Threat Category**	**Priority 1 Recovery Actions**	**Involved Parties**	**Species Benefited**	**Ecosystem Processes**	**Stage 2 Actions**	**Involved Parties**	**Species Benefited**	**Geographic Location**	**Restoration Actions/Evaluations**	**Involved Parties**
Winter-run Spring-run Steelhead	Habitat loss and degradation	1.5.5 Enhance the Yolo Bypass by re-configuring Fremont and Sacramento weirs to (1) allow for fish passage through Fremont Weir for multiple species; (2) enhance lower Putah Creek floodplain habitat; (3) improve fish passage along the toe drain/Lisbon Weir; (4) enhance floodplain habitat along the toe drain; (5) eliminate stranding events; and (6) create annual spring inundation of at least 8,000 cfs to fully activate the Yolo bypass floodplain.	Reclamation, DWR	Native fish and wildlife	Floodplains	Action 1. Continue coordination with Yolo Basin Foundation and other local groups to identify, study, and implement projects on public and private land with willing participants, to create regionally significant improvements in habitat and fish passage.	Yolo Basin Foundation. Others not stated.				
				Native fish and wildlife	Floodplains	Action 3. Pursue opportunities for land and easement acquisitions in the Yolo Bypass and along the lower Cosumnes and San Joaquin rivers, which could be utilized as floodplain inundation areas in the near term or in the future.	Not stated.				
Winter-run Spring-run Steelhead	Water management	1.5.6 Implement Actions IV.1 through IV.6 of the Reasonable and Prudent Alternative described in the NMFS BO on the long-term operations of the CVP/SWP (NMFS 2009):	Reclamation, DWR								
		▸ Action IV.1 Modify DCC gate operations and evaluate methods to control access to Georgiana Slough and the Interior Delta to reduce diversion of listed fish from the Sacramento River into the southern or central Delta.		Aquatic species	Bay-Delta hydraulics	Action 1. Conduct further Delta Cross Channel Gate operational and fish survival studies.	Not stated.	Juvenile Chinook salmon		Operational Target 1. Close Delta Cross Channel (DDC) up to 45 days in the November through January period. Operational details omitted herein.	CALFED agencies
				Aquatic species	Bay-Delta hydraulics	Action 4. Study the effectiveness of nonphysical barriers in controlling fish movements at key channel intersections. No specific intersections noted.	Not stated.	Chinook salmon Anadromous fish	Delta	Operational Target 3. Maximize DCC closure from May 21 through June 15 when anadromous species are abundant in the lower Sacramento River.	CALFED agencies, U.S. Coast Guard, boating interests
								Juvenile Chinook salmon	Delta	Supplemental Action Requiring Water 11. Close the DCC during the November through January period beyond the 45-day limit defined under Operational Target 1 should meeting one of the triggers stipulated in Operational Target 1 require additional closure.	CALFED agencies
								Anadromous salmonids	Delta	Evaluation 5. Evaluate opportunities to provide modified operations and a new or improved control structure for the DCC and Georgiana Slough or other methods at those locations to assist in the successful migration of anadromous salmonids.	SWP and CVP contractors IEP agencies

Appendix C
Comparison of actions identified by federal and state agencies to recover listed Central Valley salmonids in the Sacramento-San Joaquin Delta.

NMFS (2009)				CDFG (2011)				USFWS			
Species Benefited	**Threat Category**	**Priority 1 Recovery Actions**	**Involved Parties**	**Species Benefited**	**Ecosystem Processes**	**Stage 2 Actions**	**Involved Parties**	**Species Benefited**	**Geographic Location**	**Restoration Actions/Evaluations**	**Involved Parties**
		▸ **Action IV.2** Control the net negative flows toward the export pumps in Old and Middle rivers to reduce the likelihood that fish will be diverted from the San Joaquin or Sacramento rivers into the southern or central Delta.						Chinook salmon	Delta	Supplemental Action Not Requiring Water 16. Construct and operate a barrier at the head of Old River to improve conditions for Chinook salmon migration and survival if Evaluation 1 determines that a barrier can be operated to improve conditions for salmon with minimal adverse effects on other Delta species. Evaluation 1. In conjunction with Evaluation 2, evaluate whether a temporary rock barrier at the head of Old River can be operating during the 30-day April through May pulse flow period to improve conditions for Chinook salmon migration and survival with minimal adverse effects on other Delta species.	CALFED agencies
								Anadromous fish	Delta	Evaluation 9. Continue to evaluate the effects of Delta hydraulic conditions such as net reverse flows on anadromous fish.	SWP and CVP contractors IEP agencies
		▸ **Action IV.3** Curtail exports when protected fish are observed near the export facilities to reduce mortality from entrainment and salvage.						Juvenile Chinook salmon	Delta	Operational Target 2 and Supplemental Action Requiring Water 14. When the DCC is closed, limit the average SWP and CVP exports to no greater than 35% of Delta inflow if Evaluation 3 determines that a relatively high ratio of Delta export to inflow limits juvenile salmon survival through the Delta.	CALFED agencies
								Winter-run	Delta	Operational Target 4. Maintain an average export to inflow ratio of no more than 45% during February in dry years by increasing the ratio to ~55% in early February and decreasing the ratio to ~35% in late February when winter-run Chinook salmon smolts are present in the Delta.	CALFED agencies

Appendix C Comparison of actions identified by federal and state agencies to recover listed Central Valley salmonids in the Sacramento-San Joaquin Delta.											
NMFS (2009)				CDFG (2011)				USFWS			
Species Benefited	Threat Category	Priority 1 Recovery Actions	Involved Parties	Species Benefited	Ecosystem Processes	Stage 2 Actions	Involved Parties	Species Benefited	Geographic Location	Restoration Actions/Evaluations	Involved Parties
								Delta smelt	Delta	Supplemental Action Requiring Water 6. In conjunction with operation of a barrier at the head of Old River and consistent with efforts to conduct Evaluations 1 and 2, Maximize the difference between flows and export rates at levels greater than those required under the delta smelt BO during the 30-day April and May pulse flow period.	CALFED agencies
								Not stated.	Delta	Supplemental Action Requiring Water 7. When a barrier at the head of Old River is not operational, limit the combined SWP and CVP exports to 1,500 cfs or maintain a Vernalis inflow to total export ratio of 5 to 1 during the 30-day April through May pulse flow period.	
								Anadromous fish	Delta	Operational Target 5. Minimize fish losses and predation at facilities by operating state and federal pumps interchangeable when this operation achieves a net benefit to anadromous fish production in the Delta.	CALFED Agencies
								Not stated.	Delta	Supplemental Action Requiring Water 12. Limit the average SWP and CVP exports to no greater than 35% of Delta inflow in July.	CALFED agencies
								Chinook salmon	Delta	Evaluation 2. Evaluate in conjunction with Evaluation 1 the impacts of San Joaquin River Delta inflow and SWP and CVP export rates on salmon smolt survival through the San Joaquin Delta.	IEP agencies
								Late fall-run	Delta	Evaluation 3. Evaluate the effect of a low (~35%) versus a high (~65%) SWP and CVP export to Delta inflow ratio on the survival of coded-wire-tagged, late fall-run Chinook salmon smolts migrating through the Delta when the DCC is closed.	IEP agencies
								Juvenile salmon	Delta	Evaluation 11. Evaluate whether Delta inflow and export rates and other Delta hydrodynamic parameters effect juvenile salmon survival when the DCC is closed.	SWP and CVP contractors IEP agencies

Appendix C
Comparison of actions identified by federal and state agencies to recover listed Central Valley salmonids in the Sacramento-San Joaquin Delta.

NMFS (2009)				CDFG (2011)				USFWS			
Species Benefited	**Threat Category**	**Priority 1 Recovery Actions**	**Involved Parties**	**Species Benefited**	**Ecosystem Processes**	**Stage 2 Actions**	**Involved Parties**	**Species Benefited**	**Geographic Location**	**Restoration Actions/Evaluations**	**Involved Parties**
								Juvenile anadromous fish	Delta	Supplemental Action Not Requiring Water 15. Implement actions to reduce losses of juvenile anadromous fish resulting from unscreened or inadequately screened diversions in the Delta and Suisun Marsh, even of Evaluation 12 determines significant benefits to juvenile anadromous fish can be achieved by screening.	Diverters, CDFG, DWR, USBR, USFWS, NMFS, SWRCB, ACOE
		► **Action IV.4** Improve fish screening and salvage operations to reduce mortality from entrainment and salvage. ► **Action IV.5** Establish a technical group to assist in determining real-time operational measures, evaluating the effectiveness of the actions, and modifying them if necessary. ► **Action IV.6** Do not implement the South Delta Barriers Improvement Program.						Juvenile anadromous fish	Delta	Evaluation 12. Evaluate the benefits to juvenile anadromous fish of and opportunities for screening diversions and relocating riparian diversions in the Delta and Suisun Marsh.	SWP and CVP contractors IEP agencies
Winter-run Spring-run Steelhead	Water management	1.5.7 Develop a comprehensive governance system that has reliable funding, takes advantage of established and effective ecosystem restoration and science programs, and has clear authority to determine priorities and strong performance measures to ensure accountability to the new governing doctrine of the Delta; operation of coequal goads of Delta ecosystem restoration and protection and reliable water supply.	CDFG, DWR, NMFS, Reclamation, SWRCB, USFWS, water contractors								
Winter-run Spring-run Steelhead	Water management	1.5.8 Following the first autumn flows exceeding 15,000 cfs at Wilkins Slough, maintain suitable rearing and migratory habitats for emigrating winter-run salmon throughout the Sacramento River and distributaries in the Delta through the end of April.	CDFG, DWR, NMFS, Reclamation, SWRCB, USFWS, water contractors					Anadromous fish Striped bass	Delta	Supplemental Action Requiring Water 9. During May, maintain at least 13,000 cfs daily flow in the Sacramento River at the I Street Bridge and 9,000 cfs at Knights Landing to improve transport of eggs and larval striped bass and other young anadromous fish.	CALFED agencies

Appendix C

Comparison of actions identified by federal and state agencies to recover listed Central Valley salmonids in the Sacramento-San Joaquin Delta.

NMFS (2009)				CDFG (2011)				USFWS			
Species Benefited	**Threat Category**	**Priority 1 Recovery Actions**	**Involved Parties**	**Species Benefited**	**Ecosystem Processes**	**Stage 2 Actions**	**Involved Parties**	**Species Benefited**	**Geographic Location**	**Restoration Actions/Evaluations**	**Involved Parties**
Winter-run Spring-run Steelhead	Water management	1.5.9 Provide pulse flows of at least 20,000 cfs measured at Freeport periodically during the winter-run emigration season to facilitate outmigration past Chipps Island (i.e., December-April).	CDFG, DWR, NMFS, Reclamation, SWRCB, USFWS, water contractors					Anadromous fish	Delta	Evaluation 8. Evaluate the benefits of short-term pulsed Delta inflows (Five days or less) on the migration rate and survival of anadromous fish.	SWP and CVP contactors, IEP agencies
				Native fishes	Water diversions	Action 1. Continue participation in the Sacramento Valley-Delta Fish Screen Program to reduce entrainment mortality of juvenile fish by installing state-of-the-art fish screens on Sacramento River and Delta diversions as determined to be appropriate based on new information. No specific sites noted.					
				Aquatic biota	Contaminants	Action 3. Improve coordination with the regional water quality control boards and other entities on evaluating ecological effects from pesticides, methods to reduce pesticide and nutrient impacts, and methods to reduce toxicity.	Not stated.				
				Aquatic biota	Contaminants	Action 5. Work with the regional water quality control boards and other entities to participate in an integrated monitoring program that evaluates water and sediment pollution and toxicity, and tissue contamination, and ecological impacts to key species.	Regional WQCBs				
								Not stated.	Delta	Supplemental Action Requiring Water 10. During the last half of May, ramp (linearly) the total SWP and CVP export level from what it is at the end of the 30-day April and May pulse flow period to that export level proposed by the SWP and CVP to meet the requirements of the 1995 WQCP on June 1.	CALFED agencies
								Migrating fish	Delta	Evaluation 7. Evaluate the benefit of and opportunities for new technologies to improve water quality and to guide migrating fish.	SWP and CVP contactors, IEP agencies
								Anadromous fish	Delta	Evaluation 10. Evaluate the potential effects of reductions in food chain organisms in the Delta and Suisun Bay on anadromous fish production.	SWP and CVP contractors IEP agencies

Appendix C Comparison of actions identified by federal and state agencies to recover listed Central Valley salmonids in the Sacramento-San Joaquin Delta.											
NMFS (2009)				**CDFG (2011)**				**USFWS**			
Species Benefited	**Threat Category**	**Priority 1 Recovery Actions**	**Involved Parties**	**Species Benefited**	**Ecosystem Processes**	**Stage 2 Actions**	**Involved Parties**	**Species Benefited**	**Geographic Location**	**Restoration Actions/Evaluations**	**Involved Parties**
								Fall-run San Joaquin Chinook	Delta	Evaluation 13. Evaluate the potential effects of Delta export rate during the fall on the upstream migration of adult San Joaquin Chinook salmon.	SWP and CVP contractors IEP agencies

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APPENDIX D

Comparison of Actions for the Sacramento River Watershed

Appendix D

Comparison of actions identified by federal and state agencies to recover listed Central Valley salmonids in the Sacramento River watershed (i.e., headwaters to Collinsville).

NMFS (2009)				CDFG (2011)				USFWS (2001)			
Species Benefited	**Threat Category**	**Priority 1 Recovery Actions**	**Involved Parties**	**Species Benefited**	**Ecosystem Processes**	**Stage 2 Actions**	**Involved Parties**	**Species Benefited**	**Geographic Location**	**Restoration Actions/Evaluations**	**Involved Parties**
Winter-run Spring-run Steelhead	Habitat degradation and loss	1.6.1 Restore and maintain a continuous meander belt along the Sacramento River from Keswick downstream to Colusa. ▸ Pursue these opportunities, consistent with efforts conducted pursuant to Senate Bill 1086 to create a meander belt from Keswick Dam to Colusa to recruit gravel and large woody debris, to moderate temperatures and to enhance nutrient input. Also pursue actions under the Sacramento River Flood Control Project and the Central Valley Plan for Flood Control.	ACOE, DWR, CDFG, TNC, USFWS					Anadromous fishes Salmonids	Upper mainstem Sacramento River Upper mainstem Sacramento River	Action 9. Pursue opportunities, consistent with efforts conducted pursuant to Senate Bill 1086, to create a meander belt from Keswick Dam to Colusa to recruit gravel and large woody debris, to moderate temperatures and to enhance nutrient input. Evaluation 4. Evaluate the contribution of large woody debris and boulders in the upper mainstem Sacramento River to salmonid production and rearing habitat quality.	Upper Sacramento River Fisheries and Riparian Habitat Advisory Council, CDFG, ACOE, USFWS, USBR, DWR, NMFS CDFG, USFWS, USBR, RWQCB, NMFS
Winter-run Spring-run Steelhead	Habitat degradation and loss	1.6.2 Restore and maintain a continuous 60-mile stretch of riparian habitat and functioning floodplains of an appropriate, science-based width to maintain ecologically viable flood-prone lands along both banks of the Sacramento River between Colusa and Verona. ▸ Separate levee systems from active river channels, restore dendritic channel systems in areas where this habitat feature existed historically, and allow for the natural development of floodplain habitats. Pursue actions under the Sacramento River Flood Control Project and the Central Valley Plan for Flood Control.	ACOE, DWR, SAFCA,CDFG, TNC, USFWS					Anadromous fishes Not stated.	Upper mainstem Sacramento River Upper mainstem Sacramento River	Evaluation 2. Evaluate opportunities to incorporate flows to restore riparian vegetation from Keswick Dam to Verona that are consistent with the overall river regulation plan. Evaluation 5. Identify opportunities for restoring riparian forests in channelized sections of the upper mainstem Sacramento River that are appropriate with flood control and other water management constraints.	USFWS, USBR, NMFS, CDFG, USRFHAC USRFHAC, The Nature Conservancy, CDFG, ACOE, USFWS, USBR, DWR, NMFS

Appendix D

Comparison of actions identified by federal and state agencies to recover listed Central Valley salmonids in the Sacramento River watershed (i.e., headwaters to Collinsville).

NMFS (2009)				CDFG (2011)				USFWS (2001)			
Species Benefited	**Threat Category**	**Priority 1 Recovery Actions**	**Involved Parties**	**Species Benefited**	**Ecosystem Processes**	**Stage 2 Actions**	**Involved Parties**	**Species Benefited**	**Geographic Location**	**Restoration Actions/Evaluations**	**Involved Parties**
Winter-run Spring-run Steelhead	Habitat degradation and loss	1.6.3 Restore and maintain a continuous 70-mile stretch of riparian habitat and maintain existing floodplain terraces along both banks of the Sacramento River between Verona and Collinsville. Restore floodplain areas as necessary to achieve the restoration targets described in action 1.5.2. ▸ Seek opportunities through the ACOE's Sacramento River Bank Protection Project, the Central Valley Plan for Flood Control, and other flood management programs and agencies such as SAFCA, to protect existing riparian habitat, restore riparian, protect remaining floodplain terraces, and integrate floodplain bench designs into levee repair projects.	ACOE, DWR, CDFG, CDPR, USFWS, local agencies, NGOs								
				Variety of species.	Riparian and riverine aquatic habitat	Action 1.Acquire title or easements for river corridor meander zones on appropriate rivers and streams throughout the Sacramento Valley. No specific streams noted.	Not stated.				
				Not stated.	Natural floodplains and flood processes	Action 1. Restore 50-100 miles of tidal channels in the Yolo Bypass by constructing a network of channels within the bypass that connect to the Delta. Channels should be effectively drain all flooded lands in the bypass after flood flows cease entering the bypass from Fremont and Sacramento weirs.	Not stated.				
Winter-run Spring-run Steelhead	Habitat degradation and loss	1.6.4 Relocate the M&T Ranch fish screen (Sacramento River at confluence with Big Chico Creek) and water diversion from its current location to a downstream, geomorphically stable, river reach and relocate the 3000,000 cubic yards of dredged gravel to upstream reaches of the Sacramento River for spawning habitat enhancement.	No parties listed.	Not stated.	Central Valley streamflows	Action 2. Continue implementation of short (e.g., gravel dredging) and long-term solutions to protect M&T Llano Seco infrastructure.	Not stated.	Not stated.	Big Chico Creek	Action 1. Relocate and screen the M&T Ranch Diversion on Big Chico Creek.	M&T Ranch owners, Western Canal Water District, USFWS, USBR, NMFS, CDFG, DWR

Appendix D
Comparison of actions identified by federal and state agencies to recover listed Central Valley salmonids in the Sacramento River watershed (i.e., headwaters to Collinsville).

NMFS (2009)				CDFG (2011)				USFWS (2001)			
Species Benefited	**Threat Category**	**Priority 1 Recovery Actions**	**Involved Parties**	**Species Benefited**	**Ecosystem Processes**	**Stage 2 Actions**	**Involved Parties**	**Species Benefited**	**Geographic Location**	**Restoration Actions/Evaluations**	**Involved Parties**
Winter-run Spring-run Steelhead	Habitat degradation and loss	1.6.5 Develop and implement an ecological flow tool for the Sacramento River below Keswick and Shasta Dams and use in conjunction with Frequently Activated Floodplain (FAF) tools and hydrodynamic river models to create and implement a floodplain inundation program that allows for existing functional floodplains to be activated in two out of three years for at least seven days between mid-March to mid-May.	No parties listed.								
Winter-run Spring-run Steelhead	Water management	1.6.6 Implement a Sacramento River flow management plan that balances carryover storage needs with instream flow <u>and water temperature</u> needs for winter-run, spring-run, and steelhead based on runoff and storage conditions, including flow fluctuation and ramping criteria	No parties listed.					Winter-run Other anadromous fishes	Upper mainstem Sacramento River	Action 1. Implement a river flow regulation plan that balances carryover storage needs with instream flow needs consistent with the 1993 BO for winter-run Chinook salmon based on runoff and storage conditions, including minimum recommended flows at Keswick and Red Bluff Diversion dams.	USFWS, USBR, NMFS, CDFG, (Tehama-Colusa Canal Authority (TCCA)
								Anadromous salmonids	Upper mainstem Sacramento River	Action 2. Implement a schedule for flow changes that avoids, to the extent controllable, dewatering redds and isolating or stranding juvenile anadromous salmonids, consistent with SWRCB Order 90-5.	USFWS, USBR, CDFG, SWRCB, NMFS
								Winter-run	Upper mainstem Sacramento River	Action 3. Continue to maintain water temperatures at or below 56°F from Keswick Dam to Bend Bridge to the extent controllable, consistent with the 1993 BO for winter-run Chinook salmon and with SWRCB Order 90-5.	USFWS, USBR, CDFG, SWRCB, NMFS
								Anadromous fishes	Upper mainstem Sacramento River	Evaluation 1. Continue study to refine a river regulation program, consistent with SB 1086, that balances fish habitats with the flow regime and addresses temperatures, flushing flows, attraction flows, emigration, channel and riparian corridor maintenance.	USFWS, USBR, CDFG, SWRCB, NMFS, USRFHAC

Appendix D
Comparison of actions identified by federal and state agencies to recover listed Central Valley salmonids in the Sacramento River watershed (i.e., headwaters to Collinsville).

NMFS (2009)				CDFG (2011)				USFWS (2001)			
Species Benefited	**Threat Category**	**Priority 1 Recovery Actions**	**Involved Parties**	**Species Benefited**	**Ecosystem Processes**	**Stage 2 Actions**	**Involved Parties**	**Species Benefited**	**Geographic Location**	**Restoration Actions/Evaluations**	**Involved Parties**
Winter-run Spring-run Steelhead	Water management	1.6.7 Implement Action I.3.1 and I.3.2 (Long-term and interim operations of RBDD) of the RPA described in the NMFS BO on the long-term operations of the CVP/SWP (NMFS 2009) and install NMFS-approved, state-of-the-art fish screens on the Sacramento River at the Tehama-Colusa Canal Diversion point.	DWR, Reclamation, TCCA					Chinook salmon	Upper mainstem Sacramento River	Action 4. Continue to raise the gates of the Red Bluff Diversion Dam (RBDD) for a minimum duration form September 15 through at least May 14 to protect adult and juvenile Chinook salmon migrations, consistent with the 1993 BO for winter-run Chinook salmon and with SWRCB Order 90-5, and accommodate water delivery using appropriate pumping facilities.	USFWS, USBR, SWRCB, NMFS, CDFG, TCCA
								Anadromous fishes	Upper mainstem Sacramento River	Evaluation 3. Continue the evaluation to identify solutions to passage at RBDD, including measures to improve passage when the RBDD gates are in the raised position from September 15 through at least May 14.	USFWS, USBR, CDFG, TCCA, NMFS
								Chinook salmon Steelhead	Upper mainstem Sacramento River	Action 5. Construct an escape channel for trapped adult Chinook salmon and steelhead from the Keswick Dam stilling basin to the Sacramento River, as designed by NMFS and USBR.	USFWS, USBR, NMFS, CDFG
				Not stated.	Water diversions	Action 4. Design, permit, and construct priority fish screen projects on the Sacramento River. No specific projects noted.	Not stated.	Anadromous fishes	Upper mainstem Sacramento River	Action 6. Continue to implement the Anadromous Fish Screen Program.	Diverters, USFWS, USBR,, NMFS, CDFG, CDWR
								Juvenile salmon	Upper mainstem Sacramento River	Action 7. Implement structural and operational modifications to the GCID water diversion facility to minimize impingement and entrainment of juvenile salmon.	GCID, USFWS, USBR, CDFG, NMFS, SWR
								Anadromous fishes	Upper mainstem Sacramento River	Action 8. Remedy water quality problems from toxic discharges associated with Iron Mountain Mine and water quality problems associated with metal sludge in Keswick Reservoir, consistent with the Comprehensive Environmental Response, Compensation, and Liability Act and the Clean Water Act.	USEPA, SWRCB, USFWS, USBR, NMFS, CDFG

Appendix D

Comparison of actions identified by federal and state agencies to recover listed Central Valley salmonids in the Sacramento River watershed (i.e., headwaters to Collinsville).

NMFS (2009)				CDFG (2011)				USFWS (2001)			
Species Benefited	**Threat Category**	**Priority 1 Recovery Actions**	**Involved Parties**	**Species Benefited**	**Ecosystem Processes**	**Stage 2 Actions**	**Involved Parties**	**Species Benefited**	**Geographic Location**	**Restoration Actions/Evaluations**	**Involved Parties**
								Chinook salmon Steelhead	Upper mainstem Sacramento River	Action10. Implement operational modifications to Anderson-Cottonwood Irrigation District (ACID) diversion dam to eliminate passage and stranding problems for Chinook salmon and steelhead adults and early life stages; eliminate toxic discharges from the canal and implement structural modifications to improve the strength of the fish screens.	ACID, USFWS, USBR, CDFG, RWQCB, NMFS
Winter-run Spring-run Steelhead	Habitat degradation and loss	1.6.8 Develop and implement a long-term gravel augmentation plan to enhance Sacramento River spawning habitat downstream of Keswick and Shasta dams.	CDFG, NMFS, Reclamation, USFWS					Salmonids	Upper mainstem Sacramento River	Action 11. Develop and implement a program for restoring and replenishing spawning gravel, where appropriate, in the Sacramento River.	CDFG, USFWS, USBR, NMFS, DWR
Spring-run	Habitat degradation and loss	1.7.1.1 Operate the Clear Creek weir to separate spring-run and fall-run Chinook salmon.	USFWS								
Spring-run Steelhead	Habitat degradation and loss	1.7.1.2 Develop and implement a spawning gravel budget and implement a long-term augmentation plan in Clear Creek.	Reclamation, USFWS					Spring-run Fall-run Late Fall-run	Clear Creek	Action 5. Replenish gravel on Clear Creek and restore gravel recruitment blocked by Whiskeytown Dam.	CDFG, USFWS, USBR, BLM, WSRCD
Spring-run Steelhead	Habitat degradation and loss	1.7.1.3 Develop and implement optimal Clear Creek flow schedules to mimic the natural hydrograph (including spring pulse flows and winter spillway releases to restore a proper functioning system) and use instream flow study results to guide flow schedule development.	Reclamation, USFWS					Spring-run Fall-run Late Fall-run	Clear Creek	Action 1. Release to Clear Creek 200 cfs October 1 to June 1 from Whiskeytown Dam for spring-, fall-, and late fall-run Chinook salmon spawning, egg incubation, emigration, gravel restoration, spring flushing and channel maintenance; release 150 cfs, or less from July through September to maintain ≤60°F temperatures in stream sections utilized by spring-run Chinook salmon. Both release should be within the average total annual unimpaired flows to the Clear Creek watershed.	CDFG, USFWS, USBR, SWRCB
Spring-run Steelhead	Water temperature	1.7.1.4 Develop a real time water temperature model to track the coldwater pool in Whiskeytown Reservoir and budget releases to Clear Creek to meet daily water temperature of 60°F at the Igo gauge from June to September 15 and 56°F from September 15 to October 31.	Reclamation, USFWS								

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Comparison of actions identified by federal and state agencies to recover listed Central Valley salmonids in the Sacramento River watershed (i.e., headwaters to Collinsville).

NMFS (2009)				CDFG (2011)				USFWS (2001)			
Species Benefited	**Threat Category**	**Priority 1 Recovery Actions**	**Involved Parties**	**Species Benefited**	**Ecosystem Processes**	**Stage 2 Actions**	**Involved Parties**	**Species Benefited**	**Geographic Location**	**Restoration Actions/Evaluations**	**Involved Parties**
								Spring-run Steelhead	Clear Creek	Evaluation 1. Evaluate the feasibility of reestablishing habitat for spring-run Chinook salmon and steelhead in Clear Creek, including ensuring that water temperatures five miles downstream of Whiskeytown Dam do not exceed upper temperature limits for each of the life history stages present in the creek from June 1 to November 1, ≤60°F for holding of prespawning adults and for rearing of juveniles, and ≤56°F for egg incubation.	CDFG, USFWS, USBR
								Spring-run Fall-run Late Fall-run	Clear Creek	Action 3. Remove sediment from behind McCormick-Saeltzer Dam on Clear Creek and provide fish passage wither by removing the dam or improving fish passage facilities.	McCormick-Saeltzer Dam owners, CDFG, USFWS, USBR, NRCS, WSRCD
								Spring-run Fall-run Late Fall-run	Clear Creek	Action 2. Halt further habitat degradation on Clear Creek and restore channel conditions from the effects of past gravel mining.	CDFG, USFWS, USBR, BLM, Western Shasta Resource Conservation District (WSRCD), NPS, NRCS
								Spring-run Fall-run Late Fall-run	Clear Creek	Action 4. Develop an erosion control and stream corridor protection program or Clear Creek to prevent habitat degradation due to sedimentation and urbanization.	CDFG, USFWS, USBR, BLM, WSRCD, NRCS
								Spring-run Fall-run Late Fall-run	Clear Creek	Action 6. Preserve the productivity of habitat in the Clear Creek watershed through cooperative watershed management and development of a watershed management analysis and plan.	CDFG, USFWS, USBR, BLM
								Fall-run Steelhead	Cow Creek	Action 1 Supplement flows in Cow Creek with water acquired from willing sellers consistent with applicable guidelines or negotiate agreements to provide flows for suitable passage and spawning for fall-run Chinook salmon and adequate summer rearing habitat for juvenile steelhead.	Diverters, CDFG, USFWS, USBR, SWRCB

Appendix D
Comparison of actions identified by federal and state agencies to recover listed Central Valley salmonids in the Sacramento River watershed (i.e., headwaters to Collinsville).

NMFS (2009)				CDFG (2011)				USFWS (2001)			
Species Benefited	**Threat Category**	**Priority 1 Recovery Actions**	**Involved Parties**	**Species Benefited**	**Ecosystem Processes**	**Stage 2 Actions**	**Involved Parties**	**Species Benefited**	**Geographic Location**	**Restoration Actions/Evaluations**	**Involved Parties**
								Fall-run Steelhead	Cow Creek	Action 2. Screen all diversions ton Cow Creek to protect all life history stages of anadromous fish.	Diverters, USFWS, USBR, NMFS, CDFG, DWR
								Fall-run Steelhead	Cow Creek	Action 3. Improve passage on Cow Creek at agricultural diversion dams.	Diverters, CDFG, USFWS, USBR
								Fall-run Steelhead	Cow Creek	Action 4. Fence select riparian corridors within the Cow Creek watershed to exclude livestock.	NRCS, Landowners, CDFG, USFWS, USBR
								Fall-run Steelhead	Bear Creek	Action 1 Supplement flows in Bear Creek with water acquired from willing sellers consistent with applicable guidelines or negotiate agreements to provide flows for suitable passage and spawning of juvenile and adult Chinook salmon and steelhead during spring and early fall.	Diverters, CDFG, USFWS, USBR
								Fall-run Steelhead	Bear Creek	Action 2. Screen all diversions ton Bear Creek to protect all life history stages of anadromous fish.	Diverters, USFWS, USBR, NMFS, CDFG, DWR
Winter-run Spring-run Steelhead	Habitat loss	1.8.1.1 Develop and implement a salmon reintroduction plan to re-colonize historic habitats above Keswick and Shasta dams into the Little Sacramento River. ▸ Conduct feasibility study ▸ Conduct habitat evaluation ▸ Conduct 3-5 year pilot testing program ▸ Implement long-term fish passage program	CDFG, NMFS, Reclamation, USFWS	Chinook salmon	Chinook salmon	Action 1. Investigate whether individual species' respective range of distribution can be extended or changed, so they may persist in changing future conditions. No specific streams noted.	Not stated.				

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Comparison of actions identified by federal and state agencies to recover listed Central Valley salmonids in the Sacramento River watershed (i.e., headwaters to Collinsville).

NMFS (2009)				CDFG (2011)				USFWS (2001)			
Species Benefited	**Threat Category**	**Priority 1 Recovery Actions**	**Involved Parties**	**Species Benefited**	**Ecosystem Processes**	**Stage 2 Actions**	**Involved Parties**	**Species Benefited**	**Geographic Location**	**Restoration Actions/Evaluations**	**Involved Parties**
Winter-run Spring-run Steelhead	Habitat loss	1.8.2.1 Develop and implement a salmon reintroduction plan to re-colonize historic habitats above Keswick and Shasta dams into the McCloud River. ▸ Conduct feasibility study ▸ Conduct habitat evaluation ▸ Conduct 3-5 year pilot testing program ▸ Implement long-term fish passage program	CDFG, NMFS, Reclamation, USFWS	Chinook salmon	Chinook salmon	Action 1. Investigate whether individual species' respective range of distribution can be extended or changed, so they may persist in changing future conditions. No specific streams noted.	Not stated.				
								Spring-run Fall-run Steelhead	Cottonwood Creek	Action 1. Establish limits on instream gravel mining operations by working with state and local agencies to protect spawning gravel and enhance recruitment of spawning gravel to the Sacramento River in the valley sections of Cottonwood Creek.	ACOE, Shasta and Tehama counties, California Division of Mines, CDFG, USFWS, USBR
								Spring-run Fall-run Steelhead	Cottonwood Creek	Action 2 Restore the stream channel of Cottonwood Creek to prevent the ACID siphon from becoming a barrier to the migration of spring- and fall-run Chinook salmon and steelhead.	ACID, gravel miners USFWS, USBR
								Fall-run	Cottonwood Creek	Action 3. Eliminate adult fall-run Chinook stranding by stopping attraction flows in Crowley Gulch or by constructing a barrier at the mouth of Crowley Gulch.	ACID, CDFG, USFWS, USBR
								Salmonids	Cottonwood Creek	Action 4. Facilitate watershed protection and restoration to reduce water temperatures and siltation in Cottonwood Creek to improve holding, spawning, and rearing habitats for salmonids.	Landowners, CDFG, USFWS, USBR
								Not stated	Cottonwood Creek	Action 5. Establish, restore, and maintain riparian habitat on Cottonwood Creek.	ACID, Gravel miners, Landowners, USFWS, USBR

Appendix D
Comparison of actions identified by federal and state agencies to recover listed Central Valley salmonids in the Sacramento River watershed (i.e., headwaters to Collinsville).

NMFS (2009)				CDFG (2011)				USFWS (2001)			
Species Benefited	**Threat Category**	**Priority 1 Recovery Actions**	**Involved Parties**	**Species Benefited**	**Ecosystem Processes**	**Stage 2 Actions**	**Involved Parties**	**Species Benefited**	**Geographic Location**	**Restoration Actions/Evaluations**	**Involved Parties**
Winter-run Spring-run Steelhead	Habitat degradation and loss	1.8.3.1 Develop and implement a salmon reintroduction plan to re-colonize historic habitats after implementation of the Battle Creek Restoration Project.	CDFG, NGOs, NMFS, PG&E, Reclamation, USFWS	Chinook salmon	Chinook salmon	Action 1. Investigate whether individual species' respective range of distribution can be extended or changed, so they may persist in changing future conditions. No specific streams noted.	Not stated.	Winter-run Spring-run Steelhead	Battle Creek	Evaluation 2. Evaluate the feasibility of establishing naturally spawning populations of winter-run and spring-run Chinook salmon and steelhead through a comprehensive plan to restore Battle Creek.	CDFG, USFWS, USBR, NMFS
								Not stated.	Battle Creek	Evaluation 4. Develop a comprehensive restoration plan for Battle Creek that integrates CNFH operations	WSRCD, CDFG, USFWS, USBR
Winter-run Spring-run Steelhead	Habitat degradation and loss	1.8.3.2 Fully fund and implement the Battle Creek Restoration Project through Phase 2.	CDFG, NMFS, PG&E, Reclamation, USFWS								
								Winter-run Spring-run Fall-run Steelhead	Battle Creek	Evaluation 3. Evaluate alternatives for providing a disease-safe water supply to CNFH to that winter-, spring- and fall-run Chinook salmon and steelhead would have access to an additional 41 miles of Battle Creek habitat.	CDFG, USFWS, USBR
								Spring-run Steelhead Fall-run Late fall-run	Battle Creek	Action 1. Continue to allow adult spring-run Chinook salmon and steelhead passage above the Coleman National Fish Hatchery (CNFH) weir on Battle Creek. After a disease-safe water supply becomes available to the CNFH, allow passage of fall- and late fall-run Chinook salmon and steelhead above the CNFH weir. In the interim, prevent anadromous fish from entering the main hatchery water supply by blocking fish ladders at Wildcat Canyon, Eagle Canyon, and Coleman diversion dams.	USFWS, USBR, CDFG, NMFS
								Anadromous salmonids	Battle Creek	Action 2. Acquire water from willing sellers consistent with applicable guidelines or negotiate agreements to increase flows past PG&E's hydropower diversions in two phases to provide adequate holding, spawning and rearing habitat for anadromous salmonids in Battle Creek.	CDFG, PG&E, USFWS, USBR, NMFS, FERC

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Comparison of actions identified by federal and state agencies to recover listed Central Valley salmonids in the Sacramento River watershed (i.e., headwaters to Collinsville).

NMFS (2009)				CDFG (2011)				USFWS (2001)			
Species Benefited	**Threat Category**	**Priority 1 Recovery Actions**	**Involved Parties**	**Species Benefited**	**Ecosystem Processes**	**Stage 2 Actions**	**Involved Parties**	**Species Benefited**	**Geographic Location**	**Restoration Actions/Evaluations**	**Involved Parties**
								Chinook salmon	Battle Creek	Action 3. Construct barrier racks at the Gover Diversion Dam and waste gates from the Gover Canal to prevent adult Chinook salmon from entering Gover Diversion.	Gover Diversion Dam owners, CDFG, USFWS, USBR
								Chinook salmon	Battle Creek	Action 4. Screen Orwick Diversion Dam to prevent entrainment of juvenile salmonids and straying of adult Chinook salmon.	Orwick Diversion Dam owners, USFWS, USBR, NMFS, CDFG, DWR, BLM
								Chinook salmon Steelhead	Battle Creek	Action 5. Screen tailrace of Colman Powerhouse to eliminate attraction of adult Chinook salmon and steelhead into an area with little spawning habitat and contamination of the CNFH water supply.	CDFG, PG&E, USBR, USFWS
								Anadromous salmonids	Battle Creek	Action 6. Construct fish screens on all PG&E diversions, as appropriate, after both phases of upstream flow actions (see Action 1) are completed and fish ladders on Coleman and Eagle Canyon diversion dams are opened.	PG&E, USFWS, USBR, NMFS, CDFG, DWR
								Adult salmonids	Battle Creek	Action 7. Improve fish passage in Eagle Canyon by modifying a bedrock ledge and boulders that are potential barriers to adult salmonids, and rebuild fish ladders on Wildcat and Eagle Canyon diversion dams.	CDFG, USFWS, USBR
								Juvenile Chinook salmon Steelhead	Battle Creek	Action 8. Screen CNFH intakes 2 and 3 to prevent entrainment of juvenile Chinook salmon and steelhead.	USFWS, USBR, CDFG, WSRCD
								Anadromous salmonids	Battle Creek	Evaluation 1. Evaluate the effectiveness of fish ladders at PG&E diversions.	CDFG, PG&E, USFWS, USBR
								Fall-run Steelhead	Paynes Creek	Action 1. Supplement flows with water acquired from willing sellers consistent with applicable guidelines or negotiate agreements to improve spawning, rearing and migration opportunities for fall-run Chinook salmon and steelhead in Paynes Creek.	Diverters, CDFG, BLM, USFWS, USBR, Tehama Co. RCD

Appendix D
Comparison of actions identified by federal and state agencies to recover listed Central Valley salmonids in the Sacramento River watershed (i.e., headwaters to Collinsville).

NMFS (2009)				CDFG (2011)				USFWS (2001)			
Species Benefited	**Threat Category**	**Priority 1 Recovery Actions**	**Involved Parties**	**Species Benefited**	**Ecosystem Processes**	**Stage 2 Actions**	**Involved Parties**	**Species Benefited**	**Geographic Location**	**Restoration Actions/Evaluations**	**Involved Parties**
								Fall-run Steelhead	Paynes Creek	Action 2. Restore and enhance spawning gravel in Paynes Creek.	CDFG, BLM, USFWS, USBR, Tehama Co. RCD
Spring-run Steelhead	Water management	1.9.1.1 Restore instream flows in Antelope Creek during upstream and downstream migration periods through water exchange agreements and provide alternative water supplies to Edwards Ranch and Los Molinos Mutual Water Company in exchange for instream fish flows.	CDFG, Edwards Ranch, Los Molinos Water Company					Spring-run Fall-run Late fall-run Steelhead	Antelope Creek	Action 1. Supplement flows with water acquired from willing sellers consistent with applicable guidelines or negotiate agreements to allow passage of juvenile and adult spring-, fall- and late fall-run Chinook salmon and steelhead.	Diverters, CDFG, USFWS, USBR, USFS
Spring-run Steelhead	Water management	1.9.1.2 Restore in Antelope Creek connectivity of the migration corridor during upstream and downstream migration periods by implementing Edwards and Penryn fish passage and entrainment improvement projects and identify and construct a defined stream channel for upstream and downstream fish migration.	CDFG, Edwards Ranch					Not stated. Not stated. Not stated.	Antelope Creek Elder Creek Elder Creek	Evaluate the creation of a more defined stream channel in Antelope Creek to facilitate fish passage by minimizing water infiltration into the streambed and maintaining flows to the Sacramento River. Action 1. Work with Tehama County to develop an erosion control ordinance to minimize sediment input into Elder Creek. Evaluation 1. Evaluate the feasibility of constructing a fish passage structure over the Corning Canal Siphon on Elder Creek.	Landowners, CDFG, USFWS, USBR Tehama County, CDFG, USFWS, USBR, Tehama Co. RCD, NRCS CDFG, USFWS, USBR, TCCA
Spring-run Steelhead	Habitat degradation and loss	1.9.2.1 Implement a Mill Creek anadromous fish passage study (AFRP Website 2005) that will evaluate fish passage at all agricultural diversions to determine if they meet NMFS' fish passage criteria. Design and install state-of-the-art fish passage facilities at diversions that currently do not meet the passage criteria.	CDFG, USFWS					Not stated.	Mill Creek	Evaluation 1. Develop and implement an interim fish passage solution at Clough Dam on Mill Creek until such time that a permanent solution is developed and accepted by landowners.	Diverters, Mill Creek Conservancy, Los Molinos Municipal Water Company, CDFG, DWR, USFWS, USBR, Vina Resource Conservation District

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Comparison of actions identified by federal and state agencies to recover listed Central Valley salmonids in the Sacramento River watershed (i.e., headwaters to Collinsville).

NMFS (2009)				CDFG (2011)				USFWS (2001)			
Species Benefited	**Threat Category**	**Priority 1 Recovery Actions**	**Involved Parties**	**Species Benefited**	**Ecosystem Processes**	**Stage 2 Actions**	**Involved Parties**	**Species Benefited**	**Geographic Location**	**Restoration Actions/Evaluations**	**Involved Parties**
Spring-run Steelhead	Habitat degradation and loss	1.9.2.2 Conduct a study designed to determine adult fish passage flows at critical riffles and fish ladders in Mill Creek. Develop a water exchange agreement with all Mill Creek water users to allow implementation of those flows.	CDFG, Mill Creek water users					Adult and juvenile Spring-run Fall-run Late fall-run Steelhead	Mill Creek	Action 1. Continue to provide instream flows in the valley reach of Mill Creek to facilitate the passage of adult and juvenile salmonids.	Mill Creek Conservancy Landowners, CDFG, USFWS, USBR, DWR
Spring-run Steelhead	Habitat degradation	1.9.2.3 Eliminate sources of chronic sediment delivered to Mill Creek from roads and other near-stream development by out-sloping roads, constructing diversion prevention dips, replacing under-sized culverts and applying other storm proofing guidelines.	CDFG, USFS								
								Not stated.	Mill Creek	Action 2. Preserve the habitat productivity of Mill Creek through cooperative watershed management and development of a watershed strategy.	CDFG, Mill Creek Conservancy, USFWS, USBR, Vina Resource Conservation District
								Fall-run	Mill Creek	Action 3. Improve spawning habitats in lower Mill Creek for fall-run Chinook salmon.	CDFG, Mill Creek Conservancy, USFWS, USBR, Vina Resource Conservation District
								Not stated.	Mill Creek	Action 4. Establish, restore, and maintain riparian habitat along the lower reaches of Mill Creek.	County agencies, California State University at Chico, CDFG, USFWS, USBR, Mill Creek Conservancy, Los Molinos School District, Vina Resource Conservation District

Appendix D
Comparison of actions identified by federal and state agencies to recover listed Central Valley salmonids in the Sacramento River watershed (i.e., headwaters to Collinsville).

NMFS (2009)				CDFG (2011)				USFWS (2001)			
Species Benefited	**Threat Category**	**Priority 1 Recovery Actions**	**Involved Parties**	**Species Benefited**	**Ecosystem Processes**	**Stage 2 Actions**	**Involved Parties**	**Species Benefited**	**Geographic Location**	**Restoration Actions/Evaluations**	**Involved Parties**
								Salmonids	Thomes Creek	Action 1. Modify gravel mining methods on Thomes Creek to reduce their effects on salmonid spawning habitats.	Gravel miners, Tehama County Planning Commission, CDFG, DWR, USFWS, USBR
								Not stated.	Thomes Creek	Action 2. Employ the most ecologically sound timber extraction practices by implementing the Forest Plan on federal lands within the Thomes Creek drainage.	Landowners, USFWS, USFS, California Department of Forestry and Fire Protection, Tehama-Colusa Canal Authority
								Not stated.	Thomes Creek	Action 3. Modify and employ the most ecologically sound grazing practices by implementing the Forest Plan on federal lands and through partnerships on private and state-owned land within the Thomes Creek drainage.	Landowners, USFS, USFWS, USBR, Tehama Colusa Resource Conservation District
								Chinook salmon Steelhead	Thomes Creek	Action 4. Reduce use of seasonal diversion dams on Thomes Creek that may be barriers to migrating Chinook salmon and steelhead.	Henleyville and Paskenta diversion dam operators, CDFG, USFWS, USBR
								Not stated.	Thomes Creek	Evaluation 1. Identify and evaluate restoring highly erodible watershed areas in the Thomes Creek watershed.	CDFG, USFWS, USBR
								Chinook salmon	Thomes Creek	Evaluation 2. Monitor water quality throughout Thomes Creek and identify limiting conditions for salmon.	CDFG, USFWS, USBR
Spring-run Steelhead	Habitat degradation	1.9.3.1 Develop and implement a water exchange agreement with the Deer Creek Irrigation District and the Stanford Vina Ranch Irrigation Company and dedicate fish passage flows. The agreement should identify water infrastructure facilities required to meet fish passage needs.	CDFG, Deer Creek Irrigation District, Stanford Vina Ranch Irrigation Company, USFWS					Adult and juvenile Spring-run Fall-run Steelhead	Deer Creek	Action 1. Acquire water from willing sellers consistent with applicable guidelines or negotiate agreements to supplement instream flows in the lower ten miles of Deer Creek to ensure passage of adult and juvenile spring- and fall-run Chinook salmon and steelhead over three diversion dams.	Deer Creek Watershed Conservancy, CDFG, USFWS, USBR

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Comparison of actions identified by federal and state agencies to recover listed Central Valley salmonids in the Sacramento River watershed (i.e., headwaters to Collinsville).

NMFS (2009)				CDFG (2011)				USFWS (2001)			
Species Benefited	**Threat Category**	**Priority 1 Recovery Actions**	**Involved Parties**	**Species Benefited**	**Ecosystem Processes**	**Stage 2 Actions**	**Involved Parties**	**Species Benefited**	**Geographic Location**	**Restoration Actions/Evaluations**	**Involved Parties**
Spring-run Steelhead	Habitat degradation	1.9.3.2 Construct on Deer Creek state-of-the-art inflatable dams and install fish ladders that meet NMFS' adult fish passage criteria at the Cone-Kimball Diversion, Stanford Vina Dam, and the Deer Creek Irrigation District Dam.	CDFG, Deer Creek Irrigation District, Stanford Vina Ranch Irrigation Company, USFWS								
Spring-run Steelhead	Habitat degradation	1.9.3.3 Implement the Deer Creek Flood Improvement Project	No parties listed.					Fish resources	Deer Creek	Action 5. Plan and coordinate required flood management activities with least damage to the fishery resources and riparian habitats of lower Deer Creek; and establish, restore, and maintain riparian habitat on Deer Creek.	Tehama County Flood Control, Deer Creek Watershed Conservancy, ACOE, CDFG, USFWS, USBR
Spring-run Steelhead	Habitat degradation	1.9.3.4 Implement watershed restoration actions that reduce sedimentation and thermal loading in low gradient headwater habitats of Deer Creek Meadows and Gurnsey Creek.	CDFG, USFS, Deer Creek landowners					Chinook salmon Steelhead	Deer Creek	Action 2. Develop a watershed management plan to preserve the Chinook salmon and steelhead habitat in Deer Creek through cooperative watershed management.	Deer Creek Watershed Conservancy, CDFG, USFWS, USBR
								Fall-run Late fall-run	Deer Creek	Action 3. Improve spawning habitats in lower Deer Creek for fall- and late fall-run Chinook salmon.	Deer Creek Watershed Conservancy, CDFG, USFWS, USBR, Vina Resource Conservation district
								Not stated.	Deer Creek	Action 4. Negotiate long-term agreements to restore and preserve riparian habitats along Deer Creek.	Landowners, Deer Creek Watershed Conservancy, CDFG, USFWS, USBR, Vina Resource Conservation District

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NMFS (2009)				**CDFG (2011)**				**USFWS (2001)**			
Species Benefited	**Threat Category**	**Priority 1 Recovery Actions**	**Involved Parties**	**Species Benefited**	**Ecosystem Processes**	**Stage 2 Actions**	**Involved Parties**	**Species Benefited**	**Geographic Location**	**Restoration Actions/Evaluations**	**Involved Parties**
								Anadromous salmonids	Stony Creek	Evaluation 1. Determine the feasibility of restoring anadromous salmonids to Stony Creek by evaluating water releases from Black Butte Dam, water exchanges with the Tehama-Colusa Canal, interim and long-term water diversion solutions at Red Bluff Diversion Dam, water Quality improvements, spawning gravel protection and restoration, riparian habitat protection and restoration, creek channel creation, and passage improvements at water diversions.	Stony Creek Task Force, Tehama-Colusa Canal Authority, CDFG, ACOE, USFWS, USBR
				Chinook salmon Steelhead	Dams and other structures	Action 1. Repair the Iron Canyon fish ladder on Big Chico Creek.	Not stated.	Not stated.	Big Chico Creek	Action 2. Repair the Iron Canyon fish ladder on Big Chico Creek.	CDFG, USFWS, USBR, Big Chico Creek Task Force
								Not stated.	Big Chico Creek	Action 3. Replenish spawning gravel in reaches modified for flood control on Big Chico Creek.	Chico Parks Department, CDFG, DWR, ACOE, USFWS, USBR, Big Chico Creek Task Force
								Not stated.	Big Chico Creek	Action 4. Repair the Lindo Channel weir and fishway at the Lindo Channel box culvert at the Five-Mile Diversion on Big Chico Creek.	Chico Parks Department, CDFG, DWR, ACOE, USFWS, USBR, Big Chico Creek Task Force
								Not stated.	Big Chico Creek	Action 5. Improve cleaning procedures at One-Mile Pool on Big Chico Creek.	City of Chico, CDFG, USFWS, USBR
								Spring-run	Big Chico Creek	Action 6. Protect spring-run Chinook salmon summer holding pools on Big Chico Creek by obtaining from willing sellers titles or conservation easements on lands adjacent to the pools.	Landowners, CDFG, USFWS, USBR

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Comparison of actions identified by federal and state agencies to recover listed Central Valley salmonids in the Sacramento River watershed (i.e., headwaters to Collinsville).

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Species Benefited	**Threat Category**	**Priority 1 Recovery Actions**	**Involved Parties**	**Species Benefited**	**Ecosystem Processes**	**Stage 2 Actions**	**Involved Parties**	**Species Benefited**	**Geographic Location**	**Restoration Actions/Evaluations**	**Involved Parties**
								Not stated.	Big Chico Creek	Action 7. Cooperate with local landowners to encourage revegetation of denuded stream reaches; and establish, restore, and maintain riparian habitat on Big Chico Creek.	Landowners, Sacramento River Preservation Trust, CDFG, California Department of Parks and Recreation, USFWS, USBR
								Not stated.	Big Chico Creek	Action 8. Preserve the productivity of the habitat on Big Chico Creek through cooperative watershed management and development of a watershed management plan.	USFS, CDFG, USFWS, USBR
								Not stated.	Big Chico Creek	Evaluation 1. Evaluate the water management operations between Big Chico Creek and Lindo Channel.	City of Chico, CDFG, DWR, USFWS, USBR
								Not stated.	Big Chico Creek	Evaluation 2. Evaluate the replenishment of gravel in the flood-diversion reach of Mud Creek.	Butte County, CDFG, DWR, USFWS, USBR
				Chinook salmon	Dams and other structures	Action 2. Install an adult salmon exclusion device at the Knights Landing outfall for Colusa Basin Drain as an interim action pending completion of Colusa Basin Drain Evaluation 1.	Not stated.	Chinook salmon	Colusa Basin Drain	Action 1. Install an adult exclusion device at the Knights Landing outfall for Colusa Basin Drain as an interim action pending completion of Colusa Basin Drain Evaluation 1.	CDFG, USFWS, USBR
								Anadromous fishes	Colusa Basin Drain	Evaluation 1. Investigate the feasibility of restoring the access of anadromous fish to westside tributaries through development of defined migrational routes, sufficient flows, and adequate water temperatures.	CDFG, USFWS, USBR
Spring-run Steelhead	Water management	1.9.4.1 Develop, implement and evaluate a Butte Creek flow test for the PG&E DeSabla-Centerville Hydroelectric Project to determine the flow conditions that optimize coldwater holding habitat and spawning distribution.	CDFG, PG&E					Not stated.	Butte Creek	Action 2. Maintain a minimum 40 cfs instream flow below Centerville Diversion Dam on Butte Creek.	Butte Creek Watershed Conservancy, CDFG, PG&E, USFWS, USBR

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NMFS (2009)				CDFG (2011)				USFWS (2001)			
Species Benefited	**Threat Category**	**Priority 1 Recovery Actions**	**Involved Parties**	**Species Benefited**	**Ecosystem Processes**	**Stage 2 Actions**	**Involved Parties**	**Species Benefited**	**Geographic Location**	**Restoration Actions/Evaluations**	**Involved Parties**
Spring-run Steelhead	Habitat degradation and loss	1.9.4.2 Install state-of-the-art fish ladders at DWR Weir 2 and Willow Slough Weir on Butte Creek.	DWR					Not stated.	Butte Creek	Evaluation 3. Evaluate operational alternatives and establish operational criteria for Sutter Bypass Weir #2 on Butte Creek.	Diverters, Butte Creek Watershed Conservancy, CDFG, USFWS, USBR
								Not stated.	Butte Creek	Evaluation 8. Evaluate alternatives to help fish passage, including the installation of a high water volume fish ladder, on Sutter Bypass Weir #2 on Butte Creek.	Butte Creek Watershed Conservancy, CDFG, USFWS, USBR
Spring-run Steelhead	Habitat degradation and loss	1.9.4.3 Maintain state-of-the art fish passage facilities at diversions on Butte Creek to meet NMFS's passage criteria.	No parties listed.	Salmonids	Dams and other structures	Action 3. Remove any remaining physical barriers that impede access for salmonid fish on Butte Creek.	Not stated.	Not stated.	Butte Creek	Action 4. Build a new high water volume fish ladder at Durham Mutual Dam on Butte Creek.	Durham Mutual Water Company, Butte Creek Watershed Conservancy, CDFG, The Nature Conservancy, USFWS, USBR
								Not stated.	Butte Creek	Action 4. Install fish screens on both diversions at Durham Mutual Dam on Butte Creek.	Diverters, Durham Mutual Water Company, The Nature Conservancy, USFWS, USBR, NMFS, CDFG, DWR
								Not stated.	Butte Creek	Action 10. Build a new high water volume fish ladder at Adams Dam on Butte Creek.	Diverters, Butte Creek Watershed Conservancy, CDFG, USFWS, USBR
								Not stated.	Butte Creek	Action 11. Install fish screens on both diversions at Adams Dam on Butte Creek.	Diverters, Butte Creek Watershed Conservancy, CDFG, DWR, NMFS, USFWS, USBR
								Not stated.	Butte Creek	Action 12. Build a new high water volume fish ladder at Gorrill Dam on Butte Creek.	Diverters, CDFG, USFWS, USBR

Appendix D
Comparison of actions identified by federal and state agencies to recover listed Central Valley salmonids in the Sacramento River watershed (i.e., headwaters to Collinsville).

NMFS (2009)				CDFG (2011)				USFWS (2001)			
Species Benefited	**Threat Category**	**Priority 1 Recovery Actions**	**Involved Parties**	**Species Benefited**	**Ecosystem Processes**	**Stage 2 Actions**	**Involved Parties**	**Species Benefited**	**Geographic Location**	**Restoration Actions/Evaluations**	**Involved Parties**
								Not stated.	Butte Creek	Action 13. Install a fish screen on the Gorrill Dam diversion on Butte Creek.	Diverters, Butte Creek Watershed Conservancy, CDFG, DWR, NMFS, USFWS, USBR
								Not stated.	Butte Creek	Action 14. Install a fish screen at White Mallard Dam on Butte Creek.	Diverters, Butte Creek Watershed Conservancy, CDFG, DWR, NMFS, USFWS, USBR
								Not stated.	Butte Creek	Action 18. Install a high water volume fish ladder at White Mallard Dam on Butte Creek.	Diverters, Butte Creek Watershed Conservancy, CDFG, USFWS, USBR
								Not stated.	Butte Creek	Action 20. Install fish screens and fish ladder at Parrott-Phelan Diversion Dam on Butte Creek.	Diverters, Butte Creek Watershed Conservancy, CDFG, USFWS, USBR
								Not stated.	Butte Creek	Evaluation 2. Evaluate alternatives or build a new high water volume fish ladder at East-West Diversion Weir on Butte Creek.	Diverters, Butte Creek Watershed Conservancy, CDFG, USFWS, USBR
								Not stated.	Butte Creek	Evaluation 5. Evaluate alternatives to help fish passage, including the installation of a fish screen, at Sanborn Slough Bifurcation Structure on Butte Creek.	Diverters, Butte Creek Watershed Conservancy, CDFG, DWR, NMFS, USFWS, USBR
								Not stated.	Butte Creek	Evaluation 6. Evaluate alternatives to help fish passage, including the installation of fish screens, within Sutter Bypass where necessary.	Diverters, Butte Creek Watershed Conservancy, CDFG, DWR, NMFS, USFWS, USBR
								Not stated.	Butte Creek	Evaluation 9. Evaluate alternatives to help fish passage, including the installation of a high water volume fish ladder, on Sutter Bypass Weir #1 on Butte Creek.	Butte Creek Watershed Conservancy, CDFG, USFWS, USBR

Appendix D
Comparison of actions identified by federal and state agencies to recover listed Central Valley salmonids in the Sacramento River watershed (i.e., headwaters to Collinsville).

NMFS (2009)				CDFG (2011)				USFWS (2001)			
Species Benefited	**Threat Category**	**Priority 1 Recovery Actions**	**Involved Parties**	**Species Benefited**	**Ecosystem Processes**	**Stage 2 Actions**	**Involved Parties**	**Species Benefited**	**Geographic Location**	**Restoration Actions/Evaluations**	**Involved Parties**
								Not stated.	Butte Creek	Evaluation 10. Evaluate alternatives to help fish passage, including the installation of a high water volume fish ladder, on Sutter Bypass Weir #5 on Butte Creek.	Butte Creek Watershed Conservancy, CDFG, USFWS, USBR
								Not stated.	Butte Creek	Evaluation 11. Evaluate alternatives to help fish passage, including the installation of a high water volume fish ladder, on Sutter Bypass Weir #3 on Butte Creek.	Butte Creek Watershed Conservancy, CDFG, USFWS, USBR
								Not stated.	Butte Creek	Action 1. Obtain additional instream flows from Parrott-Phelan Diversion on Butte Creek.	Diverters, Butte Creek Watershed Conservancy, CDFG, USFWS, USBR
								Not stated.	Butte Creek	Action 3. Purchase existing wat4er rights for Butte Creek from willing sellers.	Diverters, Butte Creek Watershed Conservancy, CDFG, USFWS, USBR, SWRCB
								Anadromous salmonids	Butte Creek	Action 6. Remove the Western Canal Damon Butte Creek and construct the Western Canal Siphon.	Western Canal Water District, Butte Creek Watershed Conservancy, The Nature Conservancy, CDFG, USFWS, USBR
								Anadromous salmonids	Butte Creek	Action 7. Remove McPherrin and McGowan dams on Butte Creek and provide an alternate source of water as part of the Western Canal Dam removal and siphon construction.	Diverters, Western Canal Water District, Butte Creek Watershed Conservancy, CDFG, USBR, USFWS
								Not stated.	Butte Creek	Action 8. As available, acquire water rights in Butte Creek as a part of the Western Canal Siphon project.	Western Canal Water District, Butte Creek Watershed Conservancy, CDFG, SWRCB, USBR

Appendix D
Comparison of actions identified by federal and state agencies to recover listed Central Valley salmonids in the Sacramento River watershed (i.e., headwaters to Collinsville).

NMFS (2009)				CDFG (2011)				USFWS (2001)			
Species Benefited	**Threat Category**	**Priority 1 Recovery Actions**	**Involved Parties**	**Species Benefited**	**Ecosystem Processes**	**Stage 2 Actions**	**Involved Parties**	**Species Benefited**	**Geographic Location**	**Restoration Actions/Evaluations**	**Involved Parties**
								Not stated.	Butte Creek	Action 9. Adjudicate water rights on Butte Creek and provide water master service for the entire creek.	Diverters, Butte Creek Watershed Conservancy, CDFG, SWRCB, USFWS, USBR
								Chinook salmon	Butte Creek	Action 15. Eliminate Chinook salmon stranding at White Mallard Duck Club outfall on Butte Creek.	Diverters, Butte Creek Watershed Conservancy, CDFG, USFWS, USBR
								Not stated.	Butte Creek	Action 16. Rebuild and maintain existing culvert and riser at Drumheller Slough outfall on Butte Creek.	Diverters, Butte Creek Watershed Conservancy, CDFG, USFWS, USBR
								Not stated.	Butte Creek	Action 17. Install screened portable pumps in Butte Creek as an alternative to the Little Dry Creek diversion.	Diverters, Butte Creek Watershed Conservancy, CDFG, DWR, NMFS, USFWS, USBR
								Spring-run	Butte Creek	Action 19. Develop land use plans that create buffer zones between Butte Creek and agricultural, urban, and industrial developments; and restore, maintain, and protect riparian and spring-run Chinook salmon summer-holding habitat along Butte Creek.	City and county government agencies, Conservation groups, Butte Creek Watershed Conservancy, CDFG, USFWS, USBR
								Not stated.	Butte Creek	Action 21. Develop a watershed management program for Butte Creek.	Butte Creek Watershed Conservancy, CDFG, USFWS, USBR
								Not stated.	Butte Creek	Action 22. Establish operational criteria for Sanborn Slough Bifurcation on Butte Creek.	Diverters, Butte Creek Watershed Conservancy, CDFG, USFWS, USBR

Appendix D
Comparison of actions identified by federal and state agencies to recover listed Central Valley salmonids in the Sacramento River watershed (i.e., headwaters to Collinsville).

NMFS (2009)				CDFG (2011)				USFWS (2001)			
Species Benefited	**Threat Category**	**Priority 1 Recovery Actions**	**Involved Parties**	**Species Benefited**	**Ecosystem Processes**	**Stage 2 Actions**	**Involved Parties**	**Species Benefited**	**Geographic Location**	**Restoration Actions/Evaluations**	**Involved Parties**
								Not stated.	Butte Creek	Action 23. Establish operational criteria for the East Barrow pit and West barrow pit on Butte Creek.	Diverters, Butte Creek Watershed Conservancy, CDFG, USFWS, USBR
								Not stated.	Butte Creek	Action 24. Establish operational criteria for Nelson Slough tributary to Butte Creek.	Diverters, Butte Creek Watershed Conservancy, CDFG, USFWS, USBR
								Not stated.	Butte Creek	Evaluation 1. Develop and evaluate operational criteria and potential modifications to Butte Slough outfall on Butte Creek.	Diverters, Butte Creek Watershed Conservancy, CDFG, USFWS, USBR
								Not stated.	Butte Creek	Evaluation 4. Evaluate operational alternatives and establish operational criteria for Sutter Bypass Weir #1 on Butte Creek.	Diverters, Butte Creek Watershed Conservancy, CDFG, USFWS, USBR
								Not stated.	Butte Creek	Evaluation 7. Evaluate operational alternatives and establish operational criteria for Sutter Bypass Weir #5 on Butte Creek.	Diverters, Butte Creek Watershed Conservancy, CDFG, USFWS, USBR
								Spring-run	Butte Creek	Evaluation 12. Evaluate enhancement of fish passage at a natural barrier below the Centerville Diversion Dam on Butte Creek.	Butte Creek Watershed Conservancy, PG&E, CDFG, USFWS, USBR
								Spring-run	Butte Creek	Evaluation 13. Evaluate fish passage enhancements at PG&E diversion dams and other barriers above Centerville Diversion Dam on Butte Creek.	Butte Creek Watershed Conservancy, Spring-run Chinook Salmon Workgroup, PG&E, CDFG, USFWS, USBR
								Juvenile Spring-run	Butte Creek	Evaluation 14. Evaluate the juvenile life history of spring-run Chinook salmon in Butte Creek.	Butte Creek Watershed Conservancy, CDFG, USFWS, USBR

Appendix D
Comparison of actions identified by federal and state agencies to recover listed Central Valley salmonids in the Sacramento River watershed (i.e., headwaters to Collinsville).

NMFS (2009)				CDFG (2011)				USFWS (2001)			
Species Benefited	**Threat Category**	**Priority 1 Recovery Actions**	**Involved Parties**	**Species Benefited**	**Ecosystem Processes**	**Stage 2 Actions**	**Involved Parties**	**Species Benefited**	**Geographic Location**	**Restoration Actions/Evaluations**	**Involved Parties**
								Juvenile and adult Chinook salmon	Butte Creek	Evaluation 15. Evaluate juvenile and adult Chinook salmon stranding in Sutter Bypass and behind Tisdale, Moulton, and Colusa weirs during periods of receding flows on the upper mainstem Sacramento River.	Butte Creek Watershed Conservancy, CDFG, USFWS, USBR
				Not stated.	Central Valley streamflows	Action 1. Encourage partner agency continuation of existing stream gages/real-time flow monitoring on Big Chico Creek, Butte Creek, Deer Creek, and Mill Creek.	Not stated.				
				Spring-run Steelhead	Central Valley hydrodynamics	Action 1. Continue to prioritize fish habitat and fish passage restoration projects particularly for spring-run Chinook salmon and steelhead trout (CALFED 2001a). No specific streams noted.	Not stated.				
				Not stated.	Central Valley hydrodynamics	Action 2. Continue to conduct adaptive management experiments in regards to natural and modified flow regimes to promote ecosystem functions or otherwise support restoration actions (CALFED 2001a). No specific streams noted.					
				Chinook salmon Steelhead	Central Valley hydrodynamics	Action 3. Continue to improve process understanding and support the development of ecologically-based plans to restore conditions in the rivers, sloughs and floodplains sufficient to meet restoration targets for Chinook salmon, steelhead, sturgeon, and splittail (CALFED 2001a). No specific streams noted.					
								Juvenile Winter-run Spring-run Fall-run Late fall-run Steelhead	Small Sacramento River Tributaries	Evaluation 1. Evaluate the contribution of small Sacramento River tributaries as rearing areas of juvenile Chinook salmon and steelhead.	CDFG, USFWS, USBR, Chico State University

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Comparison of actions identified by federal and state agencies to recover listed Central Valley salmonids in the Sacramento River watershed (i.e., headwaters to Collinsville).

NMFS (2009)				CDFG (2011)				USFWS (2001)			
Species Benefited	**Threat Category**	**Priority 1 Recovery Actions**	**Involved Parties**	**Species Benefited**	**Ecosystem Processes**	**Stage 2 Actions**	**Involved Parties**	**Species Benefited**	**Geographic Location**	**Restoration Actions/Evaluations**	**Involved Parties**
Spring-run	Habitat loss	1.9.5.1 Implement the use of a weir in the Feather River to spatially segregate spring-run Chinook salmon and fall-run Chinook salmon during their spawning migrations.	DWR								
Spring-run Steelhead	Hatchery effects	1.9.5.2 Develop a hatchery genetic management plan for the Feather River Fish Hatchery, including specific criteria for operating as either an integrated or segregated hatchery	CDFG, DWR					Chinook salmon	Feather River	Evaluation 3. Evaluate the distribution of Feather River Fish Hatchery Chinook salmon in Central Valley stocks and determine the genetic integrity of Feather River spring-run Chinook salmon.	DWR, CDFG
Spring-run Steelhead	Water management	1.9.5.3 Develop and implement a spring-run pulse flow schedule for the Feather River that is coordinated with Yuba River operations for dry and critically dry years.	DWR, YCWA								
Spring-run Steelhead	Habitat degradation and loss	1.9.5.4 Develop a spawning gravel budget, identify gravel depleted areas, and implement an augmentation plan in the Feather River.	DWR					Chinook salmon	Feather River	Evaluation 2. Evaluate the quality of spawning gravel in the Feather River in areas used by Chinook salmon, and if indicated, consider gravel renovation or supplementation to enhance substrate quality.	DWR
Steelhead	Habitat degradation and loss	1.9.5.5 Construct steelhead side channel habitats using carrying capacity models sufficient to support a viable naturally spawning population of steelhead in the lower Feather River.	DWR								
Spring-run Steelhead	Water temperature	1.9.5.6 Implement facilities modifications to achieve Feather River water temperatures at least as protective as those specified in Table 2 of the Settlement Agreement For Licensing of the Oroville Facilities (March 2006).	DWR, FERC, SWRCB					Fall-run Spring-run Steelhead	Feather River	Action 1. Supplement flows in the Feather River with water acquired from willing sellers consistent with applicable guidelines or negotiate agreements to improve conditions for all life history stages of fall- and spring-run Chinook salmon and steelhead.	DWR, CDFG, USFWS, USBR

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Comparison of actions identified by federal and state agencies to recover listed Central Valley salmonids in the Sacramento River watershed (i.e., headwaters to Collinsville).

NMFS (2009)				CDFG (2011)				USFWS (2001)			
Species Benefited	**Threat Category**	**Priority 1 Recovery Actions**	**Involved Parties**	**Species Benefited**	**Ecosystem Processes**	**Stage 2 Actions**	**Involved Parties**	**Species Benefited**	**Geographic Location**	**Restoration Actions/Evaluations**	**Involved Parties**
								Not stated. Salmonids	Feather River Feather River	Action 3. Develop and utilize a temperature model for the Feather River as a tool for river management. Evaluation 1. Evaluate the response of spawning salmonids to increased flows in the low-flow channel of the Feather River.	DWR DWR CDFG
Spring-run Steelhead	Habitat degradation and loss	1.9.6.1 Develop and implement a salmon reintroduction plan to re-colonize historic habitats above Englebright Dam on the Yuba River. Implement actions to: (1) enhance habitat conditions including providing flows and suitable water temperatures for successful upstream and downstream passage, holding, spawning and rearing; and (2) improve access within the area above Englebright Dam, including increasing minimum flows, providing passage at Our House, New Bullards Bar, and Log Cabin dams, and assessing feasibility of passage improvement at natural barriers. ▸ Conduct feasibility study ▸ Conduct habitat evaluation ▸ Conduct 3-5 year pilot testing program ▸ Implement long-term fish passage program	CDFG, NMFS, PG&E, USFWS, YCWA	Chinook salmon	Chinook salmon	Action 1. Investigate whether individual species' respective range of distribution can be extended or changed, so they may persist in changing future conditions. No specific streams noted.	Not stated.				
Spring-run Steelhead	Habitat degradation	1.9.6.2 Improve spawning habitat in the lower Yuba River by gravel restoration program below Englebright Dam and improve rearing habitat by increasing floodplain availability.	CDFG, NMFS, PG&E, USFWS, YCWA					Chinook salmon Steelhead	Yuba River	Action 1. Supplement flows in the Yuba River with water acquired from willing sellers consistent with applicable guidelines or negotiate agreements to improve conditions for all life history stages of Chinook salmon and steelhead.	Yuba County Water Agency, SWRCB, CDFG, USFWS, USBR

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Comparison of actions identified by federal and state agencies to recover listed Central Valley salmonids in the Sacramento River watershed (i.e., headwaters to Collinsville).

NMFS (2009)				CDFG (2011)				USFWS (2001)			
Species Benefited	**Threat Category**	**Priority 1 Recovery Actions**	**Involved Parties**	**Species Benefited**	**Ecosystem Processes**	**Stage 2 Actions**	**Involved Parties**	**Species Benefited**	**Geographic Location**	**Restoration Actions/Evaluations**	**Involved Parties**
								Juvenile salmonids	Yuba River	Action 3. Reduce and control flow fluctuations in the Yuba River to avoid and minimize adverse effects to juvenile salmonids.	Yuba County Water Agency, PG&E, SWRCB, CDFG
								Juvenile salmonids	Yuba River	Evaluation 1. Evaluate the effectiveness of pulse flows to facilitate successful juvenile salmonid emigration from the Yuba River.	Yuba County Water Agency, CDFG, USFWS, USBR
								Not stated.	Yuba River	Action 4. Maintain adequate instream flows in the Yuba River for temperature control.	Yuba County Water Agency, CDFG, USFWS, USBR
				Various native fishes	Water diversions	Action 2. Improve the efficiency of screening devices on the Yuba River at Hallwood-Cordua and Brophy-South Yuba diversions, and construct screens at Brown's Valley water diversion and other unscreened diversions.	Not stated.	Not stated.	Yuba River	Action 5. Improve efficiency of screening devices at Hallwood-Cordua and Brophy-South Yuba water diversions, and construct screens at the Browns Valley water diversion and other unscreened diversions on the Yuba River.	Diverters, SWRCB, USFWS, USBR, NMFS, CDFG, DWR
				Various native fishes	Water diversions	Action 3. Construct or improve the fish bypasses at Hallwood-Cordua and Brophy-South Yuba water diversions on the Yuba River.	Not stated.	Not stated.	Yuba River	Action 6. Construct or improve the fish bypasses and Hallwood-Cordua and Brophy-South Yuba water diversion on the Yuba River.	Diverters, SWRCB, USFWS, USBR, NMFS, CDFG, DWR
				Juvenile salmonids	Dams and other structures	Action 4. Facilitate passage of juvenile salmonids by modifying the dam face of Daguerre Point Dam on the Yuba River.	Not stated.	Juvenile salmonids	Yuba River	Action 9. Facilitate passage of juvenile salmonids by modifying the dam face of Daguerre Point Dam on the Yuba River.	Yuba County Water Agency, CDFG, ACOE
								Adult salmonids	Yuba River	Action 7. Facilitate passage of spawning adult salmonids by maintaining appropriate flows through the fish ladders, or by modifying the fish ladders at Daguerre Point Dam on the Yuba River.	Yuba County Water Agency, CDFG, ACOE, USFWS, USBR
								Anadromous fish	Yuba River	Action 10. Operate reservoirs to provide adequate water temperatures for anadromous fish in the Yuba River.	Yuba River Water Temperature Advisory Committee, SWRCB

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Comparison of actions identified by federal and state agencies to recover listed Central Valley salmonids in the Sacramento River watershed (i.e., headwaters to Collinsville).

NMFS (2009)				CDFG (2011)				USFWS (2001)			
Species Benefited	**Threat Category**	**Priority 1 Recovery Actions**	**Involved Parties**	**Species Benefited**	**Ecosystem Processes**	**Stage 2 Actions**	**Involved Parties**	**Species Benefited**	**Geographic Location**	**Restoration Actions/Evaluations**	**Involved Parties**
								Not stated.	Yuba River	Evaluation 2. Evaluate whether enhancement of water temperature control via shutter configuration and present management of the cold water pool at New Bullards Bar Dam if effective, and modify the water release outlets at Englebright Dam if enhancement of water temperature control via shutter configuration is effective.	Yuba County Water Agency, CDFG, PG&E, USFWS, USBR
								Salmonids	Yuba River	Evaluation 4. Evaluate the benefits of restoring stream channel and riparian habitats of the Yuba River, including the creation of side channels for spawning and rearing habitats for salmonids.	Yuba County Water Agency, CDFG, PG&E, USFWS
				Not stated.	Riparian and riverine aquatic habitat	Action 3. Remove small, non-essential dams on gravel-rich streams. No specific streams noted.					
				Salmonids	Riparian and riverine aquatic habitat	Action 2. Purchase streambank conservation easements from willing sellers or establish voluntary incentive programs to improve salmonid habitat and instream cover along the Yuba River, Feather River, and Bear River.	Not stated.	Salmonids	Yuba River	Action 8. Purchase streambank conservation easements along the Yuba River to improve salmonid habitat and instream cover.	Landowners, Yuba County Water Agency, BLM, USFWS, USBR
				Anadromous fish	Water diversions	Action 1. Screen all diversions to protect all life history stages of anadromous fish on Bear River.	Not stated.	Anadromous fish	Bear River	Action 3. Screen all diversions on the Bear River to protect all life history stages of anadromous fish.	Diverters, USFWS, USBR, NMFS, CDFG, DWR
								Chinook salmon Steelhead	Bear River	Action 1. Supplement flows in the Bear River with water acquired from willing sellers consistent with applicable guidelines or negotiate agreements to improve conditions for all life history stages of Chinook salmon and steelhead.	South Sutter Water District, SWRCB, CDFG, USFWS, USBR
								Chinook salmon Steelhead	Bear River	Action 2. Provide adequate water temperatures in the Bear River for all life-stages of Chinook salmon and steelhead.	South Sutter Water District, SWRCB, CDFG

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Comparison of actions identified by federal and state agencies to recover listed Central Valley salmonids in the Sacramento River watershed (i.e., headwaters to Collinsville).

NMFS (2009)				CDFG (2011)				USFWS (2001)			
Species Benefited	**Threat Category**	**Priority 1 Recovery Actions**	**Involved Parties**	**Species Benefited**	**Ecosystem Processes**	**Stage 2 Actions**	**Involved Parties**	**Species Benefited**	**Geographic Location**	**Restoration Actions/Evaluations**	**Involved Parties**
								Anadromous fish	Bear River	Action 4. Negotiate removal or modification of the culvert crossing at Patterson Sand and Gravel and other physical chemical barriers impeding anadromous fish migration on the Bear River.	Patterson Sand and Gravel, CDFG, USFWS, USBR
								Salmonids	Bear River	Evaluation 1. Determine and evaluate instream flow requirements for the Bear River that ensure adequate flows for all life stages of all salmonids.	South Sutter Water District, CDFG, USFWS, USBR
								Anadromous fish	Bear River	Evaluation 3. Monitor water quality in the Bear River, particularly at agricultural return outfalls, and evaluate potential effects on anadromous fish.	Diverters, CDFG
				Salmonids	Dams and other structures	Action 3. Remove any remaining physical barriers that impede access for salmonid fish on Dry Creek, Auburn Ravine, and Miner's Ravine.	Not stated.				
				Not stated.	Dams and other structures	Action 6. Reestablish the natural stream corridor of Miner's Ravine through the Hidden Valley Estates subdivision in Granite Bay; primarily through dam removal, sediment stabilization/removal and re-engineering of the natural stream corridor and ancillary features.	Not stated.				
				Anadromous fish	Dams and other structures	Action 7. Removal or modification of culvert crossings and other physical and chemical barriers impeding anadromous fish migration. No specific streams/sites noted.					
Steelhead	Habitat degradation and loss	1.9.7.1 Develop and implement a steelhead reintroduction plan to re-colonize historic habitats in the American River watershed above Nimbus and Folsom dams. ▸ Conduct feasibility study ▸ Conduct habitat evaluation ▸ Conduct 3-5 year pilot testing program ▸ Implement long-term fish passage program	CDFG, NMFS, Reclamation, USFWS	Chinook salmon	Chinook salmon	Action 1. Investigate whether individual species' respective range of distribution can be extended or changed, so they may persist in changing future conditions. No specific streams noted.	Not stated.				

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Comparison of actions identified by federal and state agencies to recover listed Central Valley salmonids in the Sacramento River watershed (i.e., headwaters to Collinsville).

NMFS (2009)				CDFG (2011)				USFWS (2001)			
Species Benefited	**Threat Category**	**Priority 1 Recovery Actions**	**Involved Parties**	**Species Benefited**	**Ecosystem Processes**	**Stage 2 Actions**	**Involved Parties**	**Species Benefited**	**Geographic Location**	**Restoration Actions/Evaluations**	**Involved Parties**
Steelhead	Water temperature	1.9.7.2 Implement physical and structural modifications to the American River Division of the CVP in order to improve water temperature management.	ACOE, CDFG,NMFS, Reclamation, USFWS					Not stated.	American River	Action 4. Reconfigure Folsom Dam shutters for improved management of Folsom Reservoir's cold water pool and better control over the temperature of water released downstream to the American River.	County of Sacramento, Sacramento Area Flood Control Agency, USFWS, USBR, CDFG
				Not stated.	Central Valley streamflows	Action 3. Increase flow by purchasing water from willing sellers or providing alternative sources of water to diverters during important fish passage periods in spring and fall on the American and Bear rivers.	Not stated.	Anadromous fish	American River	Action 1. Develop and implement a river regulation plan the meets American River minimum flow objectives for different water year types by modifying CVP operations, using (b)(2) water, and acquiring water from willing sellers as needed.	Sacramento Area Water Forum, CDFG, USBR, USFWS
								Not stated.	American River	Action 2. Develop a long-term water allocation plan for the American River watershed.	Sacramento Area Water Forum, CDFG, Other water users, USFWS, USBR
								Juvenile salmonids	American River	Action 3. Reduce and control flow fluctuations to avoid and minimize adverse effects on juvenile salmonids in the American River.	USFWS, USSBR, CDFG
								Salmonids	American River	Action 5. Replenish spawning gravel and restore existing spawning grounds in the American River.	USFWS, USBR, CDFG
								Not stated.	American River	Action 6. Improve the fish screen at Fairbairn Water Treatment Plant on the American River.	City of Sacramento, USFWS, USBR, NMFS, CDFG, DWR
								Juvenile salmonids	American River	Action 7. Modify the timing and rate of water diverted from the American River annually to reduce entrainment losses of juvenile salmonids.	City of Sacramento, Other water users, CDFG, USFWS, USBR
								Not stated.	American River	Action 8. Develop a riparian corridor management plan to improve and protect riparian habitat and instream cover in the American River.	Sacramento Area Flood Control Agency, ACOE, USFWS, USBR, CDFG

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Species Benefited	**Threat Category**	**Priority 1 Recovery Actions**	**Involved Parties**	**Species Benefited**	**Ecosystem Processes**	**Stage 2 Actions**	**Involved Parties**	**Species Benefited**	**Geographic Location**	**Restoration Actions/Evaluations**	**Involved Parties**
								Not stated.	American River	Action 9. Terminate current programs that remove woody debris from the American River channel.	County of Sacramento, City of Sacramento, Sacramento Area Flood Control Agency, ACOE, USFWS, USBR, CDFG
								Juvenile salmonids	American River	Evaluation 1. Evaluate the effectiveness of pulse flows to facilitate successful emigration of juvenile salmonids in the American River.	USFWS, USBR, CDFG
								Anadromous fish	American River	Evaluation 2. Evaluate and refine a river regulation plan that provides flows to protect all life stages of anadromous fish based on water storage at Folsom Reservoir and predicted hydrological conditions in the American River watershed.	Sacramento Area Water Forum, CDFG, USFWS, USBR
				Not stated.	Central Valley hydrodynamics	Action 4. Continue to support projects to: ▸ develop ecological and hydrodynamic modeling tools and conceptual models that describe ecological attributes, processes, habitats, and outflow/fish population relationships ▸ develop ecological and biological criteria for water acquisitions ▸ evaluate previous water acquisition strategies and their biological and ecological benefits No specific streams noted.	Not stated.				
Spring-run Steelhead	Habitat degradation and loss	1.9.8.1 Evaluate and, if feasible, develop and implement a fish passage program for Camanche and Pardee dams on the Mokelumne River. ▸ Conduct feasibility study ▸ Conduct habitat evaluation ▸ Conduct 3-5 year pilot testing program ▸ Implement long-term fish passage program	CDFG, NMFS, Reclamation, USFWS EBMUD not listed.	Chinook salmon	Chinook salmon	Action 1. Investigate whether individual species' respective range of distribution can be extended or changed, so they may persist in changing future conditions. No specific streams noted.	Not stated.				

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Comparison of actions identified by federal and state agencies to recover listed Central Valley salmonids in the Sacramento River watershed (i.e., headwaters to Collinsville).

NMFS (2009)				CDFG (2011)				USFWS (2001)			
Species Benefited	**Threat Category**	**Priority 1 Recovery Actions**	**Involved Parties**	**Species Benefited**	**Ecosystem Processes**	**Stage 2 Actions**	**Involved Parties**	**Species Benefited**	**Geographic Location**	**Restoration Actions/Evaluations**	**Involved Parties**
Spring-run Steelhead	Water temperature	1.9.8.2 Manage cold water pools in Camanche and Pardee reservoirs on the Mokelumne River to provide suitable water temperatures for all downstream life stages.	CDFG, EBMUD, NMFS, Reclamation, USFWS					Salmonids	Mokelumne River	Action 6. Maintain suitable water temperatures in the Mokelumne River for all salmonid life stages.	EBMUD, CDFG
								Chinook salmon Steelhead	Mokelumne River	Action 1. Supplement flows with water acquired from willing sellers consistent with applicable guidelines or negotiate agreements to improve conditions for all life history stages of Chinook salmon and steelhead in the Mokelumne River.	EBMUD, SWRCB, Woodbridge Irrigation District, FERC, CDFG, USFWS
								Salmonids	Mokelumne River	Action 2. Replenish gravel suitable for salmonid spawning habitat in the Mokelumne River.	CDFG, EBMUD
								Salmonids	Mokelumne River	Action 3. Cleasne spawning gravel in the Mokelumne River of fine sediments and prevent sedimentation of spawning gravel.	CDFG, EBMUD
								Juvenile salmonids	Mokelumne River	Action 4. Reduce and control flow fluctuations in the Mokelumne River to avoid and minimize adverse effects to juvenile salmonids.	
								Anadromous fish	Mokelumne River	Action 5. Screen all diversions on the Mokelumne River to protect all life history stages of anadromous fish.	Diverters, CDFG, DWR, USFWS, USBR, NMFS
								Juvenile salmonids	Mokelumne River	Action 7. Enhance and maintain the riparian corridor along the Mokelumne River to improve streambank and channel rearing habitat for juvenile salmonids.	Landowners, CDFG
								Salmonids	Mokelumne River	Action 8. Establish and enforce water quality standards for the Mokelumne River to provide optimal water quality for all life history stages of salmonids.	CDFG
								Salmonids	Mokelumne River	Action 9. Eliminate or restrict gravel mining operations in the Mokelumne River floodplain to prevent damage to potential spawning areas and encroachment of vegetation.	Gravel miners, CDFG

Appendix D
Comparison of actions identified by federal and state agencies to recover listed Central Valley salmonids in the Sacramento River watershed (i.e., headwaters to Collinsville).

NMFS (2009)				CDFG (2011)				USFWS (2001)			
Species Benefited	**Threat Category**	**Priority 1 Recovery Actions**	**Involved Parties**	**Species Benefited**	**Ecosystem Processes**	**Stage 2 Actions**	**Involved Parties**	**Species Benefited**	**Geographic Location**	**Restoration Actions/Evaluations**	**Involved Parties**
								Juvenile salmonids	Mokelumne River	Evaluation 1. Evaluate the effectiveness of pulse flows in the Mokelumne River to facilitate successful emigration of juvenile salmonids in the spring, and determine the efficacy in all water year types.	EBMUD, CDFG, USFWS, USBR
								Juvenile and adult salmonids	Mokelumne River	Evaluate 2. Evaluate and facilitate passage of spawning adult salmonids in the fall and juvenile salmonids in the spring past Woodbridge Dam and Lodi Lake on the Mokelumne River.	Woodbridge Irrigation District, City of Lodi, EBMUD, CDFG, USFWS
								Juvenile salmonids	Mokelumne River	Evaluation 3. Evaluate the incidence of predation on juvenile salmonids emigrating past Woodbridge Dam on the Mokelumne River, and investigate potential remedial actions if necessary.	Woodbridge Irrigation District, EB MUD, CDFG, USFWS, USBR
								Juvenile salmonids Adult steelhead	Mokelumne River	Evaluation 4. Evaluate the effects of extending the closure of the fishing season on the Mokelumne River from 31 December to 31 March (and possible to 1 June) to protect juvenile salmonids and adult steelhead and prevent anglers from wading on redds.	CDFG
								Salmonids	Cosumnes River	Action 1. Acquire water from willing sellers consistent with applicable guidelines or negotiate agreements to reduce water diversions or augment instream flows on the Cosumnes River during critical periods for salmonids.	Diverters, CDFG, USFWS, USBR
								Salmonids	Cosumnes River	Action 2. Pursue opportunities to purchase existing water rights from will sellers consistent with applicable guidelines to ensure adequate flows for all life stages of salmonids in the Cosumnes River.	CDFG, The Nature Conservancy, USFWS, USBR
								Not stated.	Cosumnes River	Action 3. Enforce Fish and Game Code sections that prohibit construction of unlicensed dams on the Cosumnes River.	CDFG

Appendix D Comparison of actions identified by federal and state agencies to recover listed Central Valley salmonids in the Sacramento River watershed (i.e., headwaters to Collinsville).											
NMFS (2009)				CDFG (2011)				USFWS (2001)			
Species Benefited	**Threat Category**	**Priority 1 Recovery Actions**	**Involved Parties**	**Species Benefited**	**Ecosystem Processes**	**Stage 2 Actions**	**Involved Parties**	**Species Benefited**	**Geographic Location**	**Restoration Actions/Evaluations**	**Involved Parties**
								Anadromous fish	Cosumnes River	Action 4. Screen all diversions on the Cosumnes River to protect all life history stages of anadromous fish.	Diverters, CDFG, DWR, USFWS, USBR, NMFS, The Nature Conservancy
								Not stated.	Cosumnes River	Action 5. Establish a riparian corridor protection zone along the Cosumnes River.	The Nature Conservancy, Landowners, CDFG
								Not stated.	Cosumnes River	Action 6. Rehabilitate damaged areas and remedy incompatible land practices to reduce sedimentation and instream water temperatures in the Cosumnes River.	The Nature Conservancy, Landowners, CDFG
								Salmonids	Cosumnes River	Evaluation 1. Determine and evaluate instream flow requirements that ensure adequate flows in the Cosumnes River for all life stages of all salmonids	Diverters, The Nature Conservancy, CDFG, USFWS, USBR
								Adult and juvenile salmonids	Cosumnes River	Evaluation 2. Evaluate and facilitate passage of adult and juvenile salmonids at existing diversion dams and barriers on the Cosumnes River.	Diverters and dam builders, The Nature Conservancy, CDFG, USBR, USFWS
								Salmonids	Cosumnes River	Evaluation 3. Evaluate the feasibility of restoring and increasing available spawning and rearing habitat in the Cosumnes River for salmonids.	The Nature Conservancy, CDFG, USBR, USFWS
				Not stated.	Non-native invasive species	Action 2. Continue research and monitoring programs to increase understanding of the invasion process and the role of established NIS in the Sacramento Valley ecosystem. No specifics given.					
				Chinook salmon	Chinook salmon	Action 2. Continue monitoring individual species' status and trends using new and existing data sets. No specific streams noted.					

Appendix D Comparison of actions identified by federal and state agencies to recover listed Central Valley salmonids in the Sacramento River watershed (i.e., headwaters to Collinsville).											
NMFS (2009)				CDFG (2011)				USFWS (2001)			
Species Benefited	Threat Category	Priority 1 Recovery Actions	Involved Parties	Species Benefited	Ecosystem Processes	Stage 2 Actions	Involved Parties	Species Benefited	Geographic Location	Restoration Actions/Evaluations	Involved Parties
				Chinook salmon	Chinook salmon	Action 3. To the extent possible, limit interaction between wild and hatchery-reared fish. No specifics noted.					

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APPENDIX E

Comparison of Actions for the San Joaquin Valley Watershed

Appendix E

Comparison of actions identified by federal and state agencies to recover listed Central Valley salmonids in the San Joaquin River watershed (i.e., headwaters to Mokelumne River confluence).

NMFS (2009)				CDFG (2011)				USFWS			
Species Benefited	**Threat Category**	**Priority 1 Recovery Actions**	**Involved Parties**	**Species Benefited**	**Ecosystem Processes**	**Stage 2 Actions**	**Involved Parties**	**Species Benefited**	**Geographic Location**	**Restoration Actions/Evaluations**	**Involved Parties**
Spring-run Steelhead	Habitat degradation and loss; Water quality	1.10.1 Develop and implement a suite of actions to improve salmon and steelhead outmigration survival through the mainstem San Joaquin River downstream of the Merced River by: ▸ Restoring floodplain habitat, and implementing ecological flow schedules to create frequently activated floodplain ▸ Reducing contaminants ▸ Implementing remedies for the biological oxygen demand and low dissolved oxygen levels in the Stockton Deep Water Ship Channel that impede fish migration.	CDFG, DWR. NMFS, Reclamation, SWRCB, USFWS, water districts	Fish	Dissolved oxygen	Action 1. Maintain dissolved oxygen levels in the San Joaquin River that meet SWRCB water quality objectives for the protection of fish and wildlife beneficial uses. No specific streams/sites noted.	SWRCB	Not stated.	San Joaquin River	Action 5. Maintain the 6 mg/L dissolved oxygen standard during September through November in the San Joaquin River between Turner Cut and Stockton, as described in the SWRCB's 1995 Water Quality Control Plan.	CDFG, DWR, ACOE, City of Stockton, Port of Stockton
				Aquatic biota	Contaminants	Action 1. Continue coordination and support for the TMDL and associated implementation to address dissolved oxygen depletion in the lower San Joaquin River. Listed in the Delta narrative.	SWRCB				
Spring-run Steelhead	Water management	1.10.2 Implement Action IV.2.1 (San Joaquin River Inflow to Export Ratio) of the Reasonable and Prudent Alternative described in the NMFS BO on the long-term operation of the CVP/SWP (NMFS 2009) to improve juvenile outmigration for steelhead and future spring-run Chinook salmon in the mainstem San Joaquin River downstream from the Merced River.	CDFG, DWR. NMFS, Reclamation, SWRCB, USFWS, water districts	Aquatic species	Water diversions	Further investigate the role of E/I ratio as dominant factor in particle fate, in relation to entrainment of pelagic organisms (including eggs and larvae) in SWP and CVP pumps and other diversions.	Not stated.	Not stated.	San Joaquin River	Action 2. Develop an equitable, integrated San Joaquin Basin plan that will meet outflow:export objectives identified under Sacramento-San Joaquin Delta Operational Target 4 and Supplemental Actions Requiring Water 7, 8, and 9.	River and tributary water managers and diverters, CDFG, SWRCB, DWR, USFWS, USBR
Spring-run Steelhead	Habitat loss	1.11.1.1 Evaluate and, if feasible, develop and implement a fish passage program for Goodwin, New Melones, and Tulloch dams on the Stanislaus River. ▸ Conduct feasibility study ▸ Conduct habitat evaluations ▸ Conduct 3-5 year pilot testing program ▸ Implement long-term fish passage program	CDFG, NMFS, Reclamation, USFWS	Chinook salmon	Chinook salmon	Action 1. Investigate whether individual species' respective range of distribution can be extended or changed, so they may persist in changing future conditions. No specific streams noted. No mention of steelhead.	Not stated.				

Appendix E

Comparison of actions identified by federal and state agencies to recover listed Central Valley salmonids in the San Joaquin River watershed (i.e., headwaters to Mokelumne River confluence).

NMFS (2009)				CDFG (2011)				USFWS			
Species Benefited	**Threat Category**	**Priority 1 Recovery Actions**	**Involved Parties**	**Species Benefited**	**Ecosystem Processes**	**Stage 2 Actions**	**Involved Parties**	**Species Benefited**	**Geographic Location**	**Restoration Actions/Evaluations**	**Involved Parties**
Spring-run Steelhead	Water temperature	1.11.1.2 Manage cold water pools behind Goodwin, New Melones and Tulloch dams to provide suitable water temperatures for all downstream life stages in the Stanislaus River.	CDFG, NMFS, Reclamation, USFWS	Salmonids	Water temperature	Action 3. Manage storage of and release from San Joaquin river tributaries to ensure the duration of cool temperatures are supportive of spawning, egg survival, and rearing of juvenile salmonids. No specific streams/reservoirs noted.	Not stated.	Anadromous fish	Stanislaus River	Evaluation 3. Evaluate and refine a Stanislaus River regulation plan that provides adequate flows to protect all life stages of anadromous fish based on water storage at New Melones Reservoir, predicted hydrologic conditions, and current aquatic habitat conditions.	USFWS, USBR, CDFG, ACOE
Steelhead	Water management	1.11.2.1 Develop and implement long-term instream flow schedules and requirements for the Calaveras River based on physical habitat modeling and critical riffle analysis.	CDFG, NMFS, USFWS					Fish	Calaveras River	Evaluation 2. Evaluate instream flow, water temperature and fish habitat use in the Calaveras River to develop a real-time management program so that reservoir operations can maintain suitable habitat when fish are present.	CDFG, Diverters, USFWS
Steelhead	Water management	1.11.2.2 Establish a minimum carryover storage level at New Hogan Reservoir that meets the instream flow and water temperature requirements in the lower Calaveras River.	ACOE, CDFG, NMFS, USFWS	Salmonids	Water temperature	Action 3. Manage storage of and release from San Joaquin river tributaries to ensure the duration of cool temperatures are supportive of spawning, egg survival, and rearing of juvenile salmonids. No specific streams/reservoirs noted.	Not stated.	Salmonids	Calaveras River	Action 2. Provide flows in the Calaveras River of suitable water temperature for all salmonid life stages.	CDFG,USFWS, USBR
Steelhead	Habitat degradation and loss	1.11.2.3 Remove or modify all fish passage impediments in the lower Calaveras River to meet NMFS fish passage criteria.	ACOE, CDFG, NMFS, USFWS					Anadromous fish Salmonids	Calaveras River Calaveras River	Action 3. Facilitate passage of adult and juvenile salmonids at existing diversion dams and barriers on the Calaveras River. Evaluation 1. Monitor sport fishing on the Calaveras River and evaluate the need for regulations to protect salmonids.	Diverters, CDFG CDFG
Spring-run Steelhead	Habitat loss	1.11.3.1 Evaluate and, if feasible, develop and implement a fish passage program for LaGrange and Don Pedro dams on the Tuolumne River. ▸ Conduct feasibility study ▸ Conduct habitat evaluations ▸ Conduct 3-5 year pilot testing program ▸ Implement long-term fish passage program	CDFG, NMFS, USFWS, Modesto Irrigation District, Turlock Irrigation District	Chinook salmon	Chinook salmon	Action 1. Investigate whether individual species' respective range of distribution can be extended or changed, so they may persist in changing future conditions. No specific streams noted. No mention of steelhead.	Not stated.				

Appendix E
Comparison of actions identified by federal and state agencies to recover listed Central Valley salmonids in the San Joaquin River watershed (i.e., headwaters to Mokelumne River confluence).

NMFS (2009)				CDFG (2011)				USFWS			
Species Benefited	**Threat Category**	**Priority 1 Recovery Actions**	**Involved Parties**	**Species Benefited**	**Ecosystem Processes**	**Stage 2 Actions**	**Involved Parties**	**Species Benefited**	**Geographic Location**	**Restoration Actions/Evaluations**	**Involved Parties**
Spring-run Steelhead	Water temperatures	1.11.3.2 Manage cold water pools behind LaGrange and Don Pedro dams to provide suitable water temperatures for all downstream life stages in the Tuolumne River.	CDFG, NMFS, USFWS, Modesto Irrigation District, Turlock Irrigation District	Salmonids	Water temperature	Action 3. Manage storage of and release from San Joaquin river tributaries to ensure the duration of cool temperatures are supportive of spawning, egg survival, and rearing of juvenile salmonids. No specific streams/reservoirs noted.	Not stated.				
Spring-run	Habitat degradation and loss	1.11.4.1 Implement the San Joaquin Settlement Agreement (San Joaquin River from Friant Dam to confluence with Merced River). ▸ Implement interim and long-term settlement flows ▸ Develop and implement a spring-run Chinook salmon reintroduction strategy ▸ Construct channel modifications to increase the channel capacity from 475 cfs to 4,500 cfs	CDFG, DWR, NMFS, Reclamation, USFWS					Chinook salmon	San Joaquin River	Action 1. Coordinate with CDFG and others and acquire water from willing sellers consistent with applicable guidelines as needed to implement a flow schedule that improves conditions for all life history stages of Chinook salmon migrating through, or rearing in the San Joaquin River.	River and tributary water managers and diverters, CDFG, SWRCB, USFWS, USBR
		▸ Minimize entrainment and fish losses to non-viable migration pathways: • Screen Arroyo Canal		Salmonids	Water diversions	Action 2. Screen all diversions to protect all life history stages of anadromous fish on the San Joaquin River system including Merced, Tuolumne, and Stanislaus rivers. No specific sites noted.	Not stated.	Anadromous fish	Calaveras River	Action 4. Screen all diversions on the Calaveras River to protect all life history stages of anadromous fish.	Diverters, CDFG, DWR, USFWS, NMFS, USBR
		• Retrofit Sack Dam to ensure unimpeded fish passage • Construct Mendota Pool Bypass • Fill and isolate high priority gravel pits • Implement temporary barriers at Mud and Salt sloughs						Anadromous fish	Merced River	Action 4. Screen all diversions on the Merced River to protect all life history stages of anadromous fish.	Diverters, USFWS, USBR, NMFS, CDFG, DWR
								Anadromous fish	Tuolumne River	Action 4. Screen all diversions on the Tuolumne River to protect all life history stages of anadromous fish.	Diverters, Lower Tuolumne River TAC, USFWS, USBR, NMFS, CDFG, DWR
								Anadromous fish	Stanislaus River	Action 4. Screen all diversions on the Stanislaus River to protect all life history stages of anadromous fish.	Diverters, USFWS, USBR, NMFS, CDFG, DWR

Appendix E

Comparison of actions identified by federal and state agencies to recover listed Central Valley salmonids in the San Joaquin River watershed (i.e., headwaters to Mokelumne River confluence).

NMFS (2009)				CDFG (2011)				USFWS			
Species Benefited	**Threat Category**	**Priority 1 Recovery Actions**	**Involved Parties**	**Species Benefited**	**Ecosystem Processes**	**Stage 2 Actions**	**Involved Parties**	**Species Benefited**	**Geographic Location**	**Restoration Actions/Evaluations**	**Involved Parties**
								Juvenile Chinook salmon	San Joaquin River	Action 3. Reduce or eliminate entrainment of juvenile Chinook salmon at Banta-Carbona, West Stanislaus, Patterson, and El Soyo diversions on the San Joaquin River by implementing the Anadromous Fish Screen Program in conjunction with other programs.	Diverters, USFWS, USBR, NMFS, CDFG, DWR
								Juvenile Chinook salmon	San Joaquin River	Action 4. Reduce or eliminate entrainment of juvenile Chinook salmon at smaller riparian umps and diversions on the mainstem San Joaquin River.	Diverters, USFWS, USBR, NMFS, CDFG, DWR
				Chinook salmon Steelhead	Streamflows	Action 1. Continue stream gages/real-time flow monitoring with the San Joaquin River system including Merced, Tuolumne, and Stanislaus rivers.	Not stated.				
				Fall-run	Streamflows	Action 2. Continue to assist the SWRCB to develop flow standards that allow adequate and consistent instream flows within the San Joaquin River watershed including Merced, Tuolumne, and Stanislaus rivers during key fall-run Chinook salmon life stages.	SWRCB Other parties not stated.				
				Chinook salmon Steelhead	Streamflows	Action 3. Increase instream flow by purchasing water from willing sellers or providing alternative sources of water to diverters during important fish passage periods in spring and fall. No specific streams noted.	Not stated.	Chinook salmon	Calaveras River	Action 1. Supplement flows in the Calaveras River with water acquired from willing sellers consistent with applicable guidelines or negotiate agreements to improve conditions for all life history stages of Chinook salmon.	Calaveras County Water District, Stockton East Water District, CDFG, ACOE, USFWS, USBR
								Chinook salmon	Merced River	Action 1. In the Merced River supplement flows provided pursuant to the Davis-Grunsky Contract Number D-GGR17 and FERC License Number 2179 with water acquired from willing sellers consistent with applicable guidelines or negotiate agreements as needed to improve conditions for all life history stages of Chinook salmon.	Merced Irrigation District, Diverters, CDFG, DWR, USFWS, USBR

Appendix E
Comparison of actions identified by federal and state agencies to recover listed Central Valley salmonids in the San Joaquin River watershed (i.e., headwaters to Mokelumne River confluence).

NMFS (2009)				CDFG (2011)				USFWS			
Species Benefited	**Threat Category**	**Priority 1 Recovery Actions**	**Involved Parties**	**Species Benefited**	**Ecosystem Processes**	**Stage 2 Actions**	**Involved Parties**	**Species Benefited**	**Geographic Location**	**Restoration Actions/Evaluations**	**Involved Parties**
								Chinook salmon	Tuolumne River	Action 1. Implement a flow schedule for the Tuolumne River as specified in the terms of the FERC order for the New Don Pedro Project. Supplement FERC agreement flows with water acquired from willing sellers consistent with applicable guidelines or negotiate agreements as needed to improve conditions for all life history stages of Chinook salmon.	City and County of San Francisco, Turlock Irrigation District, Modesto Irrigation District, Lower Tuolumne River TAC, FERC, USFWS, USBR
								Not stated.	Stanislaus River	Action 1. Implement an interim Stanislaus River regulation plan that meets the [flow scheduled listed] by supplementing the 1987 agreement between USBR and CDFG, through reoperation of New Melones Dam, use of (b)(2) water, and acquisition of water from willing sellers as needed.	CDFG, USFWS, USBR, Oakdale Irrigation District, South San Joaquin Irrigation District, Stockton East Water District, Central San Joaquin Water Conservation District, South Delta Water Agency, ACOE
								Not stated.	Merced River	Action 2. Reduce adverse effects of rapid flow fluctuations in the Merced River.	Merced Irrigation District, CDFG, USFWS, USBR
								Salmonids	Merced River	Action 3. Improve Merced River watershed management to restore and protect instream and riparian habitat, including consideration of restoring and replenishing spawning gravel.	Landowners, Merced County, NRCS, CDFG, USFWS, USBR
								Not stated.	Merced River	Action 5. Establish a streamwatch program for the Merced River to increase public participation in river management.	Public, CDFG, USFWS
								Juvenile Chinook	Merced River	Evaluation 2. Evaluate and implement actions to reduce predation on juvenile Chinook salmon, including actions to isolate ponded sections of the Merced River.	CDFG, USFWS, USBR

Appendix E

Comparison of actions identified by federal and state agencies to recover listed Central Valley salmonids in the San Joaquin River watershed (i.e., headwaters to Mokelumne River confluence).

NMFS (2009)				CDFG (2011)				USFWS			
Species Benefited	**Threat Category**	**Priority 1 Recovery Actions**	**Involved Parties**	**Species Benefited**	**Ecosystem Processes**	**Stage 2 Actions**	**Involved Parties**	**Species Benefited**	**Geographic Location**	**Restoration Actions/Evaluations**	**Involved Parties**
								Chinook salmon Steelhead	Merced River	Evaluation 3. Evaluate fall pulse flows in the Merced River for attraction and passage benefits to Chinook salmon and steelhead.	Dam operators, CDFG, USFWS, USBR
								Salmonids	Tuolumne River	Action 2. Improve Tuolumne River watershed management and restore and protect instream and riparian habitat, including consideration of restoring and replenishing spawning gravel and performing an integrated evaluation of biological and geomorphic processes.	Landowners, NRCS, CDFG, USFWS, USBR, Lower Tuolumne River TAC
								Noted stated.	Tuolumne River	Action 5. Establish a streamwatch program for the Tuolumne River to increase public participation in river management.	Public, Lower Tuolumne River RAC, CDFG, USFWS
								Not stated.	Tuolumne River	Action 6. Coordinate the AFRP with appropriate activities supported by the Riparian and Recreation Improvement Fund that was established by the New Don Pedro Settlement Agreement.	Lower Tuolumne River TAC, USFWS, USBR
								Juvenile Chinook	Tuolumne River	Evaluation 2. Evaluate and implement actions to reduce predation on juvenile Chinook salmon, including actions to isolate ponded sections of the Tuolumne River.	TID, MID, Lower Tuolumne River TAC, CDFG, USFWS, USBR
								Chinook salmon	Tuolumne River	Evaluation 3. Evaluate the effects of flow fluctuations in the Tuolumne River established by the guidelines of the FERC Settlement Agreement on spawning, incubation, and rearing of Chinook salmon, and if substantial adverse effects are indicated, modify guidelines to reduce effects.	Diverters, Hydropower operators, Lower Tuolumne River TAC, CDFG, USFWS, USBR
								Chinook salmon Steelhead	Tuolumne River	Evaluation 4. Evaluate fall pulse flows in the Tuolumne River for attraction and passage benefits to Chinook salmon and steelhead.	Diverters, Hydropower operators, Lower Tuolumne River TAC, CDFG, USFWS, USBR
								Salmonids	Stanislaus River	Action 2. Improve Stanislaus River watershed management to restore and protect instream and riparian habitat, including consideration of restoring and replenishing spawning gravel.	Landowners, CDFG, NRCS, ACOE, USFWS, USBR

Appendix E
Comparison of actions identified by federal and state agencies to recover listed Central Valley salmonids in the San Joaquin River watershed (i.e., headwaters to Mokelumne River confluence).

NMFS (2009)				CDFG (2011)				USFWS			
Species Benefited	Threat Category	Priority 1 Recovery Actions	Involved Parties	Species Benefited	Ecosystem Processes	Stage 2 Actions	Involved Parties	Species Benefited	Geographic Location	Restoration Actions/Evaluations	Involved Parties
								Juvenile Chinook	Stanislaus River	Evaluation 2. Evaluate and implement actions to reduce predation on juvenile Chinook salmon, including actions to isolate ponded sections of the Stanislaus River.	CDFG, USFWS, USBR, ACOE
								Chinook salmon	Stanislaus River	Evaluation 4. Develop a carryover storage target for New Melones Reservoir to ensure Vernalis flow standards are met during the 30-day pulse flow period during the third year of a dry or critical period.	USFWS, USBR, CDFG, Stockton East Water District
								Chinook salmon Steelhead	Stanislaus River	Evaluation 6. Evaluate fall pulse flows in the Stanislaus River for attraction and passage benefits to Chinook salmon and steelhead.	USFWS, USBR, CDFG, ACOE, Stockton East Water District
								Not stated.	San Joaquin River	Action 6. Establish a San Joaquin River basin-wide conjunctive use program.	River and tributary water managers and diverters, CDFG, DWR, USBR, USFWS
								Not stated.	San Joaquin River	Evaluation 1. Identify and implement actions to improve watershed management in the San Joaquin River watershed to restore and protect instream and riparian habitat.	Landowners, CDFG
								Chinook salmon	San Joaquin River and Delta	Evaluation 2. Identify and implement actions to maintain suitable water temperatures or minimize length of exposure to unsuitable water temperatures for all life stages of Chinook salmon in the San Joaquin River and Delta.	River and tributary water managers and diverters, CDFG,USFWS, USBR
								Juvenile Chinook salmon	San Joaquin River	Evaluation 3. Identify and implement actions to reduce predation on juvenile Chinook salmon in the San Joaquin River.	CDFG, USFWS

Appendix E

Comparison of actions identified by federal and state agencies to recover listed Central Valley salmonids in the San Joaquin River watershed (i.e., headwaters to Mokelumne River confluence).

NMFS (2009)				CDFG (2011)				USFWS			
Species Benefited	**Threat Category**	**Priority 1 Recovery Actions**	**Involved Parties**	**Species Benefited**	**Ecosystem Processes**	**Stage 2 Actions**	**Involved Parties**	**Species Benefited**	**Geographic Location**	**Restoration Actions/Evaluations**	**Involved Parties**
								Anadromous fish	San Joaquin River	Evaluation 6. Evaluate the potential to develop and implement a strategy of coordinating a variety of specific actions, such as coincident pulse flows on San Joaquin River tributaries, reduced Delta exports, hatchery releases, and gravel cleaning to stimulate outmigration and reduce predation and entrainment.	River and tributary water managers and diverters, CDFG,USFWS, USBR
								Steelhead	San Joaquin River	Evaluation 7. Identify, evaluate the need for, and, if needed, attempt to maintain adequate flows in the San Joaquin River for migration of steelhead, consistent with efforts to maintain adequate flows for Chinook salmon.	River and tributary water managers and diverters, CDFG,USFWS, USBR
				Native fishes	Natural floodplains and flood processes	Action 1. Support SWRCB's efforts to establish flow requirements that provide sufficient flows to inundate floodplains during critical later winter and early spring periods. No specific streams/sites noted.	SWRCB Other parties not stated.				
				Native fishes	Natural floodplains and flood processes	Action 2. Floodplains should be reestablished by settling flow requirements, constructing setback levees, and removing other obstacles. No specific streams/sites noted.	Not stated.				
				Native fishes	Natural floodplains and flood processes	Action 3. Pursue opportunities to allow reconnection of historic floodplain, with minimal impacts to private property. No specific streams/sites noted.	Not stated.				
				Salmonids	Riparian and riverine aquatic habitat	Action 1. Coordinate with other programs such as San Joaquin River Restoration Program and DWR's FloodSafe program to aide in the restoration of functional riparian corridors and to reestablished floodplains. Presumably the San Joaquin River. Other streams not noted.	DWR Other parities not stated.				

Appendix E
Comparison of actions identified by federal and state agencies to recover listed Central Valley salmonids in the San Joaquin River watershed (i.e., headwaters to Mokelumne River confluence).

NMFS (2009)				CDFG (2011)				USFWS			
Species Benefited	**Threat Category**	**Priority 1 Recovery Actions**	**Involved Parties**	**Species Benefited**	**Ecosystem Processes**	**Stage 2 Actions**	**Involved Parties**	**Species Benefited**	**Geographic Location**	**Restoration Actions/Evaluations**	**Involved Parties**
				Salmonids	Riparian and riverine aquatic habitat	Action 2. Acquire title or easements for river corridor meander zones on appropriate rivers and streams. No specific streams noted.	Not stated.				
				Salmonids	Riparian and riverine aquatic habitat	Action 3. Purchase streambank conservation easements from willing sellers or establish voluntary incentive programs to improve salmonid habitat and instream cover. No specific streams noted.	Not stated.				
				Salmonids	Riparian and riverine aquatic habitat	Action 4. Remove small, non-essential dams on gravel-rich streams. No specifics noted.	Not stated.				
				Salmonids	Water diversions	Action 1. Identify diversions within the San Joaquin River system in need of improved screens. No specifics noted.	Not stated.				
				Salmonids	Water diversions	Action 2. Screen all diversions to protect all life history stages of anadromous fish on the San Joaquin River system including Merced, Tuolumne, and Stanislaus rivers. No specific sites noted.	Not stated.				
				Salmonids	Water diversions	Action 3. Fund studies determining the effectiveness of different mechanical and operational solutions of screened diversions. No specific streams/sites noted.	Not stated.				
				Salmonids	Water diversions	Action 4. Construct or improve the fish bypasses at identified water diversions. No specific streams/sites noted.	Not stated.				
				Anadromous fishes	Water temperature	Action 1. Maintain water temperatures in the San Joaquin River and its tributaries that are beneficial to anadromous fish species. No specific streams/sites noted. Actions 1 and 2 duplicate the more specific Action 3.	Not stated.	Chinook salmon	Merced River	Evaluation 1. Identify and implement actions to provide suitable water temperatures in the Merced River for all life stages of Chinook salmon; establish maximum temperature objectives of 56°F from October 15 to February 15 for incubation and 65°F from April 1 to May 31 for juvenile emigration.	Dam operators, CDFG, USFWS, USBR

Appendix E
Comparison of actions identified by federal and state agencies to recover listed Central Valley salmonids in the San Joaquin River watershed (i.e., headwaters to Mokelumne River confluence).

NMFS (2009)				CDFG (2011)				USFWS			
Species Benefited	**Threat Category**	**Priority 1 Recovery Actions**	**Involved Parties**	**Species Benefited**	**Ecosystem Processes**	**Stage 2 Actions**	**Involved Parties**	**Species Benefited**	**Geographic Location**	**Restoration Actions/Evaluations**	**Involved Parties**
								Chinook salmon	Tuolumne River	Evaluation 1. Identify and implement actions to provide suitable water temperatures in the Tuolumne River for all life stages of Chinook salmon; establish maximum temperature objectives of 56°F from October 15 to February 15 for incubation and 65°F from April 1 to May 31 for juvenile emigration.	Dam operators, CDFG, USFWS, USBR, Lower Tuolumne River TAC
								Chinook salmon	Stanislaus River	Evaluation 1. Identify and implement actions to provide suitable water temperatures in the Tuolumne River for all life stages of Chinook salmon; establish maximum temperature objectives of 56°F from October 15 to February 15 for incubation and 65°F from April 1 to May 31 for juvenile emigration.	Dam operators, CDFG, USFWS, USBR, ACOE
				Steelhead	Steelhead	Action 1. Identify and fund projects increasing the understanding of the status of steelhead within the San Joaquin River watershed. No specific projects noted.	Not stated.				
				Steelhead	Steelhead	Action 2. Identify and fund projects monitoring steelhead population trends within the San Joaquin River watershed. No specific projects noted.	Not stated.				
				Chinook salmon	Chinook salmon	Action 2. Continue monitoring individual species' status and trends using new and existing data sets. No streams/sites noted.	Not stated.				
				Chinook salmon	Chinook salmon	Action 3. To the extent possible, limit interaction between wild and hatchery-reared fish. No specifics provided.	Not stated.				

Review of Scientific Information Pertaining to SWRCB's February 2012 Technical Report on the Scientific Basis for Alternative San Joaquin River Flow Objectives

Prepared for State Water Resources Control Board
Phase II Comprehensive Review Workshops
Workshop 2, "Bay-Delta Fisheries" to be held October 1-2, 2012

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On behalf of the
San Joaquin Tributaries Authority

September 14, 2012

1. SPRING FLOWS

Overview

Increasing spring flows in the San Joaquin River (SJR) basin is one of the main goals in Section 3 of the February 2012 SJR Flow and Southern Delta Salinity Technical Report (SWRCB Technical Report 2012). Justifications for the increased flows are based on research conducted by Dr. Carl Mesick, California Department of Fish and Game (DFG; largely based on Mesick research), Anadromous Fish Restoration Program (AFRP; again largely based on Mesick research), The Bay Institute/ Natural Resources Defense Council (TBI/NRDC 2010a-c), and a variety of survival studies conducted from the early 1980s to 2010. Increased spring flows (occurring in the months of February through June) are thought to be the main factor influencing juvenile Chinook salmon (*Oncorhynchus tshawytscha*) survival and subsequent adult spawning abundance.

Research investigating the relationship between flows in the SJR, the Sacramento-San Joaquin Delta (Delta) and various aspects of Chinook salmon life history (e.g. smolt survival, escapement) has been conducted for nearly 35 years. Much of the research has been inconclusive and early studies are well summarized by Baker and Morhardt (2001) and more recently by the Vernalis Adaptive Management Program (VAMP) independent review panel (Dauble et al. 2010). Some key points from Dauble et al. (2010, pages 3 and 4) are:

- "Panel members are in agreement that simply meeting certain flow objectives at Vernalis is unlikely to achieve consistent rates of smolt survival through the Delta over time."
- "The complexities of Delta hydraulics in a strongly tidal environment, and high and likely highly variable impacts of predation, appear to affect survival rates more than the river flow, by itself, and greatly complicate the assessment of effects of flow on survival rates of smolts."
- "Apparent downstream migration survival of juvenile Chinook salmon was very poor during 2005 and 2006 even though Vernalis flows were unusually high (10,390 cfs and 26,020 cfs, respectively). These recent data serve as an important indicator that high Vernalis flow, *by itself*, cannot guarantee strong downstream migrant survival."
- "Although some positive statistical associations between San Joaquin River flow and salmon survival have been identified, there is also very large variation in the estimated survival rates at specific flow levels and there is a disturbing temporal trend to reduced survival rates at all flows. This large variability and associated temporal decline in survival rates strongly supports a conclusion that survival is a function of a complex set of factors, of which San Joaquin River flow at Vernalis is just one."

In addition, Baker and Morhardt (2001) and Dauble et al. (2010) both identify data gaps, experimental deficiencies, and high variability in survival rates for specific flows. Both reach some similar conclusions: that more research should be conducted, the variable of flow is likely not the only factor, and that a precise flow target set by management policies would likely not provide reliable survival rates on a year-to-year basis. These two documents were "buried" deep within section 3 of the SWRCB's Technical Report (2012; pages 3-32 for Baker and Morhardt [2001] and pages 3-38 and 3-39 for Dauble et al. [2010]).

These findings are in contrast with much of the literature cited in the SWRCB's Technical Report (2012) related to flow. Specifically, much of the cited material is based on analyses conducted by DFG (2005, 2010a) and Mesick (Mesick and Marston 2007, Mesick et. al 2007, Mesick 2009), as well as similar analyses by TBI and NRDC (2010a-c) and AFRP (2005), which all generally conclude that increased spring flows would increase both smolt survival and future escapement. These analyses do not adequately account for variables other than flow that could affect smolt survival or adult escapement, and rely on improper interpretations of simplistic linear regression relationships between complex variables. The linear relationships suffer from poor fits and violate many standard assumptions of linear regression analyses (see Attachment 1 and Demko et al. 2010 for more detailed reviews).

SWRCB's Technical Report (2012) Assertions Regarding Relationship Between San Joaquin River Flows and Salmon Survival

Bold statements below indicate the SWRCB's Technical Report (2012) assertions regarding the relationship between SJR flows and salmon survival, followed by supporting/contrary evidence, as follows:

SWRCB Assertion 1: The number of Chinook salmon spawners returning to the San Joaquin system are correlated with river flows during the February-June rearing and outmigration period 2 1/2 years earlier (pages 3-32 and 3-35).

- This flow/outmigration relationship was first mentioned during 1976 SWRCB proceedings by DFG (1976).
- Since 1976, this regression of flow and escapement 2.5 years later has been mentioned in numerous documents, which were cited throughout the SWRCB 2012 report. However, the statistical analyses used in these reports do not take into account the age composition of returning adults (made up of 2–5 year old adults). Instead, they lump all ages into age-3 adults, which are typically the dominant age group among returning adults in a given year. Therefore, simply grouping adult salmon of other ages into the escapement (the dependent variable in the relationship) is the incorrect way to conduct this type of analysis and adds additional uncertainty into the purported flow/outmigration relationship. For instance, using a simple example illustrating this issue, let us say that 1,000 adult salmon (made up of ages 2-5) return in 2011. For simplicity, let's also say that 10% of that escapement class is age-2 ("jacks"), 50% are age-3, 35% are age-4, and 5% are age-5. Using that age composition, there would be 100 age-2 salmon, 500 age-3 salmon, 350 age-4 salmon, and 50 age-5 salmon. Based on life history of fall-run Chinook salmon, that would mean that the 100 age-2 salmon that returned to spawn in Fall 2011 migrated to the ocean during the spring of approximately 1.5 years earlier, during the Spring of 2010. Similarly, the 500 age-

3 adult salmon entered the ocean approximately 2.5 years earlier (Spring of 2009), age-4 adult salmon entered approximately 3.5 years earlier (Spring of 2008), and age-5 adult salmon entered the ocean approximately 4.5 years earlier (Spring of 2007). The regression of flow and escapement 2.5 years later simply does not account for the well-known life history characteristics of fall-run Chinook salmon in the Central Valley (CV) and should not be used. A more appropriate cohort-specific analysis, would relate escapement of each age group with the conditions that each age group experienced in freshwater or during the outmigration period. Therefore, time-series data of escapement of age-2 salmon would need to be analyzed with the proper time-series data of outmigration conditions approximately 1.5 years earlier, not 2.5 years earlier. Similar corrections would need to be made with the older age groups as well. Due to this additional uncertainty, cohort-specific analyses and models (i.e., those that include age composition) should be used instead of the cited analyses. Flow management decisions should not be made using such potentially unreliable analyses.

SWRCB Assertion 2: In the SJR basin, it is recognized that the most critical life stage for salmonid populations is the spring juvenile rearing and migration period (DFG 2005, Mesick and Marston 2007, Mesick et al. 2007, and Mesick 2009) (pages 1-3 and 3-2).

- Most research from the Pacific Northwest suggests that the period after ocean entry is the most critical life stage for juvenile salmonids (i.e., where most of the mortality occurs) and largely determines year-class strength (or escapement, i.e., number of spawning adults in a given year) (Pearcy 1992, Gargett 1997, Beamish and Mahnken, 2001).
- The documents cited by SWRCB's Technical Report (2012) to support this claim are not peer reviewed and all based on work conducted by Mesick and others.

SWRCB Assertion 3: Analyses indicate that the primary limiting factor for salmon survival and subsequent abundance is reduced flows during the late winter and spring (February through June) when juveniles are completing the freshwater rearing phase of their life cycle and migrating from the SJR basin to the Delta (DFG 2005; Mesick and Marston 2007; Mesick et al. 2007; Mesick 2009) (page 3-28).

- The VAMP independent scientific review panel determined that "simply meeting certain flow objectives at Vernalis is unlikely to achieve consistent rates of smolt survival through the Delta" (Dauble et al., 2010).
- Based on Figure 11 from Baker and Morhardt (2001), NMFS (2009) states that "flows below approximately 5,000 cfs have a high level of variability in the adult escapement returning 2.5 years later, indicating that factors other than flow may be responsible for the variable escapement returns. Flows above approximately 5,000 to 6,000 cfs begin to take on a linear form and adult escapement increase in relation to flow."
  - However, Baker and Morhardt (2001) indicates that there are no data points between 11,000-18,000 cfs, so there is no ability to identify a linear trend beginning at 5,000 cfs. Also, Baker and Morhardt (2001) state,

"when only the data below 10,000 cfs are considered, there appears to be a negative relationship between flow and smolt survival."

- No factors other than flow (e.g., ocean conditions, predation, etc.) were investigated in a rigorous fashion in the models suggesting a causal relationship between spring flow and adult returns.
  - "The complexities of Delta hydraulics in a strongly tidal environment, and high and likely highly variable predation, appear to affect survival rates more than flow, by itself, and complicate the assessment of flow effects of on survival rates." (Dauble et al. 2010).
  - Choice of emigration route may be more important to survival than flow (Perry et al. 2010).
- The documents cited by the SWRCB's Technical Report (2012) to support this claim are not peer reviewed and all based on work conducted by Mesick and others.
- Bay Delta Conservation Program and Delta Stewardship Council are not using these analyses and an independent review panel recently recommended that NMFS develop a life cycle model for CV salmonids to examine water management and Biological Opinion Reasonable and Prudent Actions (Rose et. al. 2011).

Other Potential Factors That Influence Survival of Juvenile Salmon Not Accounted for in SWRCB's Technical Report (2012) or in Analyses Cited

Timing of outmigration:

- Survival of later-migrating juvenile Chinook smolts in the Columbia and Snake Rivers generally decreases compared to early-migrating smolts (Anderson 2003, Figures 10 and 24).
- Smolt-to-adult survival (cohort-specific) related to migration timing. Chinook smolts that migrated earlier in outmigration season are more likely to survive to adulthood (Scheurell et al. 2009).
- Snake River fall-run Chinook survival to Lower Granite Rapids Dam had the highest correlation with release date and water quality parameters (water temperature), which co-vary (Anderson et al. 2000, NMFS 2000a).

Route-Specific Migration Probabilities and Survival Probabilities:

- Perry et al. (2010) clearly shows the complicated nature of estimating survival in a highly complex, dendritic water body such as the Delta. Perry's work adds additional uncertainty to the survival estimates used by Mesick. The variation in survival estimates in years with high flows may be due to the route(s) that fish selected instead of the actual flows themselves. Higher survival rates could be due to a higher proportion of CWT-tagged salmon migrating into a route with a higher reach-specific survival rate.

Ocean Conditions:

- The SWRCB's Technical Report (2012) largely ignores the great influence that ocean conditions can have on survival and year-class strength of CV salmon. This reflects the reliance of the SWRCB's document on analyses that largely dismisses the role of ocean conditions (Mesick and Marston 2007, Mesick et. al 2007, Mesick 2009, TBI and NRDC 2010a-c, AFRP 2005).

- Lindley et al. (2007) states that a "broad body of evidence suggests that anomalous conditions in the coastal ocean in 2005 and 2006 resulted in unusually poor survival of the 2004 and 2005 broods of the SRFC (Sacramento River Fall-run Chinook)."
- Both the 2004 and 2005 broods entered the ocean during a period of weak upwelling, warm sea surface temperatures, and low densities of prey items (Lindley et al. 2009).

Accumulated Thermal Units (ATUs) – or Thermal Experience:

- In the Columbia River, migration patterns (onset of outmigration) of Chinook smolts were most associated with accumulated thermal units (a positive relationship); while increasing flow had a negative influence (Sykes et al. 2009). Thermal experience was found to have more influence on migration than daily mean water temperature.

Distance Traveled:

- Hatchery Chinook smolt survival varied inversely with the distance traveled to Lower Granite Rapids Dam (Muir et al. 2001).
- Smolt survival in the Columbia and Snake Rivers depends on distance traveled more than travel time (Anderson 2003, Bickford and Skalski, 2000) or migration velocity (Anderson et. al. 2005).

Additional Information regarding Flow and Juvenile Salmon Survival Relationships

Central Valley:

- Survival estimates for acoustically-tagged late-fall Chinook in a December release group were lower than for the January release group despite higher discharge and shorter travel times (Perry et al. 2010, p. 151). Some of this difference, however, was due to the proportion of each group that migrated between three different routes.

Outside Central Valley:

- No consistent relationship was found between years for either flow (study used a flow exposure index) or change in flow and Chinook smolt survival from Lower Granite Dam and McNary Dam (Smith et al. 2002). However, median travel times in each year decreased with increased flow exposure index (Smith et al. 2002). There was no relationship between median travel times and survival.
- No correlation present between daily flow and daily smolt survival probabilities (spring-run Chinook) through one reach of the Columbia River (Skalski 1998).
- On the Columbia River (spring-run Chinook) - Increased survival rates in the 1990s compared to the mid to late 1970s was not a function of flows. No significant differences were found between mean daily flows between the two periods (Williams et al., 2001).

- No relationship between fall-run Chinook survival and flow-travel time (Giorgi et al., 1994).
- No within-year flow-survival relationship for spring-run Chinook salmon smolts (Smith et al. 1997a).
- No within-year flow-survival relationship for fall-run Chinook salmon smolts (Giorgi et al. 1997, Smith et al. 1997b).
- No flow-survival relationship for Snake River spring-run Chinook smolts (NMFS 2000a).

2. FLOODPLAIN HABITAT

Overview

Creation of floodplains, one of the functions supported by spring flows according to the SWRCB's Technical Report (2012), has the potential to affect salmonid populations in various ways. While the ecology of floodplains in temperate regions, particularly on salmonid bearing streams, has been poorly studied, and some literature indicates that floodplain rearing increases growth and survival of Chinook salmon. In addition, floodplains provide important ephemeral spawning and rearing habitat to which native fish fauna has adapted.

While potential floodplain benefits to salmon fry are relatively undisputed, the main issue on the SJR and its tributaries appears to be the lack of low lying areas that can be regularly inundated by elevated discharge to provide productive floodplain habitat, which SWRCB's Technical Report (2012) fails to recognize. Inundation projections from modeling exercises often derive their floodplain estimates based solely on inundated surface area, without giving consideration to characteristics of inundated habitat (depths, substrate, vegetation, etc.).

Citations presented in the SWRCB's Technical Report (2012) illustrating the benefit of floodplain to rearing fishes are based on research conducted in river basins that are not directly comparable to the SJR and its tributaries (e.g., Mississippi River, neotropical and Southeast Asia systems). While there is some supporting evidence regarding the positive effects of frequent, long duration inundation of shallow floodplains on Chinook fry rearing in California (e.g., Sommer et al 2001, 2005; Moyle et al. 2007), such habitat is extremely limited in the SJR due to extensive habitat alteration and levee construction (Essex 2009). It follows that potential implied benefits of a more variable flow regime outlined in SWRCB's Technical Report (2012) may not be realized or will be severely curtailed in the SJR basin.

SWRCB's Technical Report (2012) Assertions regarding Floodplain Habitat

Bold statements below indicate the SWRCB's Technical Report (2012) assertions regarding floodplain habitat, followed by supporting/contrary evidence, as follows:

SWRCB Assertion 1. Warm, shallow-water floodplain habitats allow steelhead juveniles to grow faster (page 3-27).

- Juvenile steelhead are not known to rear in floodplain habitats to any great degree at any time of year (Bustard and Narver 1975, Swales and Levings 1989, Keeley et al. 1996, Feyrer et al. 2006, Moyle et al. 2007).
- Based on multi-year studies in the Cosumnes River, Moyle et al. (2007) concluded that steelhead were not adapted for floodplain use and the few steelhead observed were inadvertent floodplain users (i.e., uncommon and highly erratic in occurrence) that were "presumably…carried on to the floodplain by accident."

SWRCB Assertion 2. Successful Chinook salmon rearing is often associated with connectivity between river channel and riparian and floodplain habitat (page 3-19).

- Juvenile Chinook salmon are known to use floodplains, when available, for rearing. They benefit from floodplain use during the rearing phase through higher growth and greater feeding success (e.g. Sommer et al. 2001, Moyle et al. 2007).
- Chinook salmon have been documented to utilize the floodplain habitat in the Sutter Bypass, Yolo Bypass, and in the Cosumnes River (Feyrer et al. 2006, Sommer et al. 2001, Sommer et al. 2005, Moyle 2007).
    - In the Cosumnes River (annual floodplain inundation ranged from 6 to 158 days), Moyle et al. (2007) found that Chinook salmon were the most abundant species found in February and March. Likewise, Feyrer et al. (2006) found that juvenile Chinook salmon were common in the Sutter Bypass from January through May, but were relatively rare in June; on the Yolo Bypass they occurred primarily in March.

SWRCB Assertion 3. Floodplain rearing increases growth and survival in Chinook salmon (page 3-19).

- Chinook salmon that rear on floodplains have been shown to grow more rapidly than those rearing in the main river channel (Sommer et al. 2001).
- "1998 results *suggest* that in *some* years, survival *may* actually be substantially higher for salmon that migrate through the floodplain" (Sommer et al. 2005). However, clear conclusions regarding survival effects of juvenile floodplain use on adult recruitment are not available, and increased survival of these fish is often based on the inference that increased size at outmigration reduces mortality.

SWRCB Assertion 4. Floodplain inundation in the spring may benefit native species (pages 3-41 to 3-42).

- Historically, floodplains were important spawning and rearing habitats for at least some native fishes (e.g., obligate floodplain spawners, such as splittail), but their importance to river-spawners and slough residents (sucker and blackfish, respectively) is not well understood (Crain et. al 2004).
- "Today, floodplains appear important to native fishes mainly early in the season (February– April)" (Crain et. al 2004, page 15).
- Non-native species dominate the floodplain community later in the season (April-July) particularly permanent residents of ponds, ditches, and sloughs on the

floodplain) due to warmer water temperatures and lower flows (Crain et. al 2004). This is of special importance to floodplain management in the SJR Basin, as high abundances of non-native predators may benefit from floodplain inundation during proposed period, predominantly from April-June.

SWRCB Assertion 5. Shallow-water floodplain habitat provides rearing Chinook with refuge from predatory species (page 3-44).

- Shallow-water floodplains in the Sacramento River provide a refuge from large pelagic (i.e., open water) predators (e.g., Sacramento pikeminnow and striped bass) that, due to their pelagic nature, are unlikely to invade shallow, cover-rich habitats such as inundated fields of the Yolo Bypass.
- Much of the inundated floodplain habitat in the SJR that could be provided in the managed flow range are associated with oxbow features (cbec 2010), which are unlikely to provide predator refuge benefits because predation, particularly by ambush predators (e.g., largemouth bass), is expected to increase in such habitats (Saiki 1984, Brown 2000, Grimaldo et al. 2000, Feyrer & Healey 2003). These predators have been shown to be more efficient at capturing prey in complex habitat and in turbid conditions than pelagic piscivores (Greenberg et al. 1995, Nobriga & Feyrer 2007).
- The presence of high densities of exotic piscivorous fish in the perennial oxbows would likely result in heavy mortality of juvenile salmonids that entered the flooded oxbow areas.

SWRCB Assertion 6. "Floodplain inundation provides flood peak attenuation and promotes exchange of nutrients, organic matter, organisms, sediment, and energy between the terrestrial and aquatic systems" (SWRCB 2012, page 3-43).

- This is contradictory to the content of section 3.7.6 of the SWRCB's Technical Report (2012), which lists nutrients as a main factor contributing to poor water quality in the SJR and concludes that higher flows would serve to dilute this and other constituents of water quality:

> "Eutrophication from the dissolution of natural minerals from soil or geologic formations (e.g., phosphates and iron), fertilizer application (e.g., ammonia and organic nitrogen), effluent from sewage-treatment plants (e.g., nitrate and organic nitrogen), and atmospheric precipitation of nitrogen oxides may cause chronic stress to fish (McBain and Trush 2002). Algae and plant growth under eutrophic (high nutrient) conditions, along with their subsequent decomposition in the water column, lead to increase oxygen consumption and decreased dissolved oxygen conditions, reduced light penetration and reduced visibility. These conditions may render areas unsuitable for salmonid species, and favor other species (e.g., sucker, blackfish, carp, and shad)" (SWRCB 2012, page 3-49).

Clearly, the explanation of proposed benefits of changes to the flow regime with regards to nutrient supplementation (or dilution) is in need of refinement, and a more detailed evaluation of the relationship between proposed flow alterations and food web benefits is required.

SWRCB Assertion 7. Floodplain inundation provides benefits to downstream reaches in the form of nutrient supply (page 3-43).

- This assertion is erroneously attributed to Mesick (2009) by SWRCB's Technical Report (2012). Mesick (2009) did not study floodplains and their relationship to increased smolt survival, and did not investigate nutrient flow in the Tuolumne River.
- Levels of dissolved nutrients are seldom limiting factors for primary production in the main channel of rivers (Junk et al. 1989).
- The role of floodplains in nutrient cycling has not been extensively studied in California, but studies from other parts of the world indicate that floodplains can be both sources and sinks for nutrients, depending on geology, inundation duration, riverine nutrient loading, and many other factors (Junk et. al 1989). A study from the Cosumnes River suggests that floodplain inundation can reduce the amount of nitrate transported to downstream reaches (Sheibley et al. 2002).

Additional Information regarding Floodplain Inundation and Rearing of Juvenile Chinook in the SJR Basin

Floodplain conditions in the SJR Basin differ greatly from those in other river systems.

- Floodplains in the Yolo and Cosumnes bypasses consist of virtually one, large continuous expanse of mostly shallow-water habitat; while the San Joaquin Basin consists of several disconnected, smaller areas of largely deep-water habitat (oxbow features). This deep-water habitat is similar to isolated pond habitats in the Yolo Bypass where alien fish dominate and no Chinook salmon were found (Feyrer et al. 2004).
- Floodplains consisting of large expanses of shallow (mostly <1 m), slow velocity (mostly <0.3 mps) water have shown increased productivity of food organisms for fish and increased growth of juvenile Chinook salmon (Sommer et al. 2001). Limited studies in the Cosumnes River Preserve found that growth of juvenile Chinook was slower in isolated pond areas than in adjacent flooded pastures and woodlands (Jeffries et al. 2008).
- San Joaquin Basin inundation zones estimated by the cbec analysis (cbec 2010) only indicate the amount of maximum floodplain area available under a range of flows, but do not indicate the proportion of that habitat that could be used by salmon since they did not identify habitat quality (i.e., depth and velocities).
- Growth differences between juveniles rearing in floodplains versus in-river were found after a two-week period (Jeffres et al. 2008): expecting same benefits after less than two-week inundation period not warranted.
- Increased growth on floodplains is likely related to several factors including warmer water temperatures resulting from shallower depths and greater surface area than found in-river, as well as lower velocities and better food sources (Sommer et al. 2001).

Stranding risk associated with floodplain draining.

- Sommer et al. (2005) suggests that the majority of fish successfully emigrated from the Yolo Bypass because this particular floodplain drains fairly efficiently due to the low percentage of isolated pond area under both peak flood and draining periods; yet over 120,000 Chinook may have been stranded during that study (Sommer et al. 2005).
- Compared to the Yolo Bypass, where ponds are relatively rare and the Bypass is gradually sloped into a parallel toe drain, oxbow channel features characteristic of the lower SJR may not provide ideal rearing habitat for outmigrating salmonids and flooded oxbows are likely to result in significant stranding of juvenile salmon.

Achieving floodplain inundation is questionable under the maximum monthly target flows identified for each tributary by SWRCB (2012).

- DFG (2010c) visually inferred floodplain inundation from graphs of flow-area relationships
  - Wetted surface area increases on the graphs more quickly between 3,000-5,000 cfs (Merced) and between 4,000-6,000 cfs (Tuolumne) indicating greater increases in width, which suggests bank overtopping or floodplain inundation
  - The Stanislaus River channel did not appear to have a well-defined floodplain within the 100 to 10,000 cfs flow range examined (SWRCB 2012, DFG 2010); note: other unpublished studies of a small portion of the Stanislaus River (5.7 miles) indicates that a minimum of 3,000 cfs would be required for this portion of the river.
  - Therefore, minimum floodplain thresholds considered 3,000 cfs for the Merced and Stanislaus Rivers, and 4,000 cfs for the Tuolumne River.
- Assuming minimum floodplain thresholds above (i.e., 3,000 cfs for the Merced and Stanislaus Rivers, and 4,000 cfs for the Tuolumne River), all three minima exceed the maximum monthly target flows as specified for each tributary by the SWRCB's Technical Report (2012)(i.e., 2,500 cfs for the Stanislaus River; 3,500 cfs for the Tuolumne River; and 2,000 cfs for the Merced River). It is unknown at this time how the SWRCB's Technical Report (2012) intends that these maximum flow targets would be achieved (i.e., maximum daily amounts per month, or maximum average daily amounts per month), but if the SWRCB intends for these to be maximum daily targets, then floodplain inundation thresholds (3,000-4,000 cfs) exceed all targets.

Brief floodplain inundation (< two weeks) has not shown benefit.

- Assuming that floodplain does begin to inundate at these minimum floodplain inundation threshold flows identified above (i.e., 3,000-4,000 cfs, which is questionable), it remains to be discerned whether inundation periods <two-weeks are of sufficient duration to provide measurable benefits to rearing salmonids. Growth differences between floodplain-reared and in-river juveniles have been found after a two-week growth period in the Cosumnes River (Jeffres et al. 2008),

yet expecting similar growth increases in San Joaquin River floodplains after <2-week inundation periods is not warranted. Furthermore, Sommer et al. (2001) indicated that characteristics that possibly accounted for an increased growth rate on floodplain habitats included warmer water temperatures than in-river resulting from shallower depths and greater surface area, as well as lower velocities and better food sources (Sommer et al. 2001). Warmer water temperatures did not become apparent until ambient air temperatures began to increase, beginning in March. As mentioned previously, shallow water floodplain habitat is not prevalent in the San Joaquin Basin.

Late spring floodplain inundation.

- Increasing air temperatures in late spring (late May and June) are expected to lead to warmer water on the floodplains than in the river channels. According to Feyrer et al. (2006), the water temperatures on the Sutter and Yolo bypasses rose to about 24°C by June 2002 and 2004. These temperatures are approaching the chronic upper lethal limit for CV Chinook salmon (approximately 25°C) and according to Myrick and Cech (2001), juvenile Chinook salmon reared at water temperatures between 21 and 24°C were more vulnerable to striped bass predation than those reared at lower water temperatures.

SWRCB's Technical Report (2012) emphasizes the need for creating more floodplain in the San Joaquin Basin through higher flows, but "floodplain habitat" is not defined nor quantified for the San Joaquin Basin.

- The attributes of "floodplain habitat," such as depth, velocity, cover, and water temperature, are not defined.
- No information/data is presented as to how much floodplain habitat exists in the San Joaquin Basin, how much could be gained at various flows, or what the benefit to Chinook would be.

Recent Information Not Previously Available to the SWRCB

USBR technical feedback committee meeting SJRPP, July 2012.

Recent presentations at the USBR technical feedback committee meeting for the San Joaquin River Restoration Program (SJRRP) (USBR 2012), while summarizing the current state of salmon restoration science in the SJR, clearly illustrated the lack of specific information that is required for sound decision making.

Estimates of in-river habitat (including floodplain) requirements for successful rearing of enough juvenile salmon to meet management goals currently rely on many unrealistic assumptions, and are based on "territory size" required by juvenile salmonids at various developmental stages (e.g., fry require less "territory" than smolts). It should be noted that available suitable habitat (ASH) does not directly correspond to total habitat requirements, as it doesn't take into consideration the amount of river channel, riparian vegetation, sediment input, etc. needed to support the ASH.

Survival simulations indicate that, under current estimated mortality rates (based on other watersheds), the production goal of 44,000-1.6 million (spring run) and 63,000 – 750,000 (fall run) successful juvenile outmigrants would require 121 million spring-run and 173 million fall-run fry hatched at the spawning grounds. As juveniles move downstream and their sizes increase (and abundance decreases), territory size requirements are applied to abundance modeling based on a length-territory size relationship for salmonids from Grant and Kramer (1990). Preliminary estimates for maximum required suitable rearing habitat (in acres) are summarized in the table below:

Reach	**Spring-Run**	**Fall-Run**	**Both Runs**
Lower 1B	73	158	231
2A	121	276	397
3	59	183	242
4A	13	88	101
4B1	14	40	54
4B2	6	10	16
5	7	5	12
Total	**365**	**861**	**1226**

As SJR tributaries are deficient in shallow-water floodplain habitat, higher flows are proposed to reduce available habitat requirements, as fish are moved out of the system in a conveyor belt like fashion (Dr. Merz) and will therefore spend less time rearing in-river. However, note that data from other rivers in both the northern and southern CV are used to inform simulations for the SJR, which may not be applicable or sound. In addition, the model was purposely kept simple, and many potentially important habitat characteristics (variable flow timing) were not included in the simulations.

Available floodplain modeling for the SJR is also still in its infancy, and so far only three water year scenarios have been examined (dry, normal, wet), and overall results were far too variable to draw clear conclusions:

- Overall available habitat results varied wildly depending on levee alignment;
- For each different levee alignment, the results varied drastically dependent on flow;
- Results also varied dependent on vegetative cover options;
- Some scenarios resulted in a small surplus of adequate floodplain habitat; others resulted in a deficiency of thousands of acres.

Furthermore, definitions of vegetative cover are not sufficiently refined, as shrub cover (which perhaps comprises most of the available habitat) is not included in the model since it cannot be estimated from aerial photography.

Current results from physical and biological model integration were not presented, but will be made available on the SJRRP website in the near future.

Stanislaus River Floodplain Versus Flow Relationships- USFWS results March 7, 2012.

A brief description of Stanislaus Floodplain modeling was provided in a March 2012 report (USFWS 2012) and presented at a Stanislaus Operations Group (SOG) meeting in May 2012 (SOG 2012). The goal was to develop a two-dimensional hydraulic model to quantify the relationship between floodplain area and flow for the Ripon to Jacob Myers reach of the Stanislaus River (RM 17.2 to 34.7), for flows ranging from 250 to 5,000 cfs.

Floodplain was defined based on a modeled wetted area versus flow relationship. First, a graph of total wetted area versus flow was examined to determine the flow at which floodplain inundation begins, as indicated by an inflection point in the graph (the wetted area vs. flow graph from which the inflection point was determined is the figure supplied as part of the meeting notes, inundation begins at ~1250 cfs). Then, the total wetted area at higher flows is subtracted from the total wetted area at which floodplain inundation begins to determine the inundated floodplain area at each flow (meaning that floodplain is essentially considered 0 at ~1,250 and then accrues as flows increase above this amount). Based on this standard methodology, floodplain inundation is expected to encompass low flow channels since the inflection point is likely not observed until other areas also become inundated.

No floodplain depths were specified in the graph provided in the meeting notes. However, in the report, there is one figure that provides depths of floodplain (red) expected at 1,500 cfs, which ranged from 0-2 meters deep (0-6 feet). Due to the color codes used, it is difficult to ascertain whether these depths are closer to zero or closer to 6 feet, which would affect whether these inundated areas would provide good rearing habitat. USFWS is only interested in total floodplain area (macrohabitat level), so indicated that wouldn't be providing any additional depth related figures, nor will velocities and water temperatures (microhabitat level) be incorporated into the floodplain model since the floodplain analysis is being done on a macrohabitat basis and there is no consideration of microhabitat variability (e.g., velocity or water temperature). In addition, the model used is not suitable for microhabitat level analysis given its coarse spatial scale resolution, so any efforts to look at those variables would require a different model.

USFWS' results for the Orange Blossom Bridge to Knight's Ferry reach (7.4 miles) indicate that 35 acres of floodplain accrue between flows of 1,500 cfs to 3,000 cfs with an additional 32.1 acres between 3,000 cfs and 5,000 cfs.

USFWS' future plans include conducting hydraulic models for additional reaches (Jacob Myers to Orange Blossom Bridge and Ripon to SJR confluence), and the results for all four reaches probably won't be presented in a report until February or March of 2013.

3. FLOW QUANTITY AND TIMING

Overview

Managed flow pulses are frequently used to stimulate migration of salmonids in the San Joaquin Basin. Under specific conditions, migration of returning spawners, as well as emigrating juveniles, can be temporarily stimulated through increases in discharge. However, there is no evidence that such flows are required for successful adult migration or that they can reduce straying rates of natural-origin fish.

Higher flows increase fry survival in the tributaries, but not necessarily true for parr and smolts; and the benefits to adult escapement are uncertain. Fry migrants from SJR tributaries exhibit higher survival during periods of higher flows; however, our understanding of the contribution of fry to adult recruitment is quite limited. Since 2003, survival through the South Delta has been very low, and high flow events have failed to increase survival to levels observed when flows ranged between 5,000 and 6,000 cfs, despite flood flows of up to 25,000 cfs during the juvenile emigration period.

Relevant Information Regarding Flow Quantity and Timing

Juvenile Chinook migration out of the tributaries is *temporarily* stimulated by changes in flow, but long duration pulse flows do not "flush" fish out of the tributaries.

- Juvenile Chinook migration can be temporarily stimulated by changes in flow, but the stimulatory effect is short lived (few days) and only affects fish that are ready to migrate (Demko and Cramer 1995; Demko et al. 1996, 2000, 2001).
- Juvenile migration from the tributaries typically begins in January and nearly all juveniles migrate out of the tributaries by May 15 (SJRGA 2008).
- Except in wet and above normal years, 0.7% or less of total juvenile salmon (i.e., fry, parr, and smolts), and 0.8% or less of salmon smolt outmigrate during June.

Higher flows increase fry survival in the tributaries, but not necessarily true for parr and smolts; benefits to adult escapement are uncertain.

- Over a decade of rotary screw trap monitoring in the Stanislaus River shows that flow has a strong positive relationship with migration survival of Chinook fry (Pyper et al. 2006).
- Smolt survival (CWT) studies conducted by CDFG at flows ranging from 600 cfs to 1500 cfs and at 4,500 cfs have shown that smolt survival is highly variable and not improved by higher flows in the Stanislaus River (SRFG 2004; CDFG unpublished data).
- Similarly, analyses of rotary screw trap data found that abundance ratios for parr and smolts were only weakly correlated with flows (Pyper and Justice 2006).
- Smolt survival indices in the San Joaquin River from the Merced River downstream to Mossdale indicate little relationship to flow (TID/MID 2007).
- The contribution of fry emigrants (Feb/March) to total salmon production in the San Joaquin Basin is unknown (Baker and Morhardt 2001; SRFG 2004; SJRGA 2008; Pyper and Justice 2006).
    - However, a sample (n=100) of Central Valley fall-run Chinook salmon (unknown tributary origins) captured in the 2006 ocean fisheries were comprised of an average 20.1% (± 5.4%) individuals that emigrated as fry in 2003 and 2004 (Miller et al. 2010).

A flow regime based upon 60% (or lower) of unimpaired flows in February or in June is not likely to provide the potential benefits that the SWRCB's Technical Report (2012) identified, and providing such flows in February and June is not

consistent with the States's policy to "achieve the highest water quality consistent with maximum benefit to the people of the state."

- See Palmer et. al (2012) and Fuller et. al (2012) for details.

Flow does not explain the low Delta survival of juvenile Chinook observed since 2003, so more flow is unlikely the solution.

- South Delta survival has been low since 2003. During this period, flood flows of approximately 10,000 cfs and 25,000 cfs during outmigration in two years (2005 and 2006) did not increase survival near levels when flows were moderately high (5,700 cfs) in 2000. It is unclear why smolt survival between 2003 and 2006 has been so low (SJRGA 2007b).
- Smolt survival during 2003-2006 was unexpectedly far lower than it was historically. Models based on historical data that do not accurately represent recent conditions (e.g., Newman 2008 and others) should not be used to predict future scenarios (VAMP Tech. Team 2009).

Fall flow pulses *temporarily* stimulate upstream migration of adult Chinook salmon into San Joaquin Basin tributaries, but no evidence that attraction flows benefit the species.

- Prolonged, high volume pulse flows in the fall are not warranted. Equivalent stimulation of adult migration may be achieved through relatively modest pulse flows (Pyper et. al 2006).
    - Relatively modest pulse-flow event (an increase of roughly 200 cfs for 3 days) was found to stimulate migration.
    - Stimulatory effect of both pulse-flow and attraction flows were short in duration (migration increased for 2-3 days).
- Adult migration rate and timing is not dependent upon water temperature or dissolved oxygen concentrations (Pyper et. al 2006).
    - No evidence that low flows (1,000 to 1,500 cfs) in the SJR are an impediment to migration.
- Migration appears to be stimulated by pulse flows, but no evidence that natural origin fish would stray or not migrate to San Joaquin tributaries if no pulse.
    - "Consistent movement patterns [Klamath fall Chinook migrants] with or without pulse flows is compelling evidence that these flows did not trigger upriver movement or otherwise substantially alter migration behavior" (Strange 2007).
    - No clear relationship between increased water flow and stimulated Atlantic salmon migration was found in River Mandalselva (southern Norway) (Thorstad and Heggberget 1998).
    - To attract adult Atlantic salmon migration into rivers, flows must occur in conjunction with other cues such as cooler weather or natural freshets (Mills 1991).
- Fall pulse flows may attract out-of-basin hatchery fish.
    - The Constant Fractional Marking Program, which began in 2007, is just now providing more complete information regarding straying rates, and

results indicate that hatchery straying may be substantial in the SJR Basin. In 2010, fall-run spawners in the Stanislaus River were 50% hatchery-origin despite the lack of a hatchery on the river; of those the majority came from either Nimbus Fish Hatchery fall-run net pen releases (31%), Mokelumne River Hatchery fall-run net pen releases (26%), or the Mokelumne River Hatchery fall-run trucked releases without net pen acclimation (23%)(Kormos et al. 2012).

4. WATER TEMPERATURE

Overview

The temperature tolerances of CV salmon stocks are likely distinct from those of other stocks in the Pacific Northwest, and the applicability of laboratory derived tolerance values to stocks that have evolved in (and are adapted to) habitats at the southernmost extent of the species' range is questionable. High growth and survival of natural Chinook stocks in the CV at temperatures considered higher than optimal for most stocks (based on data from northern stocks) indicate high thermal tolerance of these stocks. There is no clear evidence that San Joaquin Basin stocks are adversely impacted by the current temperature regime. Neither adult nor juvenile migration appear impeded by temperatures observed under current flow management, as indicated by the absence of high pre-spawn mortality or temperature dependent migration timing of adults. Furthermore, the vast majority of juveniles emigrate prior to increases in water temperature resulting from warming air temperatures (the main factor influencing water temperatures) in late spring.

Relevant Information Regarding Water Temperature

The dominant factor influencing water temperature is ambient air temperature.

- Ambient air temperature is the primary factor affecting water temperature.
- By the end of May, water temperatures at Vernalis range between 18 and 21°C (65°F and 70°F) regardless of flow levels between 3,000 cfs and 30,000 cfs (SRFG 2004).
    - On average, maximum daily water temperatures are at or above 20°C (68°F) at Vernalis, Mossdale, and RRI after May 15, and by June 16-30, even the coolest year on record (2005) was only slightly below 20°C at Vernalis, at 20°C at Mossdale, and above 20°C RRI.
- Based on data from the Western Regional Climate Center for Stockton during 1948-2006 (station 048558 WSO; http://www.wrcc.dri.edu), the average daily air temperature at Stockton during June is 22.6°C (72.7°F), and therefore the guideline used by the EPA, which is nearly 3°C cooler, will never be met during June.

Water temperature criteria from Pacific Northwest stocks do not apply to San Joaquin salmon and steelhead; and little is known about the responses of Central Valley species to in-river water temperatures.

- The SJR represents the southernmost extent of the current range of Chinook salmon. Southernmost stocks have evolved under much warmer and drier meteorological conditions than stocks in the Northwest; therefore, criteria based on northern stocks are not directly applicable.
- The applicability of thermal criteria derived from the laboratory has long been debated, and there has been no validation of the growth vs. water temperature relationship for any of the listed species in the CV to assess if laboratory results are transferable to these southern stocks (Myrick and Cech 2004).
- Wild Chinook salmon in the Central Valley often experience water temperatures higher than "optimal" (as based on northern stock data) yet still have high growth and survival. It is this flexibility that has made Chinook salmon so successful in the CV and able to thrive where less temperature tolerant salmonids cannot (Moyle 2005).
- Juvenile Chinook can survive exposure to water temperatures of 24ºC (75.2ºF), depending on their thermal history, availability of refuges in cooler water, and night-time water temperatures (Moyle 2005).
- While much information is available on lifestage-specific water temperature ranges of Chinook salmon and steelhead in the Pacific Northwest, little is known about the specific responses of CV species to water temperature (Williams et al. 2007).
- Water temperature standards are often based on a seven-day average of the daily maximums (7DADM) not to be exceeded; this approach does not reflect the duration of exposure and the range of temperatures that fish may experience. It is possible for Chinook salmon to maintain populations even when they experience periods of suboptimal or even near-lethal conditions. For example, the most productive spring-run Chinook salmon stream in California (i.e., Butte Creek) can experience daily maxima up to 24ºC (75.2ºF) with minima of 18-20ºC (64.4-68.0ºF) for short periods of time in pools where juveniles are rearing and adults are holding (Ward et al. 2003).
- Anecdotal evidence suggests that some species of CV salmonids are heat tolerant: "the high temperature tolerance of San Joaquin River fall run salmon, which survived temperatures of 80°F (26.7ºC), inspired interest in introducing those salmon into the warm rivers of the eastern and southern US (Yoshiyama 1996)."
- Historically, the San Joaquin Basin has had higher water temperatures than all the other rivers that support Chinook salmon and so it is possible that the San Joaquin race has evolved to withstand higher temperatures than 18.3ºC (65°F) (CALFED 1999).
- Additionally, southern steelhead stocks of the CV may have greater thermal tolerance than those in the Pacific Northwest (Myrick and Cech 2004).
- The optimum growth temperature for American River steelhead was nearly 3ºC (5ºF) warmer than the optimum growth temperature for more northern stocks (Wurtsbaugh and Davis 1977; Myrick and Cech 2004; Myrick and Cech 2001).

There is no evidence that temperatures are unsuitable for adult fall-run Chinook upstream migration in the San Joaquin Basin.

- Adult migration timing was unrelated to temperature, dissolved oxygen (DO), or turbidity conditions (Pyper et. al 2006).
- Although temperatures were exceptionally cool during September 2006, salmon did not migrate earlier than during 2003-2005. During September 2006, temperatures were as much as 3ºC (5ºF) cooler in the SJR at Rough and Ready Island (RM 37.9), Mossdale (RM 56.3), and Vernalis (RM 72.3), and as much as 5ºC (9°F) cooler in the Stanislaus River at Ripon (RM 15.7) as compared to monthly average temperatures at the same locations during 2003-2005. September flows in the Stanislaus and SJR exceeded average unimpaired flow conditions during all of these years (CDEC; Ripon gauge).
- Temperatures at Rough and Ready Island (RRI) typically above 21ºC (70°F) during early migration season; larger fraction of early migrants traveled under higher temperatures in 2003 than other years (Pyper et. al 2006).
- Managed flows in the San Joaquin Basin during September are higher than historic unimpaired (computed natural) flows. Natural SJR flows were lowest during September and flows were extremely low or nonexistent in dry years. During 1922-1992, the average unimpaired flows during September were 117 cfs in the Stanislaus River, 185 cfs in the Tuolumne River, 84 cfs in the Merced River, and 808 cfs in the SJR (CDWR 1994). Elevated discharge levels of cool water from reservoir storage actually increase flow and decreases temperature during these time intervals.
- If temperatures were a problem for adult migrants in the SJR Basin, high pre-spawn mortality would be expected. However, studies conducted by DFG demonstrated that the incidence of pre-spawn mortality is quite low (i.e., 0%-4.5%) and appears to be density, not temperature, dependent (Guignard 2005 through 2008).
- Bay temperatures over 18ºC (65°F) in September when fish are migrating (CDEC; various stations).

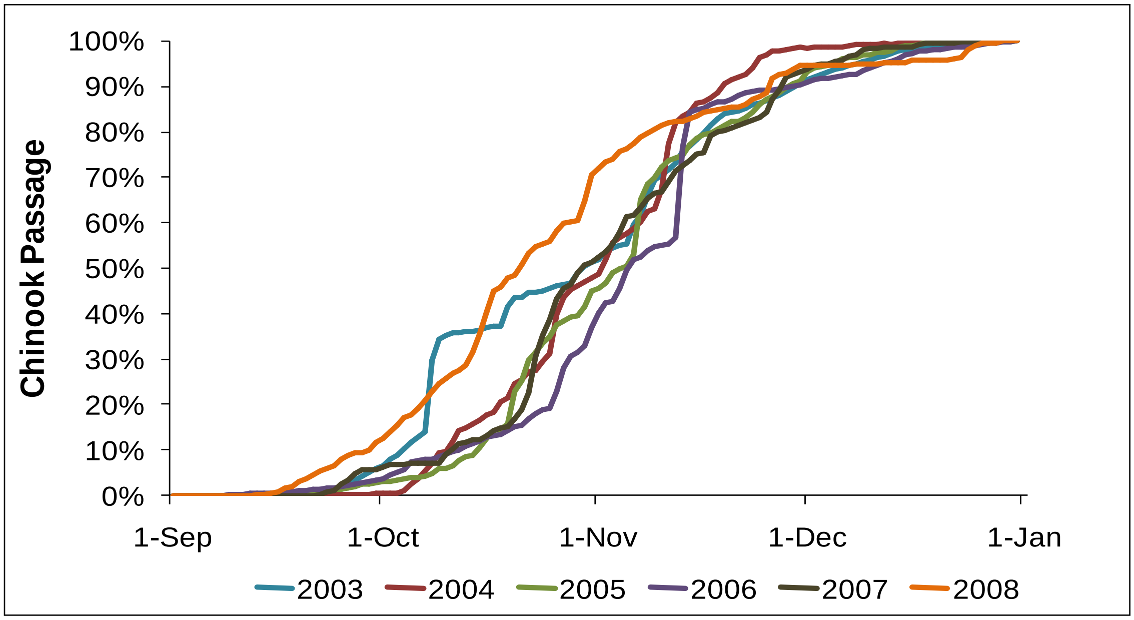

Figure 1. Cumulative upstream passage at the Stanislaus River Weir during 2003-2008 (FISHBIO 2009).

There is no evidence that temperatures for juvenile rearing and migration need to be colder than existing conditions or maintained through June 15.

- Nearly all juvenile Chinook migrate prior to May 15, and <1% migrate after May, except in wet and above normal water years. Also, 90-99% of non ad-clipped salvaged *O.mykiss* are encountered between January and May depending on water year type.
- Existing 7DADM (7 day average of the daily maximums) temperatures are generally ≤20°C (68ºF) in the San Joaquin River and the eastside tributaries through May 15.
  - After incubation, temperatures for rearing should remain below 21°C (70ºF) (Fjelstadt 1973, D-1422 testimony).
  - Studies evaluating the relationship between growth and temperature of CV Chinook found no difference in growth rates between 13-16°C (55-61ºF) and 17-20°C (63-68ºF) (Marine 1997).
  - Chinook salmon juveniles transform into smolts in the wild at temperatures in excess of 19°C (66ºF), and in a laboratory study highest growth and survival of smolts was found if they underwent transformation at temperatures of 13-17°C (55-63ºF; Marine and Cech 2004). Growth rate increased up to 19°C (66ºF; Cech and Myrick 1999).
  - Existing water temperatures have *at most*, a slightly negative effect on juvenile salmon survival (Newman 2008).
  - No evidence from Stanislaus River smolt survival experiments that existing water temperatures reduce juvenile salmon survival (SRFG 2004).

The restoration of the SJR upstream of the Merced River (San Joaquin River Restoration Program; SJRRP) will adversely affect water temperatures in the lower SJR during the spring and fall.

- The lower SJR downstream of the Merced River confluence is identified as temperature impaired (USEPA 2010). According to water temperature modeling conducted by AD Consultants (SJRGA 2007a), although the SJRRP flows will add more water in this reach, the travel time is such that when the new water reaches the Merced River confluence, it approaches equilibrium with ambient temperature. Even though it is anticipated that the water temperature at the confluence of the Merced and San Joaquin Rivers will be the same with and without the anticipated SJRRP flows, the SJRRP flows themselves are of such a large volume that it would take a comparatively large volume of water from the Merced River to reduce temperatures in the lower San Joaquin River downstream of the Merced confluence. Given the storage capacity of Lake McClure, it is not possible to provide the volume of releases that would be necessary to reduce these water temperatures without quickly exhausting the available water supply.

Releases from tributary reservoirs will not impact water temperatures in the San Joaquin River or South Delta.

- Increasing flows from the tributaries will not decrease water temperatures in the mainstem SJR (SJRGA 2007a).

5. DISSOLVED OXYGEN

Overview

Low dissolved oxygen (DO) levels have been measured in the SJR, in particular in the Deep Water Ship Channel from the Port of Stockton seven miles downstream to Turner Cut. These conditions are the result of increased residence time of water combined with high oxygen demand in the anthropogenically modified channel, which leads to DO depletion, particularly near the sediment-water interface. Despite these conditions, salmon and steelhead migration are not adversely impacted, and has been observed at concentrations as low as 5 mg/L. In addition, salmonids migrate in the upper portions of the water column where DO concentrations are highest.

It has been shown that low DO conditions in the SJR can be ameliorated through installation of the Head of the Old River Barrier (which increases SJR flow and juvenile salmonid survival by preventing fish from entering the Old River and subsequent entrainment), but there is no basis for requiring year-round DO objectives for SJR tributaries (e.g., Stanislaus at Ripon), as fish and aquatic habitat that could benefit from these DO levels are located far upstream of the SJR confluence during the summer months.

Relevant Information regarding Dissolved Oxygen

Low dissolved oxygen concentrations are limited to the Deep Water Ship Channel (DWSC), and are the result of anthropogenic manipulation of channel geometry.

- The eastside rivers (Tuolumne, Stanislaus and Merced) discharge high-quality Sierra Nevada water to the SJR which has low planktonic algal content and oxygen demand, and are not a major source of oxygen demand contributing to the low DO problem in the DWSC (Lee and Jones-Lee 2003).
- The DWSC, starting at the Port of Stockton where the SJR drops from 8-10 feet deep to 35-40 feet deep, is a major factor in DO depletion below the water quality objective. If the DWSC did not exist, there would be few, if any, low DO problems in the channel.
- The critical reach of the SJR DWSC for low DO problems is approximately the seven miles just downstream of the Port to Turner Cut (Lee and Jones-Lee 2003).

Dissolved oxygen concentrations in the DWSC are influenced by Delta exports, but can be ameliorated by installation of the Head of Old River Barrier (Brunell et al. 2010).

- Delta export pumping artificially changes the flows in the South Delta, which results in more of the SJR going through Old River. Water diverted through Old River can significantly reduce the SJR flow through the DWSC, thereby directly contributing to low DO in the DWSC.
- The physical (rock) HORB is installed to improve DO levels in fall.

Existing dissolved oxygen concentrations do not impact salmon and steelhead migration.

- Migration rate and timing is not dependent upon existing dissolved oxygen concentrations.
  - Contrary to the often cited Hallock et al. (1970) report that indicates adult migration was impeded under low dissolved oxygen, migration has been observed at DO less than 5mg/L (Pyper et. al 2006).
- Salmon and steelhead migrate in the upper portion of the water column where DO concentrations are highest due to photosynthesis and atmospheric surface aeration (Lee and Jones-Lee 2003).
- Smolt survival experiments indicate that juvenile salmon survival is not correlated with existing DO concentrations (SRFG 2004; SJRGA 2002 and 2003).

DO objective for DWSC is inconsistent with U.S. EPA national standard.

- The current U.S. EPA national water quality criterion for DO allows for averaging and for low DO concentrations to occur near the sediment-water interface. Central Valley Regional Water Quality Control Board Basin Plan DO water quality objective does not include these adjustments (Lee and Jones-Lee 2003).
- DO concentrations near the bottom in the DWSC waters are sometimes 1-2 mg/L lower than those found in the surface waters (Lee and Jones-Lee 2003).

DO objective on the Stanislaus River at Ripon is not needed year round to protect the salmon or steelhead fishery.

- While the Stanislaus River contains native fish and aquatic habitat that benefit from a minimum DO concentration of 7.0 mg/L, such fish and aquatic habitat are located more than 30 miles upstream of the Ripon compliance point during the summer months.
- Salmonids migrate through the area during late September though May. Neither salmon nor steelhead are typically located anywhere in the Stanislaus River downstream of Orange Blossom Bridge from June through August each year.

Species	Stage	Timing	Geographic Location
Fall-run Chinook salmon			
	Adult Migration	Late September - December	Goodwin Dam to confluence
	Spawning	October – December	Goodwin Dam to Riverbank
	Egg Incubation	October – March	Goodwin Dam to Riverbank
	Juvenile Rearing	Mid December – May	Goodwin Dam to Riverbank
		June – mid December	Goodwin Dam to Orange Blossom Bridge
	Juvenile Migration	January – May	Goodwin Dam to confluence
Steelhead			
	Adult Migration	Late September - March	Goodwin Dam to confluence
	Spawning	December – March	Goodwin Dam to Riverbank
	Egg Incubation	December – July	Goodwin Dam to Riverbank
	Juvenile Rearing	Year-round	Goodwin Dam to Riverbank
	Juvenile Migration	February – May	Goodwin Dam to confluence

6. FOOD

Overview

The SWRCB’s Technical Report (2012) purports that increased flows in the early spring will improve food production for early spring salmon rearing (page 3-29): “These flows may also provide for increased and improved edge habitat (generally inundated areas with vegetation) in addition to increased food production for the remainder of salmon that are rearing in-river.". Juvenile salmonids depend on a healthy aquatic food web to survive and grow rapidly. The SWRCB's Technical Report (2012; page 3-42 to 3-43) makes the case that a more natural flow regime would shift the benthic macroinvertebrate community in favor of more palatable prey for fish. While they do not provide any evidence that salmonids are food limited in the SJR and South Delta, they provide evidence that in unregulated streams there are generally more beneficial algae and diatoms, and high winter flows reduce predator-resistant invertebrates. In contrast, the benthic communities of the regulated streams are species-poor, impaired, and with higher relative abundance of predator-resistant invertebrates. However, the report does not provide any support to show that increasing flows in an already highly degraded system has the capability to return primary and secondary production quantity and quality to its pre-regulated state. Furthermore, the Technical Report (2012) does not explain the temporal and spatial scales under consideration for food production.

Relevant Information Regarding Food

Outmigrating Chinook smolts are not food limited during their 3-15 day migration through the lower SJR below Vernalis and the South Delta.

- The SWRCB's Technical Report (2012, page 3-42) provides evidence that, in northern California (unspecified location), ***unregulated*** rivers have more and better food resources than regulated rivers. However, the report does not provide any evidence that increasing flows in an already highly degraded system has the capability to return primary and secondary production quantity and quality to its pre-regulated state.
    - Furthermore, the SWRCB's Technical Report (2012) does not define how it would measure changes in food production (quality or quantity) or the mechanisms thought to drive food production in response to short-term increases in flow.
- The SWRCB's Technical Report (2012) also does not explain temporal and spatial scales under consideration for food production.
    - Based on acoustic VAMP studies in 2008, Holbrook et al. (2009) found that smolts took 3-15 days (median 6-9 days) for migration through the lower San Joaquin River and South Delta; demand for food production over such a short duration is questionable.
    - Increases in primary and secondary production that occur due to restoration or changes in management likely occur over longer periods of time, rather than that targeted by short-term pulse flows.
    - Spatial scale is important too, as impacts to food resources are generated at different rates and via different processes depending on where they are located in the river continuum.

7. CONTAMINANTS

Overview

According to the SWRCB's Technical Report (2012), contaminants are one of several "stressors" or "other factors" in the SJR Basin. One of the functions supported by spring flows according to the SWRCB's Technical Report (2012) is that higher inflows provide better water quality conditions by reducing contaminant concentrations. The influence of higher flows on contaminant concentrations in the SJR is variable and not well understood; dilution may occur in some instances but increases may occur in others (Orlando and Kuivila 2005). Dissolved contaminants and suspended contaminants respond differently to changes in flow. While higher flows may dilute some contaminants, such as selenium, mercury and DDT, contaminants in the bottom sediments of the SJR could also be remobilized during higher flows (McBain and Trush, Inc 2002). Citations were not presented in the SWRCB's Technical Report (2012) in support of the statement that higher inflows reduce contaminant concentrations.

The SWRCB's Technical Report (2012) also states that higher spring flows will reduce travel time and exposure of smolts to contaminants. Despite concerns over the threat contaminants may pose to threatened and endangered salmonid species, little is known regarding the effects of these contaminants on the health and survival of juvenile Chinook salmon in the Delta and its tributaries (Orlando et al. 2005). More studies are needed to determine the potential effects of short-term exposure to contaminants for outmigrating Chinook smolts, which pass through the South Delta relatively quickly.

Relevant Information Regarding Contaminants

No evidence or citations were provided to support the idea that higher inflows reduce contaminant concentrations.

- The SWRCB's Technical Report (2012; 3-29) states, "Higher inflows also provide better water quality conditions by reducing temperatures, increasing dissolved oxygen levels, and ***reducing contaminant concentrations***" (Emphasis added; pages 48 & 49); however, the report does not provide any references or further discussion to support this statement.
- The SWRCB's Technical Report (2012) may be inferring that higher flows would act to dilute already suspended contaminants. However, the influence of higher flows on contaminant concentrations is variable; dilution may occur in some instances but increases may occur in others.

SWRCB failed to consider that higher flows may also lead to increased suspended contaminant concentrations.

- High flows can also lead to increases in contaminant concentrations resulting from the resuspension of contaminants located in riverbed sediments. Contaminants in suspended sediments may affect the ecosystem differently from dissolved contaminants, since filter feeding organisms consume suspended sediments and organic material (allowing the contaminants in the sediments to enter into the food web) and may have longer residence times in the rivers and estuaries in comparison with water (Bergamaschi et al. 1997).

- Research has begun to focus on the relationship between freshwater flow and contaminant transport to and through the Delta. Although increased flows can result in reduced dissolved or suspended sediment concentrations of some contaminants, they can also lead to increased pesticide loading.
- In a study conducted just downstream of Vernalis, the U.S. Geological Survey (USGS) examined the concentrations of organic contaminants in surface water sites along the SJR and in the Old River before, during and after the VAMP month-long pulse flow (Orlando and Kuivila 2005).
    - Of the 13 total pesticides detected, diazinon and three herbicides (metolachlor, simazine, and trifluralin) were found in every sample.
    - Although it might be expected that the higher flows would dilute the contaminants, the results were mixed. Diazinon and simazine were highest at SJR and OR sites before VAMP (4/2/01 and 4/6/01), showed intermediate values during the VAMP period (5/14/01 and 5/18/01) and then reached lowest values during the post-VAMP period (5/31/01 and 6/4/01). Metolachlor showed the opposite trend at SJR and OR sites and increased throughout the three periods. Trifluralin showed a peak during the VAMP period for most sites. Suspended sediments were highest in the SJR during VAMP; however, the opposite was true for the Old River, suspended sediments were lower during VAMP compared to just before and after the VAMP period. This was likely influenced by the operations of the Head of the Old River Barrier (HORB), which was installed during the 2001 VAMP period. All six culvert slide gates were open from April 26 to May 26, allowing some water to pass into the Old River. Suspended sediment concentrations generally increase with increasing streamflow, but there are likely nonlinear relationships between streamflow, suspended sediment concentration, and contaminant concentration.
    - Limited conclusions can be drawn from a study with such a narrow spatial and temporal scope, however it is clear that increased flows do not necessarily lead to reduced contaminant concentrations. Undoubtedly, more research is needed to clarify this process.
- Furthermore, the relationship between flow and contaminants is not obvious upstream of Vernalis. As summarized in the Background Report for the San Joaquin River Restoration Study (McBain and Trush, Inc 2002), while higher flows may dilute some contaminants, such as selenium, mercury and DDT, contaminants in the bottom sediments of the SJR could also be remobilized during higher flows.
    - McBain and Trush (2002) found that "although water quality conditions on the SJR relating to conservative ions, (e.g., salt and boron), and some nutrients are likely to improve under increased flow conditions, it is unclear how these and other potential restoration actions will impact many of the current TMDL programs and existing contaminant load estimates. This is most true of constituents with complex oxidation reduction chemistry, and sediment/water/biota compartmentalization (e.g.,

pesticides, trace metals). Perhaps the greatest risks to potential restoration actions within the San Joaquin River study reaches relate to uncertainties regarding remobilization of past deposits of organochlorine pesticides, i.e., DDT and mercury."

It remains unknown whether, or to what extent, migrating salmonids may be affected by suspended contaminants.

- It is generally recognized that contaminants can have a negative effect on aquatic ecosystems, however despite the extensive studies conducted in the field of toxicology, the direct ('acute toxicity' leading to death; or 'chronic' or 'sublethal toxicity' leading to decreased physical health; NMFS 2009a) and indirect effects (reduction of invertebrate prey sources, reducing energetically favorable prey species relative to less energetically profitable or palatable prey; Macneale et al. 2010) of pollutants on salmon in the wild are not well understood.
- Despite concerns over the threat contaminants may pose to threatened and endangered salmonid species, little is known regarding the effects of these contaminants on the health and survival of juvenile Chinook salmon in the Delta and its tributaries (Orlando et al. 2005).
- In a small scale, pilot study of contaminant concentrations in fish from the Delta and lower SJR, resident species were tested for some of the contaminants listed above; however, no salmonid species were tested (Davis et al. 2000).
    - The study found that 11 out of 19 adult largemouth bass sampled exceeded the mercury screening values, with a general pattern of lower concentrations downstream in the SJR toward the central Delta. DDT concentrations were exceeded in 6 of 11 white catfish, but only 1 of 19 largemouth bass. All samples above the DDT screening value were obtained from the South Delta or lower SJR watershed, indicating that the South Delta is still influenced by historic DDT use in the SJR basin. Two of the listed organophosphate pesticides were measured; diazinon was not detected in any sample and chlorpyrifos was detected in 11 of 47 samples analyzed, but at concentrations well below the screening value.
    - With regards to salmonids, however, it is important to consider that resident fish may experience chronic exposure to these chemicals, while outmigrating Chinook smolts pass through the South Delta in a relatively short period of time.
- A study by Meador et al. (2002) focused on estimating threshold PCB concentrations for juvenile Chinook salmon migrating through urban estuaries. PCBs were a concern because they had been shown to alter thyroid hormones important for the process of smoltification. During smoltification, salmonids tend to show declines in muscle lipids, the main lipid storage organ for salmonids, causing the PCBs to be redistributed to, and concentrated in, other organs (Meador et al. 2002).
    - Results of this study indicate that tissue concentrations below 2.4 mg PCB g-1 lipid should protect juvenile salmon migrating through urban estuaries from adverse effects specifically due to PCB exposure. This does not take

into account any effects of other contaminants likely to also be in estuarine waters such as the Delta.

Bioaccumulation, rather than exposure to dissolved contaminants, is likely the main concern for migrating juvenile Chinook.

- Pesticides in the water column may be dissolved contaminants or they may accumulate in suspended sediments associated with organic matter.
    - Dissolved contaminants can be absorbed through the gills or skin and this uptake may show more variability than the other exposure routes depending on concentrations, temperature and stress (Meador et al. 2002).
    - Contaminants that accumulate in riverbed sediments may be resuspended (Pereira et al. 1996), and enter the food chain through filter-feeding benthic or pelagic organisms, such as Corbicula clams. In turn, bottom feeder fish species (e.g., carp and catfish) consume filter-feeding invertebrates (Brown 1997). This process leads to bioaccumulation of the contaminants up the food chain.
    - Bioaccumulation, rather than exposure to dissolved contaminants, is likely the main concern for migrating juvenile Chinook (Meadnor et al. 2002). Factors that affect bioaccumulation include: variable uptake and elimination rates, reduced bioavailability, reduced exposure, and insufficient time for sediment–water partitioning or tissue steady state can affect (Meador et al. 2002).

8. VELOCITY

Overview

According to the SWRCB Technical Report (2012; page 3-29), higher spring flows "facilitate transfer of fish downstream" and "provide improved transport". The term "facilitate transport" is undefined and is too vague to evaluate adequately. Although the SWRCB's Technical Report (2012) cites DOI's comments to the State Water Board (DOI 2010) regarding this function, there is no reference to "facilitate transport" anywhere in the DOI (2010) text. Therefore, it is unclear by what mechanisms spring flows facilitate transport of smolts, what the benefits are, and how the benefits may be influenced by factors such as flow level and duration.

Nonetheless, the SWRCB's Technical Report (2012) may be suggesting that increased flows result in increased ***velocity***, which may lead to decreased juvenile salmonid travel time through the region, thus 'facilitating transport'. Modeling suggests that velocities at the Head of Old River may increase by about 1 ft/s with an additional 6,000 cfs SJR flow, but the model predicts little to no change in velocity at other stations in the South Delta (Paulsen et al. 2008). Thus, increased flows may increase velocity near the boundary of the Delta, but do not substantially increase velocity through the Delta.

SWRCB's Technical Report (2012) Assertions Regarding Relationship Between San Joaquin River Flows and Velocity (Transport)

Bold statements below indicate the SWRCB's Technical Report (2012) assertions regarding relationship between SJR flows and transport, followed by supporting/contrary evidence, as follows:

SWRCB Assertion 1. In the late winter and spring, increased flows provide or facilitate improved transport of fish downstream (page 3-29).

- No evidence is provided that higher spring flows "facilitate transport," or present any potential mechanisms by which "facilitation" could be measured.
- The term "facilitate transport" is undefined in the SWRCB's Technical Report (2012) and it is unclear by what mechanisms spring flows facilitate transport of smolts, what the benefits are, and how the benefits may be influenced by factors such as flow level, duration, turbidity, etc.
  - The SWRCB's Technical Report (2012) cites an early USFWS exhibit submitted to the SWRCB (USFWS 1987) in support of the hypothesis that increased SJR flows are positively related to smolt migration rates, "with smolt migration rates more than doubling as inflow increased from 2,000 to 7,000 cfs." However, the original reference does not specify how and when these data were gathered and analyzed.
  - Presumably, these data (USFWS 1987) are part of the work conducted by the USFWS as part of the Interagency Ecological Program for the Sacramento-San Joaquin Delta (IEP). As in other documents related to IEP and other early studies, data have often been misinterpreted, or there were factors not considered such as the potential for different sized fish to be released (different sized fish behave differently giving the appearance that migration rates were influenced by flows).
- In 2001, these hypotheses regarding flow and migration rates were already in question as evidenced by Baker and Morhardt (2001), which stated that "initially it seems intuitively reasonable that increased flows entering the Delta from the SJR at Vernalis would decrease travel times and speed passage, with concomitant benefits to survival. The data, however, show otherwise."
  - Baker and Morhardt (2001) examined the relationship between mean smolt migration times from three locations (one above and two below the Head of the Old River to Chipps Island) and San Joaquin flow (average for the seven days following release) and found no significant relationships at the 95% confidence level, and a significant relationship at the 90% confidence level for only Old River releases.
  - Although flows were not found to facilitate transport, there was evidence of an increase in smolt migration rate with increasing size of released smolts (Baker and Morhardt 2001), which again highlights the limitation of the "black box approach" and emphasizes a need for a better understanding of the mechanisms underlying the relationship of survival and flow. This increase in migration rate with increasing size may be explained by the one factor that definitely helps facilitate the transport of salmon through the Delta: the

salmon itself. Juvenile salmonids are actively swimming, rather than moving passively with the flow, as they migrate towards the ocean (Cramer Decl., Case 1:09-cv-01053-OWW-DLB Document 167, Peake McKinley 1998), and the movements of juvenile salmonids depend on their species and size, water temperature, local hydrology, and many other factors (Cramer Decl., Case 1:09-cv-01053-OWW-DLB Document 167).

  - Baker and Morhardt (2001) provide an example of a study which compared the speed of smolt passage to that of tracer particles (particle tracking model - PTM), "in which 80% of the smolts were estimated to have been recovered after two weeks, but only 0.55% of the tracer particles were recovered after two months." According to documents filed in the Consolidated Salmon Cases (Cramer Decl., Case 1:09-cv-01053-OWW-DLB Document 167), simulations of PTM were compared to actual mark and recapture CWT data for Chinook salmon released at Mossdale on the SJR, and it was found that smolts traveled to Chipps Island 3.5 times faster than the modeled particles, with a significant difference in the time to first arrival (df=76, T=9.92, p<0.001).

- In recent years, VAMP has used acoustic tags to monitor smolt outmigration survival, therefore more detailed travel times have been estimated for the various SJR and South Delta reaches.
  - Results have generally shown short travel times between reaches, suggesting active swimming. In 2009, the average travel times were reported for each reach, and all were under 2.5 days (SJRGA 2010). For example, the average travel time between Lathrop and Stockton was only 2.29 days.
- Juvenile salmonids are actively swimming, rather than moving passively with the flow, as they migrate towards the ocean (Cramer Decl., Case 1:09-cv-01053-OWW-DLB Document 167, Peake McKinley 1998).
  - Movements of juvenile salmonids depend on their species, size, water temperature, local hydrology, and many other factors (Cramer Decl., Case 1:09-cv-01053-OWW-DLB Document 167).
  - Recall the Baker and Morhardt (2001 example of a study, which compared the speed of smolt passage to that of tracer particles (i.e., PTM), discussed above.
  - Chinook released at Mossdale traveled to Chipps Island 3.5 times faster than the modeled particles (Cramer Decl., Case 1:09-cv-01053-OWW-DLB Document 167).
- Increased flows may slightly increase velocity near the boundary of the Delta, but do not substantially increase velocity through the Delta.
  - Modeling suggests that velocities at the Head of Old River may increase by about 1 ft/s with an additional 6,000 cfs SJR flow; however, the model predicts little to no change in velocity (<0.5 ft/s) at other stations in the South Delta (Paulsen et al. 2008).

9. PHYSICAL HABITAT

Overview

The historically diverse SJR and South Delta aquatic habitats have been substantially reduced, simplified and altered by development. One of the major changes in the system is the loss of shallow rearing habitat behind levees. Furthermore, aquatic vegetation growth and expansion over the past 20 years has increased water clarity by trapping suspended solids, affecting the composition of the fish communities (Nobriga et al. 2005). The current habitat structure now benefits introduced predators (Brown 2003).

The SWRCB's Technical Report (2012) maintains that the flow regime is the "master variable" that regulates the ecology of rivers, and the other habitat factors affecting community structure (e.g., temperature, water chemistry, physical habitat complexity), "are to some extent determined by flow (Moyle et al. 2011)." The report often refers to increases in physical habitat associated with increasing flow, however it lacks recognition of the limitations due to the substantially altered physical habitat. Much of the lower SJR and South Delta are banked by steep levees (about 443 miles downstream of Stanislaus River; Figure 2), limiting access to floodplain habitat and restricting true channel mobilization flows. For additional information see the discussions in the chapters "Floodplain Habitat" and "Geomorphology".

Relevant Information Regarding Physical Habitat

The physical habitat for native San Joaquin Basin and South Delta fishes has been substantially reduced and altered.

- Diverse habitats historically available in the Delta have been simplified and reduced by development of the watershed (Lindley et al. 2009).
- Spawning and rearing habitat have been severely reduced, salmon total abundance is down, and salmon diversity is reduced (McEvoy, 1986; Yoshiyama et al., 1998, 2001; Williams 2006).
- Major change in system is the loss of shallow rearing habitat (Lindley et al. 2009).
- An estimated 95% of wetlands/floodplains lost to levee construction and agricultural conversion since the mid 1800s (TBI 1998, Simenstad and Bollens 2003, Williams 2006).
- Only ~10% of historical riparian habitat remains, with half of the remaining acreage disturbed or degraded (Katibah 1984).
- Reduction in suitable physical habitat for delta smelt has reduced carrying capacity (Feyrer et al. 2007).

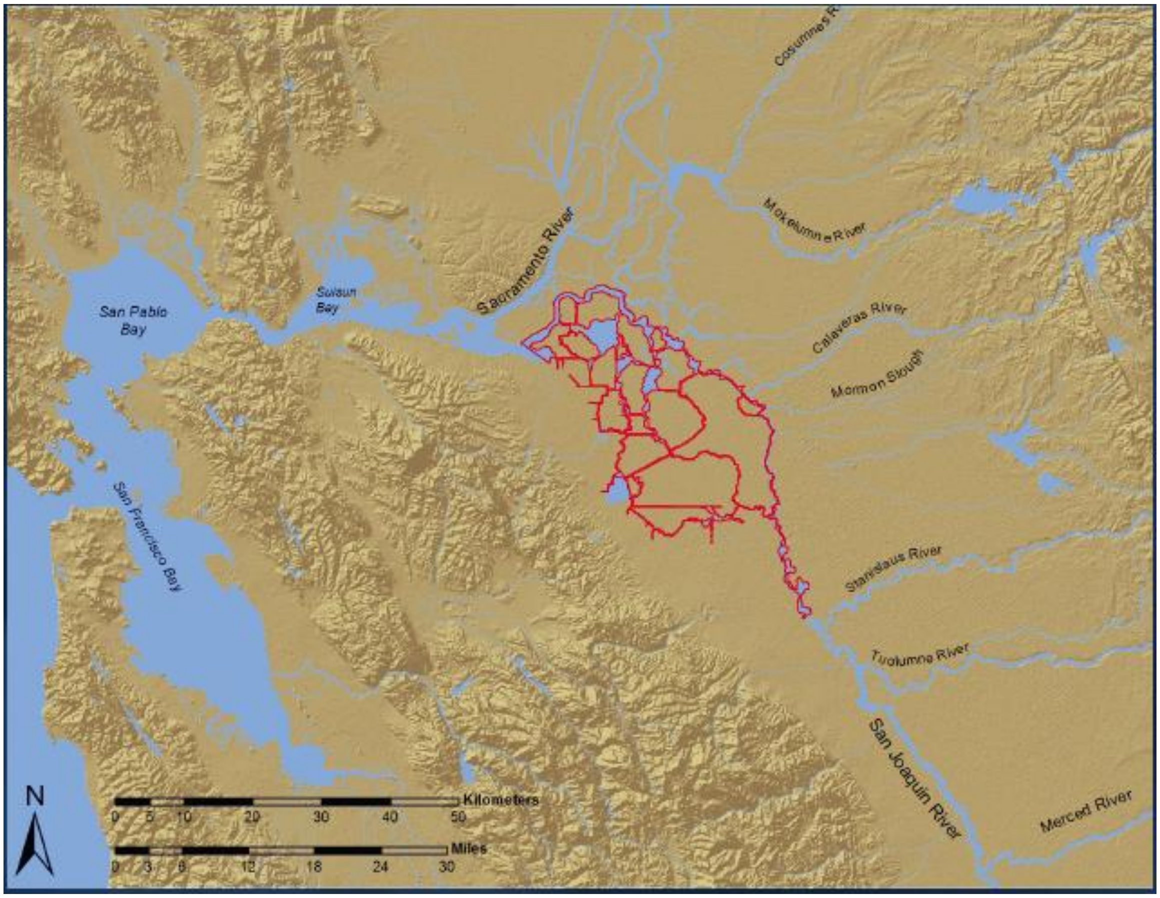

Figure 2. Levees in the South Delta and lower San Joaquin River downstream of the Stanislaus River confluence.

Habitat alterations are linked with invasive species expansions.

- *Egeria densa* (Brazilian waterweed) expansion has increased habitat and abundance of largemouth bass and other invasive predators (Baxter et al. 2008).
- The area near the CVP intake has significant amounts of *E. densa* (Baxter et al. 2008).

- Current habitat structure benefits introduced predators more than natives (Brown 2003).
- *Egeria* has strong influence on results of habitat alterations as different fish communities are found in its presence (Brown 2003).

Habitat influences growth, survival and reproduction through biological and physical mechanisms.

- Estuaries provide important rearing habitat for Chinook; salmon fry in Delta grew faster than in river (Healey 1991, Kjelson et al. 1982).
- Shallow water habitats support high growth in CV; juvenile Chinook had higher growth rates in small tributaries of Sacramento River than in the main Sacramento (Sommer et al. 2001; Jeffres et al. 2008; Maslin et al. 1997, 1998, 1999; Moore 1997).

Water quality aspect of habitat is highly variable.

- Aquatic vegetation increase, especially *E. densa*, over the past 20 years has increased water clarity by trapping suspended solids, with measurable effects on fish communities (Nobriga et al. 2005).
- Variability in habitat likely causes regional differences in the relationship between Delta smelt abundance and water quality (Baxter et al. 2008).
- Reduced pumping from the SWP in October of 2001 lowered salinity in western Delta (as desired), but led to opposite and unexpected result of increased salinity in central Delta (Monsen et al. 2007).

Improving habitat for increased abundance of native fishes.

- Increase productive capacity with access to floodplains, streams, and shallow wetlands (Lindley et al. 2009).
- Habitat quantity, quality, spatial distribution and diversity must be improved to promote life history diversity that will increase resilience and stability of salmon populations (Lindley et al. 2009).

10. GEOMORPHOLOGY

According to the SWRCB's Technical Report (2012), a more natural flow regime will improve geomorphic processes including scour and bed mobilization and will increase the number of turbidity events.

SWRCB's Technical Report (2012) Assertions Regarding Effects of Implementing a More Natural Flow Regime on Geomorphic Processes

Bold statements below indicate the SWRCB's Technical Report (2012) assertions regarding effects of implementing a more natural flow regime on geomorphic processes, followed by supporting/contrary evidence, as follows:

Assertion 1. A more natural flow regime will improve bed scour and mobilization and provide associated benefits such as creating a "less homogenous channel with

structures that are important for fish habitat, such as meanders, pools, riffles, overhanging banks, and gravel substrates of appropriate sizes…and rejuvenate riparian forests and clean gravel for salmon…" (SWRCB Technical Report 2012; page 3-48).

The natural flow paradigm assumes that channel formation and maintenance is directly influenced and modified by flow, which is generally true under natural conditions; however, leveed rivers can be nearly independent of flow. Poff et al. (1997, page 770), identify "five critical components of the ["natural," i.e., unaltered by humans] flow regime that regulate ecological processes in river ecosystems: the magnitude, frequency, duration, timing, and rate of change of hydrologic conditions (Poff and Ward 1989, Richter et al. 1996, Walker et al.1995)." The authors also recognize that most rivers are highly modified and allude to the possibility that restoration of a natural flow regime may be limited "depending on the present extent of human intervention and flow alteration affecting a particular river (Poff et al. 1997, Page 780)." The natural flow paradigm assumes that channel form is directly influenced and modified by flow, which is generally true under natural conditions (a potential exception being a bedrock controlled channel); however, the morphology of a highly engineered river (e.g., levees) can be practically independent of flow (Jacobson and Galat 2006). In such a system, flow-related factors like timing of floods, water temperature, and turbidity may be managed; but, in absence of a "naturalized morphology, or flow capable of maintaining channel-forming processes, the hydrologic pulses will not be realized in habitat availability" (Jacobson and Galat 2006, page 250).

With minimal floodplains remaining in the San Joaquin Basin due to land use changes, higher flows do not necessarily provide the channel maintenance that would occur under natural conditions. In leveed systems such as the San Joaquin Basin, true channel mobilization flows are not possible because of flood control. In some instances, higher flows can actually result in increased detrimental incision in upstream tributary areas like the Stanislaus River where existing riparian encroachment is armored and cannot be removed by high flow events, which limits "river migration and sediment transport processes" (Kondolf et al. 2001, page 39). In addition, the ability to provide a more natural flow regime is hampered by "urban and agricultural developments that have encroached down to the 8,000 cfs line," which effectively limit the highest flows to no more than the allowable flood control (i.e., 8,000 cfs) (Kondolf et al. 2001, page 46). Also, in the case of the Stanislaus River, there is limited opportunity to provide mechanical restoration of floodplains due to private landowners and flood control. In instances where flood pulses can no longer provide functions such as ***maintenance of channel habitat***, Poff et al. (1997) states, "mimicking certain geomorphic processes may provide some ecological benefits [e.g., gravel augmentation, stimulate recruitment of riparian trees like cottonwoods with irrigation]."

In the absence of floodplain connectivity, the functions attributed to higher "pulse flows" cannot be achieved as described by the Flood Pulse Concept (FPC) (Junk et al. 1989; Junk and Wantzen 2003). Under natural conditions, the SJR was a river channel connected with its floodplain. Flood pulses in the winter and spring would have provided the functions identified by Junk et al. (1989) and by Junk and Wantzen (2003). However, anthropomorphic changes in the lower river (e.g., levees), particularly below Vernalis (the focus of the SWRCB's Technical Report 2012), have substantially reduced this floodplain connectivity and the region can no longer be considered a "large river-floodplain system." In fact, the extent of inundated floodplain in the SJR between the confluence of the Stanislaus River and Mossdale only exceeds 2,000 acres at the maximum modeled flow of 25,000 cfs (cbec 2010). In comparison, the Yolo Bypass is approximately 59,000-acres (Sommer et. al 2005) and the Cosumnes floodplain is about 1,200 acres (Swenson et al. 2003).

11. HEAD OF OLD RIVER BARRIER

Overview

Although the SWRCB's Technical Report (2012) mentions the Head of Old River Barrier (HORB) in several contexts, there is no cohesive discussion about the substantial impact that the HORB has on juvenile salmon survival through the lower SJR and South Delta.

Relevant Information Regarding Head of Old River Barrier

Operation of a rock barrier at the Head of Old River improves salmon smolt survival through the Delta by 16-61% (Newman 2008).

- HORB reduces entrainment into Old River from more than 58% to less than 1.5%.
- Survival appears to be lower in the Old River than it is in the main stem San Joaquin River (Newman, 2008).
- Physical (rock) HORB increases SJR flow.
- Installation of the HORB doubles through-Delta survival by directing juvenile salmonids through the SJR mainstem (compared to the Old River route, NMFS 2012).

Absence of Head of Old River Barrier

- In the absence of the physical (rock) HORB, a statistically significant relationship between flow and survival does not exist (Newman 2008); therefore there is no justification for increasing flows when the barrier is not in operation.
    - The temporary HORB rock barrier requires flows less than 5,000 cfs for installation and flows less than 7,000 cfs for operation (SJRTC 2008).

Head of Old River Barrier Timeline.

- Initiated as a part of the South Delta Temporary Barriers Project in 1991 to be a temporary rock-fill physical barrier to prevent juvenile Chinook salmon from entering Old River at the Head of the Old River (HOR).
- Installation of the HORB had been utilized each spring (except in high water years) from 1992-2007 (see status table below).
- Between 2008 and 2011, installation of the physical barrier was prohibited by a Federal Court decision by U.S. District Court Judge Wanger due to concerns for delta smelt.
- In 2009 and 2010, a non-physical barrier (Bio-Acoustic Fish Fence; BAFF) was installed to replace the spring time HORB.

- In 2012, the physical barrier was installed as a part of a Joint Stipulation order by US District Court Judge O'Neil.
- Installation status of HORB each spring since 1992 includes:

YEAR	Type of HORB Installed	Reason
2012	Rock	Court ruling (Joint stipulation)
2011	Not installed	High Flows
2010	BAFF	VAMP/BOR study
2009	BAFF	VAMP/BOR study
2008	Not installed	Court Ruling
1992-2007	Rock installed annually with exception of high flow years	Not installed 1993, 1995, 1998, 1999, 2005, and 2006 due to high flows

Salmon versus Delta smelt.

- The HORB physical barrier in spring stops the juvenile Chinook salmon from entering the Old River, avoiding entrainment in the state and federal pumps. But, USFWS has taken the position that the physical barrier causes a negative flow to occur in the Middle and Old Rivers (OMR), which creates a situation that elevates Delta smelt entrainment.
- USFWS contends that negative OMR flows up to 1,250 cfs do not increase entrainment of Delta smelt, but negative OMR flows greater than 1,250 cfs do.
- A Joint Stipulation issued by Judge O'Neil regarding the 2012 CVP and SWP operations includes flow restrictions for OMR flows in April between -1,250 and -3,500 cfs; in May between -1,250 and -5,000 cfs.

Head of Old River Bio-Acoustic Fish Fence (BAFF; Bowen et. al 2008, 2009a-b, 2010).

- Beginning in the Spring of 2009, a three-year study was initiated by the U.S. Bureau of Reclamation (USBR) to install and monitor the effectiveness of a non-physical barrier at the head of Old River called a Bio-Acoustic Fish Fence (BAFF). The BAFF was installed in 2009 and 2010, but was not installed in 2011 because of high water.
- The BAFF consisted of three parts: a sound emitting device, a bubble curtain and a light system of strobe hi-intensity LEDs.
- In 2009, when the BAFF was on it was over 80% efficient at deterring tagged salmon smolts from entering Old River. When the BAFF was off, only 25% of tagged salmon smolts did not enter Old River.
- In 2010, the alignment of the BAFF was changed; it was set out further in the channel, lengthened to 136 m, the angle changed to 30 degrees and the downstream end of the BAFF changed from a straight layout to a "hockey stick" configuration.
- It was thought that the 2009 alignment, while being efficient in deterring acoustically tagged smolts from entering Old River, may have guided them into or near the large scour hole immediately down the SJR of the HOR. Later, the USBR

biologists attributed the high mortality of the tagged smolt to low flows in 2009, stating that the low flow consolidated the smolt path "So, prey may have been forced into a smaller volume of water with predators", thus increasing predation (Bowen 2009).

Comparison of HORB BAFF efficiencies in 2009 and 2010

	2009 Range (%)	2009 Mean (%)	2010 Range (%)	2010 Mean (%)
Mortality rates between Durham Ferry and HORB	25.2 to 61.6	40.8	2.8 to 20.5	7.8
Predation rates at HORB	11.8 to 40	27.5	17 to 37	23.5
Deterrence rate of Barrier		81.4 total		23.0 total
Protection Efficiency	14 to 62	31	31 to 60	43.1

Head of Old River Barrier Predation and "Hot Spots."

- Predation Rate at HORB
  - 2009 11.8 – 40% (mean 27.5%)
  - 2010 17 – 37% (mean 23.5%)

Head of Old River Flow conditions during VAMP releases and tracking period.

- 2009 – 75/25% split in flows; with 75% heading into Old River, 25% into the mainstem San Joaquin (dates of operation: 4/22 – 6/13/2009)
- 2010 – 58/42% split; with 58% heading into Old River 42% into the mainstem San Joaquin (dates of operation: 4/25 – 6/25/2010)

12. PREDATION

Overview

Numerous studies have found that striped bass and other piscivorous fish prey on outmigrating salmon (Shapovalov 1936, Stevens 1966, Thomas 1967, Pickard et al. 1982, Merz 2003, Gingras 1997, Tucker et al. 1998). While striped bass are likely the most significant predator of Chinook salmon and Delta smelt (Nobriga and Feyrer 2007), several other invasive predators occur in the Delta and may also contribute to the predation losses including white catfish, black crappie, smallmouth bass, and spotted bass. The predation appears to be patchy both seasonally and spatially, with higher levels of predation documented in the spring, in areas of anthropogenic influence such as near water diversion structures and dams (Gingras 1997, Tucker et al. 1998, Merz 2003, Clark et al. 2009). In recent years it has become clear that predation on salmon may significantly limit salmon recovery efforts (NMFS 2009b; Dauble et al., 2010). The NMFS Draft Recovery Plan (2009b) for Chinook salmon and CV steelhead considered “predation on juveniles” one of the most important specific stressors.

The SWRCB’s Technical Report (2012) indicates that flow can operate indirectly through other factors that directly influence survival, including predation. The report makes several statements regarding the relationship between flows and predation, asserting that increased flows will reduce the impacts of predation on outmigrating salmonids.

Relevant Information Regarding Predation

The VAMP review panel concluded that “high and likely highly variable impacts of predation, appear to affect survival rates more than the river flow” (Dauble et al. 2010).

- All fishery agencies have acknowledged that striped bass are a major stressor on Chinook populations in the CV and recovery will not occur without significant reduction in their populations and/or predation rates (DFG 2011).

Striped bass prey on juvenile Chinook.

- Many studies have found that striped bass eat salmon (Shapovalov 1936, Stevens 1966, Thomas 1967, Pickard et al. 1982, Merz 2003, Gingras 1997, Tucker et al. 1998).
- Striped bass stomachs have been collected with juvenile Chinook composing up to 65% (by volume) of the total contents (Thomas 1967).
- Waddell Creek stomach contents in April of 1935 found that large striped bass fed heavily on young salmon and trout (30.8% by number of occurrence) (Shapovalov 1936).
- In the Mokelumne River, 11 to 51% of the estimated salmon smolts were lost to striped bass predation in the Woodbridge Dam afterbay in 1993. Chinook were 24% (by volume) of juvenile bass stomach content in the spring in the Mokelumne River (Stevens 1966).
- Below Red Bluff Diversion Dam juvenile salmon outweighed other food types in striped bass stomach samples by a three to one margin (Tucker et al. 1998).
- Almost any fish occurring in the same habitat as striped bass will appear in the bass diet (Moyle 2002).
- There are roughly 1 million adult striped bass in the Delta and their abundance remains relatively high despite curtailment of a stocking program in 1992 (CDFG 2009).
- Recent concerns about the survival of endangered winter-run Chinook salmon in the Sacramento River have focused on the impacts of striped bass predation on outmigrants and the effects of striped bass population enhancement on winter-run Chinook population viability (Lindley and Mohr 1999). It was estimated that at a population of 765,000 striped bass adults, 6% of Sacramento River winter Chinook salmon outmigrants would be eaten each year (Lindley and Mohr 1999, 2003).

- "CDFG documented in their 2002 annual report to NMFS that an adult striped bass (420 mm) collected in May 2002 at Miller Ferry Bridge had 39 juvenile salmonids in its stomach (DFG022703)." (Hanson 2009).

Striped bass in the San Joaquin River and South Delta prey on juvenile Chinook to such an extent that they significantly reduce the number of Chinook returning to the San Joaquin Basin.

- High predation losses at the State Water Project (SWP) are particularly detrimental to SJR Chinook salmon populations since over 50% of juvenile salmon from the SJR travel through Old River on their way to the ocean, exposing them to predation at Clifton Court Forebay (CCF) and causing substantially reduced survival.
- Predation rates in CCF are as high as 66-99% of salmon smolts (Gingras 1997; Buell 2003; Kimmerer and Brown 2006).
- Striped bass are generally associated with the bulk of predation in CCF since their estimated populations have ranged between 30,000 and 905,000 (Healey 1997; Cohen and Moyle 2004); however, studies indicate that six additional invasive predators occur in the CCF (i.e., white catfish, black crappie, largemouth bass, smallmouth bass, spotted bass, redeye bass) with white catfish being the most numerous, having estimated populations of 67,000 to 246,000 (Kano 1990).
- Yoshiyama et al. (1998) noted that "[S]uch heavy predation, if it extends over large portions of the Delta and lower rivers, may call into question current plans to restore striped bass to the high population levels of previous decades, particularly if the numerical restoration goal for striped bass (2.5 to 3 million adults; USFWS 1995; CALFED 1997) is more than double the number of all naturally produced CV Chinook salmon (990,000 adults, all runs combined; USFWS 1995)."
- Hanson (2005) conducted a pilot investigation of predation on acoustically tagged steelhead ranging from 221-275mm, and estimated that 22 of 30 (73%) were preyed upon.
- Nobriga and Feyrer (2007) state: "Striped bass likely remains the most significant predator of Chinook salmon, *Oncorhyncus tschawytscha* (Lindley and Mohr 2003), and threatened Delta smelt, *Hypomesus transpacificus* (Stevens 1966), due to its ubiquitous distribution in the Estuary and its tendency to aggregate around water diversion structures where these fishes are frequently entrained (Brown et al. 1996)."

Recent San Joaquin Basin VAMP studies conducted from 2006–2010 provide direct evidence of high predation rates on Chinook salmon in the lower San Joaquin River and South Delta.

- An acoustic tag monitoring study was conducted from 2006 – 2010 to evaluate survival of salmon smolts emigrating from the SJR through the Delta (SJRGA 2011).
    - In 2006, results indicated that without the, "Head of Old River Barrier in place and during high-flow conditions many (half or more) of the acoustic-tagged fish, released near Mossdale, migrated into Old River."

- In 2007, a total of 970 juvenile salmon were tagged with acoustic transmitters and were detected by a combination of receivers:
  - Mobile tracking found that 20% of released fish (n=192) were potentially consumed by predators at three "hotspots" located near Stockton Treatment Plant (n=116), just upstream of the Tracy Fish Facility trashracks (n=57), and at the head of Old River flow split downstream of Mossdale (n=19).
  - Stationary detections indicate an average 45% loss, potentially attributable to predation, which does not account for losses at the largest "hotspot" at Stockton Treatment Plant, nor in the greater Delta past Stockton and Hwy 4.
- In 2008, the only tagged fish entering Old River to survive were fish collected (salvaged) at two large water conveyance projects and transported through the Delta by truck (Holbrook et al. 2009).
- In 2009, the combined loss rate from Durham Ferry to the HORB and the loss rate in the vicinity of the HORB (BAFF in) combined to show a loss rate between 60 -76% of the seven groups released at Durham Ferry (SJRGA 2010).
  - Mortality rates (likely due to predation) between Durham Ferry and the BAFF ranged from 25.2% to 61.6% (mean 40.8%) (Bowen et al. 2009).
  - Predation rates near the BAFF ranged from 11.8% to 40% (mean 27.5) (Bowen et al. 2009).
- In 2010, Old River supplemental smolt releases concluded of 162 of 247 (65.6%) tags were classified as coming from a predator rather than a smolt (SJRGA 2011).
  - Mortality rates (likely due to predation) between Durham Ferry and the BAFF ranged from 2.8% to 20.5% (mean 7.8%) (Bowen and Bark 2010).
  - Predation rates near the BAFF ranged from 17% to 37% (mean 23.5%) (Bowen and Bark 2010).

Significant predation losses are also occurring in the San Joaquin Basin tributaries due to non-native predators.

- Radio tracking studies conducted during May and June of 1998 and 1999, respectively (Demko et. al 1998; FISHBIO unpublished data), indicated that the survival of large, naturally produced and hatchery juveniles (105 to 150 mm fork length) was less than 10% in the Stanislaus River downstream of the Orange Blossom Bridge.
- Individual based, spatially explicit model – Piscivores consume an estimated 13-57% of fall-run Chinook in Tuolumne River (Jager et al. 1997).
- Significant numbers of striped bass migrate into the Stanislaus River each spring, as detected at the weir (Anderson et. al 2007; FISHBIO unpublished data), and are thought to prey heavily on outmigrating Chinook smolts.

The overwhelming majority of predation on juvenile Chinook is the result of non-native predators that were intentionally stocked by CDFG, and whose abundance can be reduced to minimize the impacts on Chinook.

- Most of the non-native fish species (69%) in California, including major predators, were intentionally stocked by CDFG for recreation and consumption beginning in the 1870s. All of the top predators responsible for preying on native fish are currently managed to maintain or increase their abundance. Historically, the Delta consisted of approximately 29 native fish species, none of which were significant predators. Today, 12 of these original species are either eliminated from the Delta or threatened with extinction, and the Delta and lower tributaries are full of large non-native predators such as striped bass that feed "voraciously" throughout long annual freshwater stays (McGinnis 2006).
  - Lee (2000) found a remarkable increase in the number of black bass tournaments and angler effort devoted to catching bass in the Delta over the last 15 years.
  - According to Nobriga and Feyrer (2007), "largemouth bass likely have the highest per capita impact on nearshore fishes, including native fishes," and concludes that "shallow water piscivores are widespread in the Delta and generally respond in a density-dependent manner to seasonal changes in prey availability."
  - "In recent years, both spotted bass (*Micropterus punctulatus*) and redeye bass (*M. coosae*) have invaded the Delta. While their impact in the Delta has not yet been determined, the redeye bass has devastated the native fish fauna of the Cosumnes River Basin, a Delta tributary" (Moyle *et al.* 2003 as cited by Cohen and Moyle 2004).
  - Black crappie were responsible for a high level of predation during a 1966/67 CDFG study (Stevens 1966). As many as 87 recognizable fish were removed from the stomach of one crappie, and counts of 40 to 50 were common. Most of the fish were undigested, hence not in the stomachs for very long.
- A lawsuit by the Coalition for a Sustainable Delta against DFG was settled in April 2011. Under the settlement, a comprehensive proposal to address striped bass predation in the Delta must be developed by state and federal fishery management agencies. As part of the settlement DFG must make appropriate changes to the bag limit and size limit regulations to reduce striped bass predation on the listed species, develop an adaptive management plan to research and monitor the overall effects on striped bass abundance, and create a $1 million research program focused on predation of protected species.
  - DFG (2011) proposed changing striped bass regulations to include raising the daily bag limit for striped bass from 2 to 6 fish with a possession limit of 12, and lowering the minimum size for striped bass from 18 to 12 inches. Proposed regulations included a "hot spot" for striped bass fishing at Clifton Court Forebay with a daily bag limit of 20 fish, a possession limit of 40 fish and no size limit. Fishing the hot spot would require a report card to be filled out and deposited in an iron ranger or similar receptacle.
  - With significant pressure from striped bass fishing groups, the California Fish and Game Commission denied the changes proposed by agency biologists in favor of keeping striped bass protections (CFGC 2012).
- According to NMFS (2009b), Priority Recovery Actions (1.5.4) Implement programs and measures designed to control non-native predatory fish (e.g., striped

bass, largemouth bass, and smallmouth bass), including harvest management techniques, non-native vegetation management, and minimizing structural barriers in the Delta, which attract non-native predators and/or that delay or inhibit migration.

Reducing striped bass predation on juvenile Chinook is the simplest, fastest, and most cost-effective means of increasing outmigration survival.
High predation likely occurs at specific "hot spots", which can be the focus of a control program. The predation on salmonids appears to be patchy both seasonally and spatially, with higher levels of predation documented in the spring, in areas of anthropogenic influence such as near water diversion structures and dams (Gingras 1997, Tucker et al. 1998, Merz 2003, Clark et al. 2009). Stevens (1966) reported a "highly localized" situation at the Paintersville Bridge; in June he found some of the highest predations rates for the region, when 90.7% of all bass with food in their stomachs had consumed Chinook salmon (198 salmon in 97 stomachs). In 1993, a diet study estimated that 11 to 28% of the natural production of salmon smolts in the Mokelumne River was lost to striped bass predation in the Woodbridge Dam afterbay (Merz 2003). Likewise, below Red Bluff Diversion Dam on the Sacramento River juvenile salmon were found in high numbers in the stomachs of striped bass (Tucker et al. 1998). In addition, striped bass are generally associated with the bulk of predation in Clifton Court Forebay, where pre-screen loss rate (attributed to predation) was estimated at 63-99% for juvenile Chinook salmon and 78-82% for steelhead migrating through the Clifton Court Forebay (Gingras 1997, Clark et al. 2009). Furthermore, during a study of predation on salvaged fish (that had already survived the Forebay) the researchers noted a lack of predators at the non-release, control sites, suggesting "that the salvaged fish releases at the release sites were the principal attractants of predators as opposed to some other factor such as the presence of a man-made structure" (Miranda et al. 2010).

The predatory fishes such as striped bass and largemouth bass prey on covered fish species and can be locally abundant at predation hot spots. Adult striped bass are pelagic predators that often congregate near screened diversions, underwater structures, and salvage release sites to feed on concentrations of small fish, especially salmon. Striped bass are a major cause of mortality of juvenile salmon and steelhead near the SWP south Delta diversions (Clark et al. 2009). Largemouth bass are nearshore predators associated with beds of invasive aquatic vegetation (BDCP 2012).

Targeted predator removal at hot spots would reduce local predator abundance, thus reducing localized predation mortality of covered fish species. Predator hot spots include submerged structures, scour holes, riprap, and pilings. Removal methods will include electrofishing, gill netting, seining, and hook and line (BDCP 2012).

Altered Delta habitat has benefited non-native predator species and increased the vulnerability of outmigration juvenile salmonids.

> "The structure of the Delta, particularly in the central and southern Delta, has been significantly altered by construction of manmade channels and dredging, for shipping traffic and water conveyance. Intentional and unintentional

introductions of non-native plant and animal species have greatly altered the Delta ecosystem. Large predatory fish such as striped bass and largemouth bass have increased the vulnerability of emigrating juveniles and smolts to predation, while infestations of aquatic weeds such as *Egeria densa* have diminished the useable near- shore, shallow water habitat needed by emigrating salmonids for rearing (NMFS 2011)."

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Attachment A

Technical Memorandum

Review regarding use of select references by SWRCB in their Draft and Final *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives* (SWRCB 2010 and 2011) and DFG in their *Quantifiable Biological Objectives and Flow Criteria for Aquatic and Terrestrial Species of Concern Dependent on the Delta* report (DFG 2010)

TO: Tim O'Laughlin

FROM: Doug Demko, Michele Palmer, Andrea Fuller

DATE: January 30, 2012

SUBJECT: Review regarding use of select references by SWRCB in their Draft and Final *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives* (SWRCB 2010 and 2011) and DFG in their *Quantifiable Biological Objectives and Flow Criteria for Aquatic and Terrestrial Species of Concern Dependent on the Delta* report (DFG 2010)

This memorandum has been developed to present results of a review regarding use of select references by SWRCB in their Draft and Final *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives* (SWRCB 2010 and 2011) and DFG in their *Quantifiable Biological Objectives and Flow Criteria for Aquatic and Terrestrial Species of Concern Dependent on the Delta* report (DFG 2010). We focused our review on those references that were used in one or both documents to support the position that inadequate spring (Feb-Jun) flows are the primary cause of salmon decline including, in chronological order, Kjelson et al. 1981, Kjelson and Brandes 1989, AFRP 1995, Baker and Mohardt 2001, Brandes and McLain 2001, Mesick 2001, DFG 2005a, DFG 2009, Mesick and Marston 2007, Mesick et al. 2007, Mesick 2008, Mesick 2009, Mesick 2010a-e, and USDOI 2010. In addition, we examined peer reviews conducted on the SWRCB (2011) and DFG (2010) documents (Quinn et al. 2011 and Gross et al. 2010, respectively). A summary of key points is provided below followed by a detailed discussion of the findings of our review.

Summary of Key Points

- **References used by the SWRCB and DFG to support their position that inadequate spring (Feb-Jun) flows are the primary cause of salmon decline are NOT the best available science for evaluating current flow/survival relationships due to a variety of reasons including:**
    - All references prior to 2008 (i.e., Kjelson et al. 1981, Kjelson and Brandes 1989, AFRP 1995, Baker and Mohardt 2001, Brandes and McLain 2001, Mesick 2001, Mesick and Marston 2007, Mesick et al. 2007) are outdated and lack recent data reflecting major anthropogenic changes to the Delta ecosystem resulting in a regime shift in about 2000-2001; and are also statistically limited and have been superseded by superior Bayesian analyses conducted by Newman (2008)[1].

[1] In 2008, a more robust Bayesian analysis was designed and conducted by Newman using data from 1985 through 2006 (Newman 2008) to address the limitations of all the previous coded wire tag data analyses presented in pre-2008 reports.

- The DFG's San Joaquin River Fall-run Chinook Salmon Population Model (SJRFRCS Model) (DFG 2005a, DFG 2009) has been found to be flawed through both peer and professional reviews, as identified in previous comments submitted to the SWRCB (Demko et. al 2010).
- Mesick references have not been peer-reviewed and their analyses are the same/similar to those used in DFG's SJRFRCS Model.
- At least two Mesick documents have been rejected previously by FERC because the authors
  - presented a "fallacy of focusing entirely on flow" and did not consider the influence of other possible limiting factors (Tuolumne River Limiting Factors Analysis; Mesick et al. 2007); and
  - improperly analyzed the Tuolumne River in isolation of other Central Valley populations, did not consider effects of hatchery introductions on Tuolumne River Chinook salmon, and discounted other potential factors (Tuolumne River Risk of Extinction Analysis; Mesick 2009).
- Additionally, Mesick 2009 and supporting references (Mesick et al. 2009 a, b) have apparently been rejected for publication.

- **Currently, the best available science that should be used to evaluate potential flow/survival relationships, which were mentioned in the SWRCB technical reports but were inappropriately applied, include the following:**
  - Newman 2008 has been subject to extensive peer-review and is a published work (unlike Mesick documents); and uses higher quality information (paired releases versus non-paired releases used in other Mesick analyses).
  - VAMP Peer Review indicates that consideration should be given regarding the role of Delta survival for the smolt life stage in the larger context of the entire life cycle of the fall-run Chinook, including survival in the upper watershed, the Bay and the ocean and fry rearing in the Delta.

- **Peer review of SWRCB's final technical report indicates several areas for improvement, which are consistent with our previously and presently submitted comments and peer review comments are also applicable to the DFG QBO report:**
  - Due to limited review time, it is likely that Peer reviewers for the SWRCB's final technical report were not aware of previous findings regarding DFG's SJRFRCS Model or of this model's similarity to the Mesick analyses, which may have affected their comments.

- Nonetheless, even with limited information and review time, Peer reviewers found several areas for improvement including, but not limited to:
  - Implausibly high linkage of higher spring flows to adult escapement;
  - Other processes besides flow have likely contributed to declines, and will continue to hinder salmon recovery;
  - Holistic view (considering other factors besides flow) would be more tenable;
  - Contradictory statements regarding influence of ocean conditions;
  - Relies too heavily on secondary sources;
  - Several figures are not clear and could be better expressed with different analyses, or some figures do not support statements.

- **Peer review of DFG's QBO report indicates several areas for improvement, which are consistent with our previously and presently submitted comments, and peer review comments are also applicable to the SWRCB's technical reports:**
  - Using the best available science means:
    - Agencies may not manipulate their decisions by unreasonably relying on some sources to the exclusion of others.
    - Agencies may not disregard scientifically superior evidence.
  - Many concerns about the use (or lack of use) of citations.
    - Citations are to support an argument, not establish a fact.
    - References must be accurately and clearly cited.
    - Peer-reviewed literature preferred.
    - Frequent use of some references to exclusion of scientifically superior sources.
  - Uncertainties and assumptions are not provided.
  - Assumption that flow alone will restore fish populations is poorly founded.
  - Salmon objectives do not distinguish between hatchery and naturally produced fish.

REVIEW OF FINDINGS

1. References used by the SWRCB and DFG to support their position that inadequate spring (Feb-Jun) flows are the primary cause of salmon decline are NOT the best available science for evaluating current flow/survival relationships due to a variety of reasons including:

- **All studies prior to 2008 (i.e., Kjelson et al. 1981, Kjelson and Brandes 1989, AFRP 1995, Baker and Mohardt 2001, Brandes and McLain 2001, Mesick 2001, Mesick and Marston 2007, Mesick et al. 2007) are outdated and lack recent data reflecting major anthropogenic changes to the Delta ecosystem resulting in a regime shift in**

about 2000-2001; and are also statistically limited and have been superseded by superior Bayesian analyses conducted by Newman (2008)[2].

Three of the references cited prior to 2001 (Kjelson et al 1981, Kjelson and Brandes 1989, AFRP 1995) present regressions of spring flow at Vernalis vs. escapement 2.5 years later, and it is hypothesized from these regressions that smolt survival is positively correlated with river flow. Since smolt survival in the San Joaquin River was not measured, the influence of river flow on smolt survival could not be assessed.

In 2001, the first multi-year analyses of smolt survival data from mark-recapture studies was conducted to estimate salmon survival relative to flow at Vernalis were conducted by Baker and Morhardt (2001) and Brandes and McLain (2001). While Brandes and McLain (2001) identified a statistically significant relationship between smolt survival from Dos Reis to Chipps Island and river flow at Stockton, Baker and Morhardt (2001) concluded that "smolt survival through the Delta may be influenced to some extent by the magnitude of flows from the San Joaquin River, but this relationship has not been well quantified yet, especially in the range of flows for which such quantification would be most useful." Baker and Morhardt (2001) noted several weaknesses in the available data including low recapture numbers which generated imprecise estimates of survival, a lack of control of flow and export conditions during individual experiments, and lack of a statistical design in combinations of flows and exports.

The Vernalis Adaptive Management Plan (VAMP) studies were designed to address these weaknesses in previous CWT data and provided additional data through 2006. CWT data continued to be analyzed in piecemeal fashion through 2006 and the analyses were eventually superseded in 2008 by superior Bayesian analyses conducted by Newman (2008).[1] During the VAMP studies an abrupt, downward shift in smolt survival was documented.

- **The DFG's San Joaquin River Fall-run Chinook Salmon Population Model (SJRFRCS Model) (DFG 2005a, DFG 2009) has been found to be flawed through both peer and professional reviews, as identified in previous comments submitted to the SWRCB (Demko et. al 2010).**

Both the SWRCB and DFG refer to the SJRFRCS Model to support the idea that more spring flows are necessary to create more Chinook salmon in the San Joaquin Basin. As identified in our previous comments (Demko et al. 2010), which the SWRCB has not incorporated into their final technical report, the SJRFRCS Model uses inappropriate statistical models that do not represent the best available science; two versions of the SJRFRCS Model have been reviewed and found to contain substantial flaws (DFG 2005a version reviewed by Deas et al. 2006 and Pyper et al. 2006, and DFG 2009 version reviewed by Lorden and Bartoff 2010).

Demko et al. (2010) stated that

> The most recent version of the DFG [SJRFRCS] model (DFG 2009) is still considered inappropriate for use by the SWRCB for a number of reasons, including the previously mentioned incomplete revisions and the lack of peer-review. Our comments, highlighting the problems with the statistical validity of the current DFG model, are summarized under the next 12 issue statements. Details regarding these statements are provided in Attachment 1 [of Demko et.al. 2010].

- DFG Model Issue 1. It is clear that in order to have a statistically sound model for escapement, one needs to incorporate environmental variables other than, or in addition to flow, such as dissolved oxygen, exports, and water temperature.
- DFG Model Issue 2. The proposed simple linear regression model of escapement versus flow is inconsistent with the most recent data from 1999-2009, which shows a negative correlation between flow and escapement.
- DFG Model Issue 3. The proposed model is inconsistent over different flow ranges. For example, when dividing the range of flow observations into 4 equally sized bins, one of the bins shows a negative correlation between flow and escapement.
- DFG Model Issue 4. There are a small number of overly influential observations in the flow versus escapement data. For example, if one selects a moderately sized subset of these paired observations at random, the model fit varies widely and one frequently observes a negative correlation between flow and escapement.
- DFG Model Issue 5. The Ecological Fallacy: The well-known phenomenon that averaging over subgroups (as has been done with the flow data) falsely inflates the strength of a linear relationship.
- DFG Model Issue 6. Outliers are present in the flow versus escapement data.
- DFG Model Issue 7. The residuals from the flow versus escapement model exhibit non-normality.
- DFG Model Issue 8. Heteroscedasticity: The estimated errors in the flow versus escapement model exhibit a non-constant error rate.
- DFG Model Issue 9. Nonlinearity is observed in the flow versus escapement data.
- DFG Model Issue 10. The estimated errors in the flow versus escapement model exhibit dependence.
- DFG Model Issue 11. The flow versus escapement model has a low R_2 value of around 0.27.
- DFG Model Issue 12. The Regression Fallacy: That correlation implies causation.

- **Mesick references have not been peer-reviewed and their analyses are the same/similar to those used in DFG's SJRFRCS Model. Not peer-reviewed/similar analyses to DFG's SJRFRCS Model**. The SWRCB and DFG rely on several Mesick documents to support the position that inadequate spring (Feb-Jun) flows are the primary cause of salmon decline (i.e., both rely on Mesick 2009; Mesick et al. 2007; SWRCB also relies on Mesick 2001 and Mesick 2010a-e; and DFG also relies on Mesick 2008 and Marston 2007) as well as the SJRFRCS Model (DFG 2005, 2008, and 2009. Mesick documents have not been peer-reviewed, and their analyses are the same/similar to those used in DFG's SJRFRCS Model (DFG 2005a, DFG 2009).

Peer-reviewed literature is preferred since supporting evidence for an argument or position is stronger as a result of independent experts critical reviews of the papers; while citations to agency reports (e.g., Mesick documents) frequently provide weaker supporting evidence because they have not been independently reviewed by recognized experts (Gross et al. 2010).

As indicated in the previous section, DFG's SJRFRCS Model (DFG 2005a, DFG 2009) has been found to be flawed through peer (Deas et al. 2006) and professional (Pyper et al. 2006, Lorden and Bartoff 2010) reviews. Mesick references are largely based on the same linear regression approach used in DFG's SJRFRCS Model, and this approach continues to be re-packaged with slight variations by Mesick, as well as by DFG (2005a, 2009), and the U.S. Fish and Wildlife Service's (USFWS) Anadromous Fish Restoration Program (AFRP 2005). Although the regressions indicate a correlation between flow at Vernalis and escapement 2 ½ years later, the use of linear regressions to assess these effects is too simple an approach particularly given the fact that all authors include violations of simple linear regression; inadequate inclusion of other environmental factors (e.g., temperature) that are clearly important (e.g., predation, temperature); and the tendency for other factors to be correlated with each other (Lorden and Bartroff 2010). Some of the major problems with the linear regression approaches used by all of these authors include:

- Averaging (such as over months of flows) reduces variation that may exist (masking biologically important variations in flow) and has potential to falsely inflate the strength of linear relationship or make one appear when there is a more complex relationship or none at all. Authors have a responsibility to show that the variation lost in averaging does not affect the inferred relationship.
- Lack of robustness in the linear regression model fit does not support a cause-effect relationship between flow and escapement.
- Small number of data points overly influence and inflate the linear relationship between escapement and flows.
- Analysis assumes that escapement is normally distributed, but it is been shown to be non-normally distributed.
- Assumes that escapement is subject to random variations whose scale is constant and which averages out to zero; however, residual plots indicate both a bias (non-zero average) and non-constant scale of variations. Also, there are outliers contributing to the bias.
- Correlation does not imply causation (Lorden and Bartroff 2010).

Therefore, although linear regression relationship results suggest that flow may affect juvenile survival, the results do not imply a direct cause-effect relationship between juvenile salmon survival and flow, or that increasing flow will cause juvenile salmon survival to increase.

- **At least two Mesick documents have previously been rejected by FERC because the authors**
  - **presented a "fallacy of focusing entirely on flow" and did not consider the influence of other possible limiting factors (Tuolumne River Limiting Factors Analysis; Mesick et al. 2007); and**
  - **improperly analyzed the Tuolumne River in isolation of other Central Valley populations, did not consider effects of hatchery introductions on Tuolumne River Chinook salmon, and discounted other potential factors (Tuolumne River Risk of Extinction Analysis; Mesick 2009).**

Tuolumne River Limiting Factors Analysis (Mesick et al. 2007) Rejected by FERC. During recent FERC proceedings (FERC 2009a) regarding the operation of the New Don Pedro Project on the Tuolumne River, FERC rejected the findings of the Limiting Factors Analysis conducted as part of the Tuolumne River Management Conceptual Model by Mesick et al. (2007) because the authors presented a "fallacy of focusing entirely on flow" and did not consider the influence of other possible limiting factors (e.g., Delta exports, ocean conditions, and unscreened diversions). Key points made by FERC in a FERC Order issued July 16, 2009 (FERC 2009a) regarding the problems associated with Mesick et al. (2007) analyses include the following:

- Page 20, ¶70. Mesick et al. (2007) identifies Tuolumne River flows as having the greatest impact on juvenile Chinook salmon survival… however, they do not include any studies to ascertain the influence of other possible limiting factors, such as pumping at the state and federal water projects in the San Francisco Bay Delta, ocean conditions, and unscreened diversions in the Tuolumne River and in the Delta. In response to these concerns, we find that it may be inappropriate to focus on flow-related studies to the exclusion of other, possibly significant, limiting factors.
- Page 29, ¶74. Our review of the Limiting Factor Analysis does not suggest that the recent collapse of the Tuolumne River fall-run Chinook salmon can be attributed to the Article 37 flow regime. Rather, the analysis simply shows that, up to a point, higher flows produce more fish. This is not surprising. However, no significant increase in run size could occur if conditions outside the river system are unfavorable. Because fall-run Chinook salmon failed in the entire Sacramento and San Joaquin River system, it seems likely that one or more factors common to all of these runs may have caused the collapse. Further, we note that in recent Congressional testimony, NMFS agreed with this conclusion, stating that "the cause of the decline is likely a survival factor common to salmon runs from different rivers and consistent with the poor ocean conditions hypothesis being the major causative factor.
- Page 29, ¶75. The Limiting Factor Analysis states that Tuolumne River spring flows in excess of 3,000 cfs are necessary to ensure successful Chinook returns. However, the fallacy of focusing entirely on flows is illustrated by the fact that

the average spring flow in 2006 and 2007 (from February 1 through May 31) exceeded 3,500 cfs, yet the returns of both jack and adult fall-run Chinook salmon in 2008 and 2009 were extremely low.

- Page 31, ¶78. The Limiting Factor Analysis also discounts the effects of ocean conditions on the Tuolumne River stock. A report by the National Oceanic and Atmospheric Administration in 2006 and a recent report prepared for the Pacific Fishery Management Council in 2009 document that poor ocean conditions in 2005 and 2006 were the primary cause for the collapse of the Sacramento River Basin fall-run Chinook salmon.

Tuolumne River Risk of Extinction Analysis (Mesick 2009) Rejected by FERC. Mesick (2009) was originally submitted to FERC as Exhibit No. FWS-50 and was reviewed by Noah Hume (Senior Aquatic Ecologist at Stillwater Sciences, a scientific consulting firm). Hume testified that Mesick's (2009) risk of extinction analysis was improperly applied and pointed out that San Joaquin salmon populations have dropped well below the minimums necessary to maintain genetic viability in several periods in the past but have rebounded within a few years. Although Hume indicated that he did not have enough time to thoroughly review Mesick's document, he pointed out the following: (1) analyzing the population demographics and trends of the Tuolumne River population in isolation of other San Joaquin and Sacramento basin populations is suspect because the Tuolumne River population is not recognized as a distinct population segment (DPS) but is part of the Central Valley faIl/late fall-run Chinook evolutionary significant unit (ESU), which is not listed as endangered or threatened [status: Species of Special Concern]; (2) no consideration was given regarding the effects of hatchery introductions on Tuolumne Chinook salmon and the influence of inbreeding; and (3) no basis was given for discounting the influence of other factors (e.g., Delta and ocean conditions).

Based on Hume's testimony and corroborating testimony from Dr. Peter Moyle (professor at the University of California, Davis), FERC found

> the Tuolumne Chinook salmon population may be subject to extirpation, but is not at risk of extinction pending relicensing. Recent declines in Chinook salmon escapement levels are comparable to those occurring in other San Joaquin River tributaries and based on past patterns of high and low spawning returns, escapement levels in the Tuolumne River and other tributaries, are likely to rebound. More monitoring is needed to determine what factors, in addition to instream flows, are adversely impacting the salmon. (FERC 2009b, ¶275)

These findings are also applicable to other San Joaquin basin populations (i.e., Stanislaus and Merced).

- **Additionally, Mesick 2009 and supporting references (Mesick et al. 2009 a, b) have apparently been rejected for publication.**

  According to Carl Mesick's Curriculum Vitae (CSPA_exh8 Carl Mesick CV), he submitted several reports to the *California Fish and Game Scientific Journal* for publication in October 2009 (i.e., Mesick 2009 and Mesick et al. 2009a, b). However, none of these papers has been published in this journal as of their Summer 2011 issue, which indicates that these papers were not adequate for publication.

  Despite being rejected for publication and by FERC, these papers were used directly (i.e., Mesick 2009) or as sub-references to other Mesick documents within the SWRCB technical report including:

  (1) Mesick et al. 2009a, b, were used as basis for risk of extinction analyses in Mesick 2009;
  (2) Mesick 2009 used as supporting evidence for the risk of extinction of Tuolumne River salmon in Mesick 2010d;
  (3) Mesick et al. 2009a used as the basis for analyses regarding the relationship of flow, temperature and exports with adult recovery rates in Mesick 2010c; and
  (4) Mesick 2009 and Mesick et al. 2009a, b used in a synthesis of these analyses in Mesick 2010a, e.

2. Currently, the best available science that should be used to identify flow/survival relationships, which were mentioned in the SWRCB technical reports but were inappropriately applied, include the following:

- **Newman 2008.** Various analyses (e.g., Mesick 2010c, Baker and Mohardt 2001, Brandes and McLain 2001, Mesick 2001, Mesick and Marston 2007, Mesick et al. 2007) regarding smolt survival through the San Joaquin River Delta are used instead of superior analyses (i.e., Newman 2008). As an example, there are several reasons why the analyses presented in Mesick 2010c are inferior to Newman 2008, including the following:

  - Newman 2008 was subject to extensive peer-review and is a published work; unlike Mesick 2010c, which has not been peer-reviewed.
  - Mesick's approach does not use paired releases to address the effects of differences in sampling effort or the influence of conditions beyond the San Joaquin Delta. The quality of the information from the 35 paired releases used by Newman is superior to the 158 non-paired releases used by Mesick.
  - There are several problems with the way the Mesick 2010c analysis is presented including:
    - Basic statistics to describe the fit or significance of trend lines shown for each regression are noticeably absent from Mesick 2010c. For instance, there are no r^2 values reported for what appear to be very poor fits.
    - It is not clear whether the 13 instances of zero recoveries shown in Table 1 were included the analyses.

- The y-axis scale of 0-3% used for the graphs is an attempt to exaggerate the purported influence of flow and water temperature on recovery rates. This is an extremely narrow range, particularly when one considers expected noise in the data, and the potential effects of sampling effort.

Besides being inferior to Newman (2008), Mesick 2010c does not support the statement on pages 3-26 and 3-51 that "numerous studies indicate the primary limiting factor for FRCS tributary abundances is reduced spring flow, and that populations on the tributaries are highly correlated with tributary, Vernalis, and Delta flows". Mesick 2010c does not support the first part of this statement because in order to identify a primary limiting factor for FRCS tributary abundances, one would need to explore the relative impacts of all factors affecting each lifestage of FRCS in the tributaries, the San Joaquin River Delta, and in the ocean. For instance, Mesick 2010c did not explore whether survival during smolt outmigration is more limiting than ocean harvest. This analysis also did not explore whether river flow is the primary factor influencing smolt survival through the San Joaquin River Delta, since the recovery rates used were inclusive of smolt survival beyond Chipps Island and adult survival.

Similarly, Mesick 2010c also does not support the statement that "populations on the tributaries are highly correlated with tributary, Vernalis, and Delta flows". This analysis did not explore how population abundance, presumably escapement, may be correlated with flow. The analysis attempted to focus on the influence of San Joaquin River Delta flow on adult return rates, however the method used did not isolate smolt survival through the Delta from survival in the Bay, the Ocean, and during adult upstream migration.

- **Vamp Peer Review.** While the Technical Report discusses findings of a peer review of the VAMP conducted in 2010 (Dauble et al. 2010), an important recommendation to the SWRCB was omitted, which provides context for interpretation of the flow and survival relationships in terms of revision to the flow objectives. Specifically, the Panel was asked "*How can the results from the VAMP to date be used to inform the SWRCB's current efforts to review and potentially revise the San Joaquin River flow objectives and their implementation?"* The first part of their response, which was not included in the SWRCB's Technical Report, states that "In our answer to question 1, we attempted to summarize the scientific information obtained from the VAMP studies related to salmon survival through the Delta and the three factors of flow, exports, and the HORB. For several reasons, it is not straightforward to use that information to inform the Board's current efforts to review and revise San Joaquin River flow objectives. Because our review focused on the survival and passage of salmon smolts through the Delta, we did not evaluate other factors that may be limiting future salmon production. In setting flow objectives, we believe the Board **should consider the role of Delta survival for the smolt life stage in the larger context of the entire life cycle of the fall-run Chinook, including survival in the upper watershed, the Bay and the ocean and fry rearing in the Delta** [emphasis added] (SJRTC 2008)." The Technical Report fails to address this recommendation.

3. Peer review of SWRCB's final technical report indicates several areas for improvement, which are consistent with our previously and presently submitted comments and are also applicable to the DFG QBO report:

Peer reviewers were given a short time frame (30 days) to review the SWRCB's final technical report and were likely not aware of previous findings regarding DFG's SJRFRCS Model (i.e., peer review by Deas et al. 2006, Pyper et al 2006, Lorden and Bartroff 2010); or of the model's similarity to the Mesick analyses, which may have affected their comments.

Even in absence of this background material, peer reviewers for SWRCB's final technical report found areas for improvement including:

- Relies too heavily on secondary sources.
- Several figures are not clear, could be better expressed with different analyses, or do not support statements.
- Implausibly high linkage of higher spring flows to adult escapement.
- Other processes besides flow have likely contribute to declines, and will continue hinder their recovery.
- Holistic view (considering other factors besides flow) would be more tenable.
- Contradictory statements regarding influence of ocean conditions.

Relevant excerpts from peer reviewers are provided in Attachment 1.

4. Peer review of DFG's QBO indicates several areas for improvement, which are consistent with our previously and presently submitted comments, and are applicable to the SWRCB's technical reports:

- "Using the best available scientific information" means (page 3):
  - Agencies may not manipulate their decisions by unreasonably relying on some sources to the exclusion of others.
  - Agencies may not disregard scientifically superior evidence.
- Many concerns about the use (or lack of use) of citations.
  - Citations are to support an argument, not establish a fact. "Citations, even to the peer-reviewed literature, are not like theorems in mathematics, and do not establish validity."(page 3)
  - References must be accurately and clearly cited.
  - "Whenever possible, references should be to peer-reviewed literature, not internal technical reports or testimony." (page 6)
  - "Frequently relies on some sources to the exclusion of scientifically superior sources… it cites outdated analyses by Kjelson and Brandes instead of superior analyses (Newman and Rice 2002; Newman 2003)… It relies on an unpublished work by Marston [i.e., Marston 2007] and ignores superior studies by Newman [i.e., Newman 2008] and others involved with VAMP, and by Terry Speed (1993). It fails to cite many relevant, more recent papers (Appendix A3), including a long review on

Central Valley Chinook and steelhead (Williams 2006) that would have drawn DFG's attention to the superior sources just noted." (page 6)

- "Does not acknowledge the uncertainty associated with most of the modeling work referred to in the Draft." (page 6)
- "Critical assumptions and areas of major uncertainty are not described." (page 6)
- "assum[tion] that flow alone will restore natural processes and restore/reconnect critical habitats for [many] species… is poorly founded." (page 7)
- "objectives for salmon fail to distinguish hatchery and naturally produced fish" (page 9)

Relevant excerpts from peer reviewers are provided in Attachment 1.

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ATTACHMENT 1

EXCERPTS FROM A PEER REVIEW OF THE STATE WATER RESOURCES CONTROL BOARD'S FINAL TECHNICAL REPORT ON THE SCIENTIFIC BASIS FOR ALTERNATIVE SAN JOAQUIN RIVER FLOW AND SOUTHERN DELTA SALINITY OBJECTIVES

[Quinn, T., J.D. Olden, and M.E. Grismer]. 2011. External Peer Review of: State Water Resources Control Board California Environmental Protection Agency "Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives"

Quinn, Page 5
In general the report relies too heavily on secondary sources (e.g., Moyle 2002; NMFS 2009a, 2009b; Williams 2006). There is nothing wrong with these references *per se* but their use compels the reader to get that reference and find the relevant place in it. In cases where the secondary source is lengthy or not readily available, this is no small task. In addition, the referencing of work outside the basin and outside California is limited. I understand that the report has a sharp focus on the San Joaquin River but there are a number of places where work done elsewhere would be relevant.

In terms of conclusions, the report makes a strong case that the shortages of salmon and steelhead are in large part related to the heavy modification of this river system. The mean flows and variances in flow that are normal in rivers of this region and for which the fish evolved have been radically altered (see more detailed comments below). It seems likely, however, that other processes have played a role over the years in the decline of these fishes, and will continue to hinder their recovery. Some of these processes may be synergistic with flows such as, perhaps, chemical contaminants or predation in streams, whereas other may operate independently such as fisheries management, ocean conditions, predation by marine mammals, etc.

Quinn, Page 7
The use of olfaction to locate natal streams deserves better citations than (NMFS 2009a, DFG 2010a). It would be better to cite Hasler and Scholz (1983) or perhaps Dittman and Quinn (1996).

[TR] P. 70 The statement "However, if natal streams have low flows and salmon cannot perceive the scent of their natal stream, straying rates to other streams typically increases." demands more details. There should be information on this important feature of the adult phase and appropriate references. I was surprised to find that there have been no tracking studies on the movements and travel rate of salmon in this system. Can this be true, and if so, why have none been done? This is off-the-shelf technology and clearly important to inform

management in many ways.
I also have some sense (though I confess to not being sure precisely where I learned it) that there are much higher straying rates from the SJR than are considered normal, and that these result from transportation of hatchery juveniles downstream, and also from the difficulties that returning adults experience in detecting odors, given the altered flow regimes. Forgive me if I am mistaken in this regard but if there is any truth to the statement that straying is more prevalent than is normal, this certainly merits more attention in the report. There should be coded wire tagging data from the main hatcheries, I would think, and the analysis of them should be simple.

Quinn, Page 8
The statement that "streamflow alteration, dictated by the dams on the major SJR tributaries, affect [sic] the distribution and quantity of spawning habitat " seems to call for more information. Presumably, the dams have reduced the sediment transport patterns but some detail and references to this would be helpful, or at least an explanation of the processes. The peak flows will play a role in these kinds of sediment transport processes. Is there a loss of intermediate gravel sizes, leaving cobbles and silt? Has the gravel become embedded and so less suitable?

Figure 3.1, which seems to be copied from the NMFS BiOp, needs a proper caption; as is, it is hard to interpret.

Figure 3.2 is quite interesting. Are there similar data for other years, and if so, perhaps a summary table or figure could be produced. Are the redd counts referring to new redds, or all that were counted on each survey? Were they flagged, and so how does the total redd count relate to the number of live fish? Were there tagging studies of stream life and generation of "area-under-the-curve" estimates? In general, I find myself wanting more detail about this kind of data.

Quinn, Page 9
"... since 1952, the average escapement of fall-run Chinook salmon has shown a steady decline. "
This statement is contradicted by the figure (3.5) associated with it. There is no obvious trend downward but rather there are a series of pronounced peaks (a pair of peaks around 1954 and 1960, then discrete ones around 1970, 1985, and 2003). Each of the peaks lasted about 8 years, with distinct "troughs" in between. I think the conclusion that this was a "steady decline" is not supported. Can there be some more sophisticated analyses? What we have seems like a visual examination. What can we make of these peaks and troughs?

Quinn, Page 11
[TR] Page 80 "The limited data that do exist indicate that the steelhead populations in the SJR basin continue to decline (Good et al. 2005) and that none of the populations are [sic] viable at this time (Lindley et al. 2007)."

This latter is a very strong statement and could use some elaboration. Presumably, the implication is that only exchange with resident trout maintains the steelhead phenotype. This should be stated more explicitly, and the biological basis for this exchange merits discussion. I am surprised that the interesting recent papers on California *O. mykiss* were not cited (e.g., those by Satterthwaite, Mangel and co-authors), nor relevant papers from elsewhere (e.g., Narum and Heath). This is not merely a matter of getting some additional references but it is fundamental to the status and recovery prospects for these fish. If the anadromous life history is latent in the resident trout then changes in environmental conditions may allow it to express itself, whereas if the forms are very discrete, as is the case with sockeye salmon and kokanee (the anadromous and non-anadromous forms of *O. nerka*: e.g., Taylor et al. 1996), then the loss of one form is likely more permanent. This extent of plasticity is directly relevant to the efforts to address the chronic environmental changes to which these fishes have been subjected, and the prospects for recovery.

It is also worth noting that the migratory behavior of steelhead differs markedly from that of sub- yearling Chinook salmon. Sub-yearlings spend a lot more time in estuaries and littoral areas whereas steelhead seem to migrate more rapidly (as individuals), exit estuaries quicker (as a population), and occupy offshore waters to a much greater extent. There was extensive sampling in the Columbia River system by Dawley, McCabe and co-workers showing this, and many references to the use of estuaries.

The summary of the importance of spring flows for Chinook salmon seems very reasonable but it would be good to actually see more of the data on which these statements are based. What relationship might there be to pre-spawning mortality or incomplete spawning of adults, or egg- fry survival?

Quinn, Page 12
Figure 3.8 would be better expressed after adjustment for the size of the parent escapement and some density-dependence. Plotting numbers of smolts vs. flow suggests a connection but I would think that multi-variate relationships should be explored.

[TR] Page 84-85. "In a 1989 paper, Kjelson and Brandes once again reported a strong long term correlation (*R2* of 0.82) between flows at Vernalis during the smolt outmigration period of April through June and resulting SJR basin fall-run Chinook salmon escapement (2.5 year lag) (Kjelson and Brandes 1989).

This relationship should be easy to update and I would like to see the recent data. Frankly, I find this correlation implausibly high. There are so many factors affecting marine survival that even a perfect estimate of the number of smolts migrating to sea will not have an R2 of 0.82 with total adult return, much less with escapement (including both process and measurement error). I do not doubt that higher flows make for speedier passage and higher survival, but to link them so closely with adult escapement is stretching it. Indeed, it would seem that NMFS (2009) came to a similar conclusion. After acknowledging the shortcomings in this approach, it seems odd to see Figure 3.10, which is a time-series with flow during the smolt period and lagged escapement. If we much have escapement as the metric rather than smolt survival, can we not at least plot flow on the x-axis rather than date, and some form of density-adjusted recruit per spawner metric on the y-axis? I find it very difficult to see the relationship when plotted as time series.

Figure 3.12. This figure is a poor quality reproduction, and the y-axis is not defined. What is CDRR? (It is not in the list of acronyms). This report is pretty dense in terms of jargon and acronyms and abbreviation, so any effort to state things in plain English will be appreciated.

The text on the Importance of Flow Regime (3.7) is very sensible. It would be helpful to know what sources of the salmon mortality are most directly affected by flow reduction but, given the obvious data gaps, this seems unlikely. Thus overall correlations with survival and basic ecological principles have to carry the day. The text on fish communities, however, is rather confusing. I expected to see information of species composition, comparative tolerances to warm and cool water by various native and non-native fishes, ecological roles with respect to salmon, etc. However, there was a shift to population structure and importance of genetic and life history diversity for the success of salmon. This text (which would benefit from basic references such as Hilborn et al. 2003 for sockeye salmon, and the more recent papers by Moore and by Carlson on salmon in areas more extensively affected by humans) is fine but the reference to variable ocean conditions and marine survival seems to contradict the earlier statements that only smolt number going to sea really matter. Overall, I think this holistic view is more tenable than one only emphasizing the link between flow and smolt production. There is no question that marine survival varies from year to year but all you can ask from a river is that it produce juvenile salmon.

With respect to water temperature, the relationships between physical factors (local air temperature, water depth, solar radiation, groundwater, and heat loss, etc.) are quite well understood so it should be possible to hind-cast the thermal regime that would have occurred in the SJR and its tributaries had the dams and diversions not taken place.

Quinn, Page 13
Delta Flow Criteria
"Finally, the relationship between smolts at Chipps Island and returning adults to Chipps Island was not significant, suggesting that perhaps ocean conditions or other factors are responsible for mortality during the adult ocean phase. " This statement, referring to DFG data, also seems to contradict the earlier statements that marine conditions do not matter and that flow is all that matters. It would seem more correct to state that flow is the most important, among the things under our control.

On Table 3.15, it would be very helpful to present the status quo, so we can see the difference between the flows that DFG concluded are needed to double smolt production from present levels.

[TR] Page 105 "State Water Board determined that approximately 60 percent of unimpaired flow during the February through June period would be protective of fish and wildlife beneficial uses in the SJR. It should be noted that the State Water Board acknowledged that these flow criteria are not exact, but instead represent the general timing and magnitude of flow conditions that were found to be protective of fish and wildlife beneficial uses when considering flow alone."

This would seem to be a critical, overall conclusion: Higher and more variable flows are needed, and can be ca. 60% of unimpaired flows. This is logical and well supported by basic ecological principles, as these flows would provide benefits specific to salmon at several life history stages, and broader ecosystem benefits a well. The various exceedance plots (Figures 3.15 to 3.20) indicate that there is substantial improvement from flow at the 60% level whereas 20% and 40% achieve much less in the important late winter and early spring periods. As the report correctly notes, this is inevitably a bit arbitrary (why 60% - might 59% not do just as well?). Just as with agriculture and wildlife, fish production depends on complex interactions among a number of factors, of which flow is very important but not the only one. Extrapolation from lab studies to the field, where so many things go on at once and where history cannot be played back in a different scenario. So, one can pick at this value, just as one might pick at any specific value, and ask whether the fish can get by with a little less overall, or at some time of the year. Likewise, how much water do crops really need? Can we give the farmers less without hurting production? Obviously, that would depend on soil, temperature, distribution of the water, insects (beneficial and otherwise), and many other factors too. I think that this value (60%) is well- supported, given these kinds of uncertainties.

Olden, Page 4
Time series for fall-run Chinook salmon escapement exceed 50 years in length, highlighting steady declines since 1952 (Figure 3.5), and evidence is presented that hatchery-produced fish constitute a majority of the natural fall-run spawners in the Central Valley (Figure 3.6). The Technical Report and scientific papers discussed within collectively highlight the decadal long declines in Chinook salmon and steelhead trout (albeit limited data in the latter case) in the San Joaquin River basin. The Technical Report also correctly emphasizes that escapement numbers for the three tributaries are comparable in many years, thus suggesting the importance of coordinating flow management across the tributary systems. Indeed, discrete contributions from different tributaries may provide a portfolio effect by decreasing inter-annual variation in salmon runs across the entire system, thus stabilizing the derived ecosystem services (*sensu* Schindler et al. 2010, but within basins).

Olden, Page 6
The benefits of flow restoration may be enhanced if riverine thermal regimes are also considered. One example supporting this notion is in the lower Mississippi River where research has shown that growth and abundance of juvenile fishes are only linked to floodplain inundation when water temperatures are greater than a particular threshold. Schramm and Eggleton (2006) reported that the growth of catfishes (*Ictaluridae* spp.) was significantly related to the extent of floodplain inundation only when water temperature exceeded 15°C; a threshold temperature for active feeding and growth by catfishes. Under the current hydrographic conditions in the lower Mississippi River, the authors report that the duration of floodplain inundation when water temperature exceeds the threshold is only about 1 month per year) on average. Such a brief period of time is believed to be insufficient for

floodplain-foraging catfishes to achieve a detectable energetic benefit (Schramm and Eggleton 2006). These results are consistent with the ‘thermal coupling’ hypothesis offered by Junk et al. (1989) whereby the concordance of both hydrologic and thermal cycles is required for maximum ecological benefit.

Grismer, Page 2
Overall, this subject is difficult scientifically in terms of appropriate data collection and analyses. For example, the curve in Figure 3.8 on p.3-27 is practically meaningless given the few points available; perhaps this why no R2 value is provided. I suggest simply eliminating the curve. In Figure 3.10, there is extremely low fish “escapement” from the Merced River during 1950-1968 that would seem to “skew” results. Is there any explanation for this dearth of salmon in this period? Is it real or an artifact of sampling? In Figure 3.11, there is clearly an increase in recovered salmon as a function of the number released as might be expected, but the statistical interpretation is strained. Basically, averaging the 2-3 data points per number released indicates that approximately 2.5% salmon ‘recovery’ at releases of ~50,000 and 2.8% ‘recovery’ at releases twice as great (~100,000), leading to the possible observation that for releases up to ~100,000 fish recoveries between 2.5-3% might be expected. The single point at large value release (~128,000) suggests a greater recovery fraction (~5%), but it is only one point. Given the wide variability in the recovery numbers, I suspect that these recovery fractions are not statistically different. Perhaps a different analysis is more appropriate here.

ATTACHMENT 2

EXCERPTS FROM A PEER REVIEW OF THE CALIFORNIA DEPARTMENT OF FISH AND GAME'S QUANTIFIABLE BIOLOGICAL OBJECTIVES AND FLOW CRITERIA FOR AQUATIC AND TERRESTRIAL SPECIES OF CONCERN DEPENDENT ON THE DELTA

Gross, W.S., G.F. Lee, C.A. Simenstad, M. Stacey, and J.G. Williams. 2010. Panel Review of the CA Department of Fish and Game's Quantifiable Biological Objectives and Flow Criteria for Aquatic and Terrestrial Species of Concern Dependent on the Delta.

Gross et al. 2010, Page 3

We interpreted "using the best available scientific information" in terms of the following statements (from NRC 2004-a):

1) The agencies may not manipulate their decisions by unreasonably relying on some sources
to the exclusion of others;
2) The agencies may not disregard scientifically superior evidence;
3) Relatively minor flaws in scientific data do not render the data unreliable;
4) The agencies must use the best data available, not the best data possible;
5) The agencies must rely on even inconclusive or uncertain information is that is the best available at the time of the decision;
6) The agencies cannot insist on conclusive data to make a decision;
7) The agencies are not required to conduct independent research to improve the pool of available data.

…citation is supporting an argument, not establishing a fact. Citations, even to the peer-reviewed literature, are not like theorems in mathematics, and do not establish validity. For example, Stevens and Miller (1983) is in a peer-reviewed journal, but commits an elementary statistical error that vitiates its findings about the effects of Delta inflows on juvenile Chinook salmon (probably the authors and the reviewers missed the error because it was masked by the use of an index).

Gross et al. 2010, Page 4

Thinking of citations as supporting an argument explains why citations to the peer-reviewed literature are preferred. They provide stronger support for an argument because independent people thought to be qualified are supposed to have read the papers carefully. Citations to agency reports provide weaker support, even if the reports are conceptually and technically sound, because they are not independently reviewed. Citations to personal communications generally provide even weaker support, unless the person cited is a recognized authority, etc.

Gross et al. 2010, Page 6

- References must be accurately cited. It is the responsibility of the authors to ensure that they are correctly citing facts, results or conclusions from particular references and attributing them correctly. There are a number of examples in the Draft (discussed below in section 4.4.1) where a conclusion or fact is attributed incorrectly to a particular reference, which leaves the statement without a scientific basis.
- References must be clearly cited. Relying on references that are "personal communication" or obscurely cited ("NMFS 3 in SWRCB 2010") makes it difficult to evaluate the underlying science.
- Whenever possible, references should be to peer-reviewed literature, not internal technical reports or testimony. In many cases, this will require that the authors trace back through the literature to determine the original source of the information, but that is part of providing BAS.
- The Draft frequently relies on some sources to the exclusion of scientifically superior sources. As three examples, it cites outdated analyses by Kjelson and Brandes instead of superior analyses (Newman and Rice 2002; Newman 2003). It cites an outdated study by Brett (1952) and a consulting report and testimony by Alice Rich on the temperature tolerance of juvenile salmon instead of scientifically superior studies by Myrick and Cech (2001, 2002, 2004) and Marine and Cech (2004). It relies on an unpublished work by Marston and ignores superior studies by Newman2 and others involved with VAMP, and by Terry Speed (1993). It fails to cite many relevant, more recent papers (Appendix A3), including a long review on Central Valley Chinook and steelhead (Williams 2006) that would have drawn DFG's attention to the superior sources just noted.
- The Draft refers to a vague source (DFG 2010a) on key points, such as "Random rare and unpredictable poor ocean conditions may cause stochastic high mortality of juvenile salmon entering the ocean, but the overwhelming evidence is that more spring flow results in higher smolt abundance, and higher smolt abundance equates to higher adult production (DFG 2010a)" at p. 47. This sentence is also misleading; it is true that rare ocean conditions can cause high mortality of juvenile salmon entering the ocean, but so can more common conditions. This claim seems to be an attempt to defend the Marston results from the criticism that fitting models to smolt-adult survival data without taking variable ocean survival into account will give misleading results (a claim that is dubious to start with, but even more so without a supporting reference).

Gross et al. 2010, Page 7

- For many species, the Draft seems to assume that flow alone will restore natural processes and restore/reconnect critical habitats for these species. This assumption is poorly founded.
- Similarly, hypothesized responses by species and species assemblages should have been placed in context of DRERIP conceptual models (see: http://science.calwater.ca.gov/drerip/drerip_index.html for peer-reviewed models and documentation; these models are being prepared for future publication in *San Francisco Estuary and Watershed Science*).

Gross et al. 2010, Page 8

- The basic (not necessarily the Delta-specific) information on coastal wetland requirements and use by juvenile Chinook salmon is relatively parochial and out of date. There has been considerable information emerging over the past decade that continues to validate at least two relevant aspects of their life history:
  - Life history diversity of Chinook salmon, whether genetic or tactical, is influenced by habitat diversity and opportunity and is considered important to population resilience; and,
  - Several life history types express strong fidelity toward prolonged estuarine wetland occupancy, fidelity toward particularly geomorphic habitat features and specific locations, and selectivity toward particular estuarine food web pathways. Miller et al. (2010) provide evidence that a substantial proportion of juvenile Central Valley fall Chinook leave fresh water at <56 mm fork length. Given that most Central Valley fall Chinook are hatchery fish, as shown by Barnett-Johnson et al. (2005) and the proportion of marked fish observed in the 2009 carcass surveys, and that fish leaving fresh water at < 56 mm are unlikely to be hatchery fish, juveniles that leave fresh water before they reach "smolt" size may be the dominant part of the naturally produced fraction of the run. The objectives in the Draft ignore these fish.

Gross et al. 2010, Page 9

- The objectives for salmon fail to distinguish hatchery and naturally produced fish. The objectives refer to the salmon protection water quality objective, which seems to be: "Water quality conditions shall be maintained, together with other measures in the watershed, sufficient to achieve a doubling of natural production of Chinook salmon from the average production of 1967-1991, consistent with the provisions of State and federal law." There is a key phrase in this language, "natural production," that is defined in the CVPIA. This excludes hatchery-reared salmon. The Draft does not deal with the difference between hatchery and natural production of salmon and steelhead.
- The first three objectives embody the notion that river flows "transport salmon smolts through the Delta." As discussed in Ch. 6 of Williams (2006), the migration of juvenile salmon is much more complicated than this and for most juvenile Chinook life history types cannot, and should not, be separated from rearing in the Delta.

Gross et al. 2010, Page 10

Year-to-year variability to meet biological objectives is missing, or is based on water year type. If we are to use functional flows, then the water year type should not be a factor – the biological requirements should be independent of the hydrology. If there is a need for year-to-year variability, then this should be stated as such (this is something that Fleenor et al. (2010) did very well). The biological objectives and required flows should not depend on the specific realization of hydrologic flows. To be clear, if we have 10 straight wet years, or 10 straight dry years, the required flows for meeting the biological objectives will be incorrect. It is possible that the DFG was using criteria based on water year type to create year-to-year variability, but the scientific basis for this approach is not established. To built this up scientifically, the authors would need to (a) define what degree of year-to-year variability in flows benefits the species (not done in the Draft); (b) establish the temporal variability of year types in the historical record (also not done here, but analysis exists); and (c) develop projections of the frequency of water year types for future conditions (the CASCaDE project the USGS has been pursuing may inform this).

Gross et al. 2010, Page 12

- The connection between Delta water temperatures and river flows is not established in the literature. The criterion proposed here (flows >5000 cfs in April-May keep Delta water temperatures below 65 F) does not have any scientific citation associated with it (in the Draft this criterion is based on testimony from the Bay Institute). Exploration of temperature in the Delta and the connection to flows has been pursued in a fundamental sense by Monismith et al. (2008) and in view of the effects of climate change in a paper that is in review by Wagner et al. (part of the USGS CASCaDE project).

Gross et al. 2010, Page 13-14

The use of testimony (unavailable for review – or at least difficult to track down) or another unreviewed technical report (SWRCB 2010) is not enough to justify conclusions. In one case (for the flow requirement to prevent flow reversal at Georgiana Slough), a fact is attributed to the SWRCB report, but in that report the fact is referenced to "personal communication" or to some testimony that is unavailable for review. Other examples include references to Snider and Titus (DFG technical reports), Allen and Titus (which is actually a proposal!) and testimony from groups like American Rivers or the Natural Heritage Institute. To ensure scientific transparency, references should be given to their original source. Otherwise, a personal communication or a proposal begins to have the appearance of a reviewed scientific reference.

Gross et al. 2010, Page 14

- Statements without scientific references are sprinkled throughout the Draft. One example lies in the statement that as natural flows have been reduced, flow conditions have become more favorable to non-native species. While this might be true, the inclusion of the modifier "flow" on "conditions" makes it a more specific statement than is likely to be defensible scientifically (i.e., the more vague statement "…as natural flows have been reduced, conditions have become more favorable to non-native species" is probably better established in the literature). As a second example, the discussion of the decline in San Joaquin River Chinook from 26000 to 13000 states "Flow related conditions are likely to be a major cause of this decline," but there is no reference to support the statement. Further, the use of non-peer-reviewed information undermines much of the results presented. The flows required to prevent salmon entrainment at Georgiana Slough, for example, are referenced from Perry et al. 2008 and 2009, but these are just technical reports, and have not been peer-reviewed; at least some of this work has been published and that should be cited.
- In most cases the report does not clarify the degree of scientific certainty/uncertainty associated with individual flow objectives. Therefore it is not clear to what extent each individual objective is supported scientifically.
- Minimal detail of relevant modeling studies has been provided. In any case where flow criteria have been based in part upon modeling studies, the modeling studies should be

briefly described in the Draft. Direct references of relevant papers and reports should be provided.

- There are a number of cases where the actual sources of a piece of information are inaccurately referenced – at times in ways that are quite deceiving. For example, the Draft attributes population declines since 1985 to flows based on Fleenor et al. (2010). Fleenor et al. (2010) do not make that statement. (It is bad enough that such a fundamental point to this whole process is being based on an unreviewed document.). They do compare 1949-1968 ('when fish were doing better') to 1986-2005 ('when fish were doing poorer') and note that the flows have changed – but they do ***not*** conclude that this is causative.
- In the first paragraph of page 75, an entrainment loss estimate of up to 40% was attributed to "PTM results" by Kimmerer (2008). The bulk of the entrainment losses estimated in Kimmerer (2008) were estimated based on survey observations, flow observations and several assumptions. Figure 16 and a small part of the text discuss particle tracking model results which estimate percent loss to the population. However, it should be noted that this is assuming no natural mortality. Kimmerer (2008) also estimates population losses by a more complete method which does take account of natural mortality but does not utilize any particle tracking results. These (lower) estimates are more appropriate to cite, preferably noting that the estimated error bounds for the calculated population losses are quite large.
- It is not entirely clear in which cases the Biological Objectives and Flow Criteria have been directly adopted from other documents such as the ERP Plan or OCAP (NMFS 2008). This should be clarified for each Biological Objective and Flow Criteria.
- The report commonly references SWRCB 2010 and DFG 2010a. SWRCB 2010 refers to the State Water Resources Control Board document. Some of the information in that document is associated with an information proceeding. This document summarizes existing information and scientific understanding. DFG 2010a refers to the participation of CDFG in the State Water Resources Control Board Informational Proceeding. Whenever possible original scientific literature should be cited as opposed to summary documents.

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- Fleenor et al. (2010) is referenced frequently when the citation should have been to the original scientific source material, especially when this was a peer-reviewed journal publication.
- The Draft misinterprets several important references. For example, at p. 40: "Based on the mainly oceantype life history observed (*i.e.*, fall-run), MacFarlane and Norton (2002) concluded that unlike other salmonid populations in the Pacific Northwest, Central Valley Chinook salmon show little estuarine dependence and may benefit from expedited ocean entry." The first clause in this sentence is incorrect; MacFarlane and Norton (2002) were contrasting their results with those from other ocean-type populations of Chinook. Moreover, MacFarlane and Norton (2002) defined the estuary in terms of salinity, rather than tidal influence, so their study applies only to the bays, not to the Delta. Further, their data collection did not begin until late spring, whereas most naturally produced fall

Chinook move into the Delta in winter or early spring.

- A large section of text regarding salmon (pp 36-39) that contain errors and poor scholarship, including the misreading just discussed, was taken from the 2009 OCAP BO without attribution. The Draft does note that "Much of this section is excerpted and adapted from DFG (2010a, 2010b) and SWRCB (2010)," and indeed much of the language also appears in SWRCB (2010). It does not seem, however, that the language was original with DFG, as suggested by the reference to DFG (2010a; 2010b), which were submissions to the process resulting in SWRCB (2010). We realize that Section 85084.5 directs DFG to develop its recommendations to the SWRCB in consultation with NMFS, but this is carrying consultation too far, and violates ordinary standards for scientific writing.