Draft BDCP South Delta Corridor Evaluation Summaries

Final Document included in BDCP Effects Analysis as

BDCP South Delta Habitat and Flood Corridor Planning, Corridor Description and Assessment Document

September 10, 2012. Attachment E.A to Appendix 5.E of BDCP

Corridor 1A - Summary

- Assumptions/Changes to Corridor Description made During Evaluation
    - Assume that restoration actions include levee setbacks, but no "active" restoration to enhance channel, floodplain, or riparian habitats or grading. However, fish stranding on the floodplain was assumed to be a "non-issue" because it can be minimized via restoration design.
    - The timeline for passive restoration to mature is late long term (30 – 50 years); this evaluation assumes late long term conditions.
    - Evaluations are based on the existing hydrology of the San Joaquin River and potential changes to hydrology associated with the San Joaquin River Restoration Program. It was acknowledged that the charter for the group also directs evaluators to consider changes to hydrology to improve ecological benefits. Specifically, the charter says the group "will consider how alternatives perform with San Joaquin restoration flows and future flows that result from Water Board orders or climate change." These additional flow scenarios were not analyzed as part of this evaluation.
    - As part of the original DRERIP evaluations, outcomes and their scores were targeted for physical processes and/or attributes that occur throughout the corridor, and fish species of concern. Outcomes for terrestrial species are not included in the following evaluations.

- Summary of Key Outcomes Related to Objectives
    - *Objective: Increase the extent of ecologically-relevant floodplain habitat to support reproduction and viability of Sacramento splittail and Chinook salmon & Steelhead*
        - Positive Outcomes
            - New floodplain areas available for inundation that would benefit splittail and salmonids
            - Additional food export from this Corridor into critical habitat areas (this would be minimal).
        - Negative Outcomes
            - Relatively-low risk of: floodplain stranding, increased mortality due to water quality degradation, mercury methylation, selenium, or resuspension of toxics.

    - *Objective: Restore habitats and river conditions (i.e., the magnitude and direction of flow in fluvial regimes) that favor survival and growth of juvenile salmonids, sturgeon, delta smelt, longfin smelt, and other native fishes*
        - Positive Outcomes

        - There is a very high probability that channel complexity will increase and natural geomorphic processes will be restored with levee setbacks.
    - Negative Outcomes
        - Very low potential for invasive species colonization (SAV, Clams). Invasive riparian vegetation is a concern.

- Key Uncertainties
    - How future geomorphic response of a less-confined San Joaquin River may result in changes in sediment transport and potentially aggradation of the channel bed. This may modify the stage-discharge relationships for floodplain inundation more-generally. (Note, this would be a positive trend for inundated floodplain habitat).
    - The expected / predicted channel meander potential of the reach with levee setbacks.
    - The presence / absence of sturgeon in this corridor, and the potential for sturgeon habitat benefits / impacts.
    - How the San Joaquin River Restoration Program restoration flow regime and future flows that may be ordered by the SWRCB or result from climate change may influence key habitats and species outcomes and associated scoring. The river's hydrology drives habitat benefits coming from newly-connected floodplain areas.

- Data Gaps
    - Sediment transport data, modeling and sediment budgeting for the Lower San Joaquin River.
    - Sturgeon population / habitat data for this area.

- Potential corridor re-configurations or combinations to increase the worth /decrease the risk of potential implementation.
    - Some evaluators felt that the floodplain inundation frequencies / ecological conditions required to benefit target fish species could be refined. Additional sensitivity analysis will provide additional information on benefits.
    - Some evaluators felt that additional sensitivity analysis should be performed to: a) determine the potential benefits and impacts associated with altered flow regimes, and b) enhance ecological benefits by evaluating different configurations and widths of levee setbacks in this corridor.
    - Active riparian forest restoration will increase the certainty of ecological benefits, and this should be considered in refining this corridor.

Corridor 1A – Detailed Evaluation Notes

Contents

Scientific Evaluation Worksheet & Notes
Corridor 1A

Evaluation Team:
Facilitator: Bruce DiGennaro
Participants: Josh Israel, Mike Hoover, Christine Joab, John Cain, John Clerici, Jeremy. Ron, Ted Sommer, Josh Israel, Michelle Orr, Will Stringfellow, Cathy Marcinkevage.
Note – taker: Kateri Harrison
Revisions: Jeremy Thomas, Eric Ginney

Workshop Date: Wednesday, February 1, 2012

Notes about Corridor 1A:

1) Take home message: San Joaquin River flow regime limits potential ecological benefits.
2) There are four ways to increase floodplain inundation: lower floodplain, change hydrology, raise the channel; block/backwater the channel at a downstream location
3) Sturgeon are not found in this location in significant numbers.
4) One suggestion is to maximize and accelerate benefits by using active restoration techniques such as horticultural riparian vegetation restoration.
5) With a levee corridor this wide, natural geomorphic processes (i.e., floodway expansion and contraction) can reverse channel incision and may lead to enhanced riffle stability---all things that would improve floodplain connectivity even given the existing flow regime.

Notes on revisions to the Corridor 1A Evaluation Worksheet:
Corridor 1A was the first corridor to be evaluated on February 1, 2012, the first of the two-day evaluation workshop. Subsequent to working through the evaluations for Corridor 1A, the group decided to refocus the approach and organize the structure of the evaluation to be consistent with the Problems and Objectives Statement as defined by the South Delta Working Group in the meeting on September 13, 2011. Therefore, the format of the outcomes and objectives originally used in the evaluation of Corridor 1A were changed and standardized for all of the corridors subsequently evaluated. The following evaluation notes were revised to reflect the reorganization of the objectives and outcomes utilized in all of the other corridor evaluations. Because of this change, Corridor 1A did not have all of the same standardized outcomes available during this evaluation, and thus not all of the outcomes examined in the other corridor evaluations are available here.

OBJECTIVE: INCREASE THE EXTENT OF ECOLOGICALLY-RELEVANT FLOODPLAIN HABITAT TO SUPPORT REPRODUCTION AND VIABILITY OF SACRAMENTO SPLITTAIL AND CHINOOK SALMON & STEELHEAD

Potential Positive Ecological Outcomes

Outcome P1: Increased frequency of inundation

Scientific Justification:
Most of the salmon returning to California rivers display a 3 year life cycle. The inundation frequency assumed in the modeling of the corridors is once every four years---this seems too infrequent to some evaluators based on the common salmon life history. Under existing conditions, approximately 900 acres are flooded. With restoration as defined for Corridor 1A, inundation will increase to approximately 2,600 acres of inundation.

It is assumed that hydrology will not change as a result of BDCP implementation. This is an important thing to recognize in regard to the benefits of floodplain restoration as a part of BDCP: that if the flows are not there, the benefits do not accrue.

In the San Joaquin River, during the large inundation (i.e. wet) years, splittail abundance increases and this relates to outcome P2 below.

Key Understanding: San Joaquin River hydrology drives habitat benefits coming from newly-connected floodplain areas.

Magnitude:
Score is a Low "2", but with some disagreement about whether a 4-yr occurrence interval is an appropriate minimum threshold. BDCP should also integrate factors (i.e. compare to the inundation threshold in Yolo Bypass) to be consistent. Also, the 4-year inundation timeframe is a statistical average, the actual time between inundation events may be much more or less. Magnitude Score: **Low "2"**

Misc. Notes: If better hydrology were provided, the magnitude would increase. Evaluation team experts recommend inundation on an average of once every 2 years,

optimally.

Certainty: Evaluation team is very certain that this magnitude will be low. There is a high level of uncertainty because it is not clear whether the once every four years inundation timeframe is representative. Although scientific understanding is high, this situation is dependent on a variable environment. Certainty Score: **Medium "3"**

Certainty of physical habitat on its own merits. **High "4"**, based on the increase in spatial area.

Magnitude for Splittail: There is redundancy with Outcome #P2. Splittail have a 5-7 year life cycle. **Medium "3".**

Certainty for Splittail: Same as Outcome #P2. **Score is Medium"3".**

Notes: Not applicable to sturgeon or smelt

Literature Cited:

- DRERIP Salmonid conceptual models (for salmon life cycle of 3 years).
- Cosumnes River and Yolo Bypass work on inundated floodplains.
- 2009 DRERIP evaluation worksheets have relevant literature citations.

Outcome P2: Increased Spawning Habitat for Splittail and White Sturgeon

Clarifying Assumptions:
Assuming a 21-day inundation period between Feb 1 and May 31 (source: Section 7 Table 3).

Magnitude for Splittail: Splittail have a seven year life-cycle and they spawn every year. Corridor 1A provides a lot of acreage for restoration. Existing inundated floodplain for splittail within existing levees is 412 acres. Assuming the existing flow continues, the restored habitat would be 1,023 acres with another 400 extra acres with the San Joaquin restoration flow regime. See Table 4.12 for Corridor 1A on page 102 in the corridor document. Magnitude is **Medium, Score: "3".**

If the hydrology were to change, then a larger area would be inundated with more frequency of inundation and this would then change the magnitude. In past discussions, Dr. Peter Moyle indicated that an inundation occurrence every 2 years would be satisfactory for native fish.

Certainty for Splittail: The magnitude score is based on peer reviewed studies in the Delta system. However, flooding is unpredictable. There is variability in the human-controlled hydrology of the San Joaquin River. If flows were managed to allow more

inundation, then this certainty score would increase. There is a close relationship between floodplain inundation and splittail. **Score is Medium"3".**

Green Sturgeon: No spawning in the San Joaquin River. Historical evidence and current monitoring does not find green sturgeon on the San Joaquin River. Not present.

Magnitude for White Sturgeon: White Sturgeon spawn in the Tuolumne River. Would white sturgeon spawn if their habitat were provided? Scientists do not have enough information about white sturgeon spawning habitat. Some studies indicate spawning habitat needs to be "in-channel" and have a sandy bottom (not floodplain). White sturgeon were spotted spawning on the San Joaquin River last year. White sturgeon likely use flow as the main characteristic of their spawning habitat. However, there is no indication that flows on San Joaquin River will change as a result of BDCP. Corridor 1A has a more naturalized channel bed, compared to other corridors. Magnitude is **Low "2".**

Certainty for White Sturgeon: Certainty is **Low "2".**

Literature Cited:
Sommer, Baxter, and Herbold 2000 "Resiliency of splittail" paper

Outcome P5: Increased Food Export

Notes about Food Production:
Food production is listed a positive outcome. An increase in primary production would yield many benefits for fish species. How much food resources might drift downstream and benefit species in the Delta? See draft corridor document Table 4.1.3a, Figure 4.1.2a, and page 105. When you increase the amount and frequency of floodplain inundation, is that significant for downstream food export? It depends on the size of the floodplain. See HEC-EFM floodplain inundation modeling and assumptions in Section 7.3. The duration of inundation is Dec 1 to May 31, between 2 to 20 days (see Tables 3 and 4 in Section 7.3). Every 4 years at least 30% of the floodplain is inundated.

The San Joaquin River flow regime will not be different as a result of BDCP implementation. Higher flows will not occur with any increase in frequency. Floodplain inundation is only one mechanism by which you get food production. However, the improvements in ecosystem level nutrient production (i.e. food production) are limited for this floodplain creation because of the lack of changes in the San Joaquin River's hydrology.

The restoration description prescribes 16 river miles of soft banks with trees. This will yield an increase in riparian-based food production. We anticipate that riparian vegetation (assuming passive restoration) will be young fringe trees. At the San

Joaquin River wildlife refuge, very rapid riparian growth has occurred. For some ecosystem functions, it is not about big wood, it is about development of a canopy (i.e., for leaf and insect drop).

There is a risk that invasive plants will move into the restoration area. Studies along the Sacramento River show that prior to Shasta Dam (i.e., under normal hydrology) a flow event that drives riparian vegetation recruitment occurs on average every 5 years . However, for the San Joaquin River, the present conditions for riparian recruitment are not good. Using passive restoration techniques and assuming inundation every 4 years, there would not be sufficient re-vegetation. It is recommended that more areas with active riparian revegetation occur as part of the levee setback process.

Clarifying Assumptions:

- Assume passive restoration along the channel margin where levees are removed.
- There is a risk of low riparian plant recruitment, unless there is active intervention to increase inundation.

Note that no one has mapped existing conditions channel margin habitat.

The Delta is a big filter with complex habitats. Nutrients are continually processed during a range of flows. Although there might be a periodic flush of nutrients into the Delta, overall this will not make a significant difference. There is a concern that tidal marsh creation would cause eutrophication. The classic location for eutrophication and low dissolved oxygen is near Stockton.

Evaluators considered whether the corridor improvements would lead to a greater export of more nutrients or algae. In the past when the floodplains are inundated (during high flows), then dilution occurs and the intakes would not divert water.

Studies by the CA Water Board suggest riparian leaf litter creates microbial activity that reduces the nutrients sent downstream. If the levees are set back and trees grow into large woody debris, then this changes habitat along miles of river. But even so, it is not expected that this would substantially alter nutrient export.

Scientific Justification:

Overall Magnitude: very low, score is **Minimal "1".**

Overall Certainty: certainty score is **High"4".**

Magnitude for salmonid food: Assumes passive restoration. Control strategies for Himalayan blackberries and other non-natives, etc needed. See notes above. **Low "2".** With active re-vegetation, the magnitude score would increase.

Certainty for salmonid food: The processes are understood, however this is a highly

variable ecosystem, **Medium "3".**

Potential Negative Ecological Outcome(s)

Outcome N2: Increased Mortality Due to Water Quality Degradation (Including Water Temperature, DO, Eutrophication)

General Notes: Soil constituents are not known. Water from natural floodplain and agricultural areas will drain into the river.

Magnitude: The action might benefit water quality given the cold high flows and riparian / floodplain shading. Dam releases in May and June could inundate the floodplain and some evaluators had concerns regarding temperature. However, overall, summer releases will be infrequent. Score: **Low "2".**

Certainty: The length of time inundation will occur on the floodplain is not certain and may be dependent upon the timing of dam releases. Although not a large problem, it is not certain. **Low certainty "2".**

Magnitude for dissolved oxygen (DO): Low "1".

Certainty for dissolved oxygen (DO): High "4".
(NOTE: the "risk" for the DO score is much lower than the overall scoring, so the 'more conservative" score of 2/2 was retained in the spreadsheet).

Outcome N4: Increased Exposure to Selenium

Magnitude: Low "2". This restoration will increase phytoplankton production that contains higher levels of selenium and gets carried up the food chain. Heavy selenium loading from San Joaquin watershed will be available to clams. Sturgeon eat clams and via the food chain may bioaccumulate selenium. However, overall effect on native fish species is **Low "2"**

Certainty: Low "2"

Outcome N5: Increased Mercury Methylation

Clarifying Assumptions:
Effects of mercury on terrestrial species, birds, and humans were not discussed during the workshop.

Magnitude: For fish, the effect is minimal because fish are relatively low on the food chain. **Minimal "1"**

Certainty: Medium "3"

Rationale is the same as 2009 DRERIP analysis.

Outcome N6: Increased Mobilization or Re-suspension of Toxics (including pesticides)

Magnitude: If riparian vegetation is established, it could make previously existing toxics bioavailable. If pesticides/herbicides are used in the corridor on non-native vegetation this could be a concern; although they break down fairly quickly. RWQCB does have 303d listings for agricultural areas in the San Joaquin areas. **Low "2"**

Certainty: If there are agricultural easements and agricultural chemicals are being used on the land, this adds to the uncertainty. There is also a data gap because we do not know what toxics exist on the soil. **Low "2"**

OBJECTIVE: RESTORE HABITATS AND RIVER CONDITIONS (I.E., THE MAGNITUDE AND DIRECTION OF FLOW IN FLUVIAL REGIMES) THAT FAVOR SURVIVAL AND GROWTH OF JUVENILE SALMONIDS, STURGEON, DELTA SMELT, LONGFIN SMELT, AND OTHER NATIVE FISHES

Potential Positive Ecological Outcomes

Outcome P16: Increased Channel Complexity (including in-channel and channel margin riparian vegetation, LWD, and emergent vegetation)

Clarifying Assumptions:
The evaluation team made the following assumptions:

- No grading of the floodplain or in-channel work. The project includes removal of the levee and passive vegetation restoration.
- The timeline for passive restoration to mature is late long term (30 – 50 years); assume evaluation is for the late long term.
- Once levees are removed, natural geomorphic sediment depositional and erosional processes will occur.
- Within 20 years, some vegetation and trees would be established along the channel corridor.
- When the bank becomes more naturalized, channel complexity will increase.

General Notes on Channel Complexity:
If we restore the physical configuration of this corridor with no change in hydrology, then the biological benefits will not be as large as if a change in hydrology were also made (as discussed in Outcome 1A). The proposed restoration may increase channel complexity. There are intrinsic benefits such as micro-scale effects and the creation of more natural interfaces.

Flow is one of many variables. Pushing out the banks or raising the channel invert would allow woody vegetation establishment. If the channel invert were raised, this would increase the frequency of inundation.

Concern that since BDCP alternative #1A is late-long term, the timeframe for realizing ecological / biological benefits would be very long from now. Upstream hydrology may change due to climate change, such that the peak discharges occur earlier in the year. Under climate change, there may be different timing for inundation and this timing may not synchronize with species life cycle. Additional modeling of these assumptions is recommended.

Two ways channel complexity can help salmon: 1) high flows spread out across floodplain, lower velocities, fish less likely to get washed downstream; 2) flows create a complex channel that creates beneficial fish habitat. Fish will use these channels even during lower flows. Ability of downstream migrating smolts to hide from predators was considered. The Vernalis Adaptive Management Plan (VAMP) shows high predation rates near the Stockton wastewater treatment plan. Complex habitat

provides hiding spots for native fish. If the habitat is restored, then more sediment will be generated/ mobilized and this will provide additional hiding opportunities for salmonid juveniles.

This outcome also includes the potential beneficial impacts of suspended sediment and turbidity on channel complexity and habitat conditions for affected fish species. Sediment transport generates turbidity, creates complex habitats, and is beneficial for native fish species. This outcome is vague because it intends to create all these benefits. Even with dams, the San Joaquin River has enough energy and enough sediment supply to provide some of these benefits. Ideally, the sediment would move into the Delta to benefit habitats there. Flows in a 4 year event may be over 15,000 cfs. Evaluators wondered: How much can you generate within this reach from those types of flow events? Would this benefit native fish species? Flow is not normally distributed, due to climate and human management of reservoirs etc. A metric could be the average number of days with suspended sediments during a 2-week period. It is anticipated that we would not see a big change in sediment conditions as a result of implementation. An evaluator postulated that if flows are high enough to move sediment downstream over a series of many years, then the beneficial downstream effects could be significant.

Scientific Justification:
River is still eroding activity and there is interface with vegetation. This interface will be beneficial. In a situation that is completely channelized then improvement would be significant.

Overall Magnitude: This outcome pertains to physical habitat conditions. Score is **High "4".**

Note: The Evaluation team has not evaluated outcomes here for splittail, salmon, steelhead, white sturgeon. It likely does not apply to smelt or green sturgeon. For salmon, there is a medium benefit arising from increased complexity of habitat.

Overall Certainty: Not scored by the group (assumed Medium "3" based on sediment processes only and that those processes are a key driver in this outcome).

Magnitude for sediment processes only: This is a physical process outcome. Biological resources are not rated here. The corridor is about 16 miles along both banks (i.e. 32 linear miles). Some of the sediment will be eroded and deposited within the reach. Over time, more riparian habitat will develop. **Medium "3"**

Certainty for sediment processes only: Understanding of the process is high; however, there is considerable uncertainty about the sediment budget and where the sediment will go. The nature of outcome is dependent on variable ecosystem process, such as hydrology. Scientists do understand the physical processes so based on theory alone, the certainty would be high. However, there is natural and human variability

associated with the sediment dynamics and hydrology. **Medium "3"**

(NOTE: only the overall score was retained in the spreadsheet; sediment processes not broken out).

Literature Cited:

- DRERIP sediment model

Potential Negative Ecological Outcome(s)

Outcome N12: Establishment of Invasive Species (SAV, Clams, invasive competitors)

Scientific Justification:
Corbicula is moderately common in the San Joaquin River. Restoration activities will result in the digging up and moving of *Corbicula* more frequently. Are we creating a new template upon which the invasives will establish? Threadfin shad likes deep channels but we are not creating deep channels here, so this is more applicable to other corridors.

Magnitude: Minimal "1"

Certainty: **Medium "3"**

DATA GAPS & KEY UNCERTAINTIES

Data Needs:

- A better understanding of sediment transport dynamics and sediment budgets for each corridor for the range of flow conditions is necessary.
- Assess the meander potential of the reach based on current channel configuration, geology, and soils. Corridor 1A has high potential for channel migration.
- Determine the presence/absence of sturgeon. Studies last year found evidence of white sturgeon spawning in the lower San Joaquin River. We need to know

what kind of habitat sturgeon spawn on. From a population perspective, perhaps high velocity habitats limit sturgeon spawning. High velocity in this case means 25,000 cfs (i.e. wet years). The Bay Study has done carrying capacity studies. There are spawning adults; however flows are not large enough for those adults to produce eggs that survive. VAMP flows are either low or high. Are intermediate flow years sufficient? Perhaps to get adults to spawn, but not enough for eggs to survive. For example, in the Columbia River, during intermediate years, predators eat the young sturgeon. It is hypothesized that sturgeon need good nursery habitat to avoid predators and this type of habitat is not presently found in Corridor 1A. Changes in channel morphology associated with the levee setbacks will produce variations in velocities through the channel. This may result in increased sediment deposition, increasing stage through the reach for a given discharge.

- Sediment deposition may also create some areas where velocities increase and that could benefit sturgeon. Sturgeon are long-lived fish. If there is a really wet year, 70,000 eggs could be spawned with a 5% survival ratio.
- Even with dams, the San Joaquin River has enough energy and enough sediment supply to provide some ecosystem benefits. How much turbidity can be generated within Corridor 1A from those types of flow events? Would this benefit native fish species (in the corridor and downstream)? A suggested metric could be the average number of days with suspended sediments during a 2-week period. It is anticipated that we would not see a big change in sediment conditions as a result of implementation. An evaluator postulated that if flows are high enough to move sediment downstream over a series of many years, then the beneficial downstream effects could be significant.

FOR FUTURE SOUTH DELTA PLANNING

Important New Ideas or Understandings:

- One way to improve hydrology would be to consider operational issues on the San Joaquin River. Ecological benefits relate to flow timing, magnitude, frequency, and durations.
- The charter for the South Delta Workgroup directs evaluators to consider changes to hydrology to improve ecological benefits. Specifically, the charter says the group "will consider how alternatives perform with San Joaquin restoration flows and future flows that result from Water Board orders or climate change." These additional aspects should be considered as South Delta planning continues.
- Communication between ecologists and DWR engineers is a key aspect of

successful water planning in this region.

- American Rivers is leading a study on the lower San Joaquin River to quantify the potential benefits for flood management, water supply and ecosystem improvements in this portion of the Delta from expanded floodplains and bypasses.
- Sensitivity analysis with different hydrologic regimes would be interesting and illustrative of potential future benefits if flow regimes were to be altered.

Corridor 2A - Summary

- Assumptions/Changes to Corridor Description made During Evaluation
    - The Evaluation Team agreed to evaluate Corridor 2A assuming an Isolated Old River Corridor (IROC) to decrease uncertainty related to the lack of available information.
    - Passive riparian restoration is assumed, which lowers certainty on benefits coming from riparian.
    - The timeline for passive restoration to mature is late long term (30 – 50 years); this evaluation assumes late long term conditions.
    - Fish stranding on the floodplain was assumed to be a "non-issue" because it can be minimized via restoration design.
    - The group decided not to evaluate the entrainment/export issue because the uncertainty is very high (i.e. there is no certainty at all; lack of data). The group considered coming back to re-visit the entrainment issue later, but never did, feeling it more important to move on to other corridors.

- Summary of Key Outcomes Related to Objectives
    - *Objective: Increase the extent of ecologically-relevant floodplain habitat to support reproduction and viability of Sacramento splittail and Chinook salmon & Steelhead*
        - Positive Outcomes
            - New floodplain areas available for inundation that would benefit splittail and salmonids
            - Lower Paradise Cut weir could increase export of juveniles and food to other parts of the South Delta (i.e., not just
        - Negative Outcomes
            - Relatively-low risk of: floodplain stranding, increased mortality due to water quality degradation or mercury methylation; more uncertainty with microcystis and selenium

    - *Objective: Restore habitats and river conditions (i.e., the magnitude and direction of flow in fluvial regimes) that favor survival and growth of juvenile salmonids, sturgeon, delta smelt, longfin smelt, and other native fishes*

        - Positive Outcomes
            - Channel complexity will increase with wider bypass
        - Negative Outcomes
            - Potential for additional invasive species colonization in downstream end of expanded Paradise Cut bypass.

- Key Uncertainties
    - The hydrodynamics (spatially, and temporally [within each water year and by water year type]) of the flow split from the San Joaquin River to a lowered Paradise Cut weir. This split influences the distribution of food and outmigrating fishes.
    - How the San Joaquin River Restoration Program restoration flow regime and future flows that may be ordered by the SWRCB or result from climate change may influence key habitats and species outcomes and associated scoring.
    - How future geomorphic response of a less-confined San Joaquin River may result in aggradation of the channel bed and thus modify the stage-discharge relationships at the weir and for floodplain inundation more-generally. (Note, this would be a positive trend for inundated floodplain habitat).

- Data Gaps
    - Multi-dimensional hydrodynamic modeling (as related to entrainment and water quality) is of particular interest as it is a key driver in many of the important processes and outcomes considered.
    - Details regarding the configuration of the weir, the Old River Corridor (i.e. the presence or absence of an IROC) need to be further refined (including sensitivity analysis) to enable additional evaluation of this corridor, especially as it relates to other corridors.
    - Additional information/research on site-specific marsh habitat design options that can improve water quality conditions/mitigate potential adverse conditions that might be generated by creation of tidal marsh habitats in the South Delta. (See also the separate M&I and Agriculture WQ Evaluations in June, 2012)

- Potential corridor re-configurations or combinations to increase the worth /decrease the risk of potential implementation.
    - Salmon and splittail could potentially end up in Fabian Tract (after being routed through a lowered Paradise Cut weir) which would have marsh habitat. The combination of Corridors 2A and 2B should be considered as a coupled pair if in the future this corridor shows promise.
    - If in future South Delta Planning this corridor appears a promising option, it will be important to evaluate Corridor 2A with and without an IROC.
    - Some evaluators felt that the December date in the assumed ecologically-relevant hydrology for salmonids (Dec. 1 – May 31) is too broad. Additional sensitivity analysis will provide additional information on benefits.

- Active riparian forest restoration will increase the certainty of ecological benefits, and this should be considered in refining this corridor.

Corridor 2A– Detailed Evaluation Notes

Contents

Scientific Evaluation Worksheet & Notes
Corridor 2A

Evaluation Team:
Facilitator: Bruce DiGennaro
Participants: Eric Ginney, Coach; Jeremy Thomas, Ray McDowell, John Cain, Steve Cimperman, Sheng Jun Wu, Christine Joab, Deanna Sereno, Mike Hoover, Michelle Orr, Andrea Thorpe, Cathy Marcinkevage, Ted Sommer, Val Connor, Josh Israel, Ray McDowell, John Cain
Note-taker: Kateri Harrison

Date: Thursday, February 2, 2012

Corridor Scale: Large

Introductory notes:

- Evaluators asked if this Bypass significantly different from DWR's Central Valley Flood Protection Plan? Answer: DWR's Central Valley Flood Protection Plan contains placeholder maps; however, it does not contain any specific modeling. The CVFPP did not make specific assumptions, and did not make any specific proposals for an assumed expansion of the Paradise Cut weir. The specific assumptions in the Corridor Document, upon which the modeling of the corridors is based, are an amalgamation of previous proposals and modeling efforts from the River Islands' bypass expansion proposal and other modeling. Corridor 2A is an initial placeholder configuration that is not a final configuration—simply something to test the outcomes of an expanded weir/bypass. If a project evolves that might include Paradise Cut, additional refinement and alternatives development would be required.

- Corridor 2A includes the following:
    - The assumed changes to the Paradise Cut weir result in the San Joaquin River beginning to overtop at 6,040 cfs (assuming Model Run F conditions, no SLR; see Section 7.3). In comparison, the existing Paradise Cut weir is modeled (using a MHW downstream boundary condition, without SLR), to begin to overtop at 12,957 cfs. Flow

stays in channel until ~10,000 cfs (i.e., floodplain inundation in Paradise Cut begins when river discharge is above 10,000 cfs).

- The group noted that to make Fabian Tract (Corridor 2B) most effective, consider routing more flow through Old River rather than Grant Line Canal. Old River doesn't get much flow under existing conditions, most flow goes through Grant Line. Terrestrial species of interest such as brush rabbit, swainson hawk, waterfowl and general migratory birds were not covered in today's evaluation but can be considered later.

OBJECTIVE: INCREASE THE EXTENT OF ECOLOGICALLY-RELEVANT FLOODPLAIN HABITAT TO SUPPORT REPRODUCTION AND VIABILITY OF SACRAMENTO SPLITTAIL AND CHINOOK SALMON & STEELHEAD.

Potential Positive Ecological Outcomes

Outcome P1: Increased Frequency of Inundation

Scientific Justification:
The restoration seems to create a reliable floodplain inundation. Inundation of this magnitude (for salmonids: 777 acres compared to 46 acres for existing conditions) happens every 4 years, for at least 14 days, sometime between December 1 and May 31 and is a sustained, but minor effect. Lower magnitude levels of inundation occur more frequently or for a longer duration.

Magnitude: Medium "3".

Certainty: The team felt certain that these flows would happen infrequently—but were also reminded that the outcome is based on real data and historical operations. Thus, while the magnitude of the acres is low, and the frequency is only every 4 years, there is some statistical certainty of that occurring. Overall, the group agreed that the San Joaquin River's flows are highly-altered, and that benefits will only manifest during times with high variability and flooding; this is unpredictable. The flows are beyond the control of BDCP and are reliant on meteorology and the river's hydrology. Understanding is high but outcome is dependent of highly variable process. It is hard to predict when the flood flows will occur. **Medium "3".**

Outcome P2: Increase Spatial Extent of Spawning Habitat for Splittail

Clarifying Assumptions:
The Evaluation Team discussed how/whether Old River would be isolated from pumps. *It was agreed to evaluate assuming an Isolated Old River Corridor (IROC) to decrease uncertainty in available information.* However, it will be important to evaluate this corridor in the future without an IROC if the corridor appears promising.

Scientific Justification:
Splittail need a minimum duration of flooding for 21-days. Page 10 of Section 7 document states 11,600 cfs is the ecologically significant flow w/out SJRRP needed to achieve this. Under existing conditions 11 acres would be flooded. Post-restoration corridor condition is modeled to be 445 acres. So, 400+ acres will be flooded every 4 years. Essentially doubling splittail spawning acreage from 413 ac (Corridors 1a and 2) to add 445 in corridor 2A. This flooding will occur from Feb to May. However, the temperature during this timeframe will obviously be variable.

Magnitude for splittail: Currently, very little floodplain gets wet (11 acres). This proposed 2A will be a significant improvement. **Medium "3".**

Certainty for splittail: Group discussed how much or whether BDCP can control the hydrology. The timing, frequency and duration of the assumed hydrology used by the consultants to identify the inundated area for splittail is based on peer reviewed studies in the Delta system. However, flooding is unpredictable. There is variability in the human-controlled hydrology of the San Joaquin River. If flows were managed to allow more inundation, then this certainty score would increase. There is a close relationship between floodplain inundation and splittail. **Medium "3".**

Outcome P3: Increased Rearing Habitat for Salmon

Note: Some evaluators felt that the December date in the assumed ecologically-relevant hydrology for salmonids (Dec. 1 – May 31) is too broad. There is some variation in the timing for juvenile (spring-run) out-migration; however, it may be a mistake to say that inundation in December would necessarily benefit salmon. In the future, sensitivity analyses would be informative. The consultant team noted they were more "inclusive" than "exclusive" in terms of the time period examined for the ecologically-relevant flows.

There is a 20-fold increase, from 46 acres to 845 acres; however, this occurs only once every 4 years. In comparison, corridor 1A's reach improves 910 acres. Corridor 2A will double the amount of physical habitat, in combination with corridor 1A. Frequency of inundation drives the score. Salmon cohorts have a 3-year life cycle; however, inundation occurs only once every 4 years, and other frequencies should be examined in the future if this corridor shows promise.
Notes, salmon could potentially end up in Fabian Tract which could have marsh. The combo of 2A and 2B should be considered as a coupled pair if in the future this corridor shows promise.

Magnitude: Score is a "2", but with some disagreement about whether a 4-yr occurrence interval is an appropriate minimum threshold. BDCP should also integrate factors as compared to the Yolo Bypass, to be consistent. What is the threshold in Yolo? **Low "2"**

Certainty: The Evaluation Team is very certain that this magnitude will be low. There is a high level of uncertainty because it is not known how representative this once every four years inundation is. The EMF model could be re-run to sort this out. Unnaturally reduced flows on the San Joaquin are a problem. Scientific understanding is high; however this situation is dependent on a variable environment. **Medium "3".**

Outcome P4: Increased Local Aquatic Primary and Secondary Production

Scientific Justification:

Notes about Food Production - Food production is listed a positive outcome. An increase in primary production would yield many benefits for fish species. How much food resources might drift downstream and benefit species in the Delta? See draft corridor document Table 4.1.3a, Figure 4.1.2a, and page 105. When you increase the amount and frequency of floodplain inundation, is that significant for downstream food export? It depends on the size of the floodplain. See HEC-EFM floodplain inundation modeling and assumptions in Section 7.3. The duration of inundation is Dec 1 to May 31, between 2 to 20 days (see Tables 3 and 4 in Section 7.3). Every 4 years at least 30% of the floodplain is inundated.

The San Joaquin River flow regime will not be different as a result of BDCP implementation. Higher flows will not occur with any increase in frequency. Floodplain inundation is only one mechanism by which you get food production. However, the improvements in ecosystem level nutrient production (i.e. food production) are limited for this floodplain creation because of the lack of changes in the San Joaquin River's hydrology.

The restoration description prescribes 16 river miles of soft banks with trees. This will yield an increase in riparian-based food production. We anticipate that riparian vegetation (assuming passive restoration) will be young fringe trees. At the San Joaquin River wildlife refuge, very rapid riparian growth has occurred. For some ecosystem functions, it is not about big wood, it is about development of a canopy (i.e., for leaf and insect drop).
There is a risk that invasive plants will move into the restoration area. Studies along the Sacramento River show that prior to Shasta Dam (i.e., under normal hydrology) a flow event that drives riparian vegetation recruitment occurs on average every 5 years . However, for the San Joaquin River, the present conditions for riparian recruitment are not good. Using passive restoration techniques and assuming inundation every 4 years, there would not be sufficient re-vegetation. It is recommended that more areas with active riparian revegetation occur as part of the levee setback process.

Magnitude: Assumes passive restoration. Control strategies for Himalayan blackberries and other non-natives, are needed. **Low "2"**

Certainty: The processes are understood, however there is a highly variable ecosystem, **medium "3"**

Outcome P5: Increased Food Export

Clarifying Assumptions:
The weir will be lower, so there is a higher likelihood that food will be pushed downstream through this corridor. However, the export would go down Grant Line and into an isolated Old River corridor (i.e. if in this evaluation Fabian Tract is not assumed). There is a concern that any food production would be exported to the pumping facilities if an IROC is not assumed. However, dual conveyance is assumed, so in some operation scenarios this might be a lesser concern (i.e., in the wet years, there would not be a lot of south Delta pumping during December to May).

Several evaluators recommended modeling of OMR flows with an IROC. However modeling is not currently available to assess this. Also, general entrainment modeling is not currently available. Modeling would need to consider operations year-by-year etc. Modeling should consider with and without the barrier. This type of modeling is recommended in order to thoughtfully analyze these issues.

During wet years, not much pumping will occur in the south Delta facilities. However, foodweb productivity in normal or dry years might be a concern (export of primary productivity via the pumps during dry years). The entrainment issue is speculative. South Delta pumping (i.e. level of diversions) is directly related to the pumping allowed from the north Delta.

The group decided not to evaluate the entrainment/export issue because the uncertainty is very high (i.e. there is no certainty; lack of data). The group considered coming back to re-visit this outcome later, but never did, feeling it more important to move on to other corridors.

Potential Negative Ecological Outcomes

Outcome N1: Increased Stranding on the floodplain

Clarifying Assumptions:

Stranding on the floodplain can be minimized via design. The evaluation team assumed the aquatic habitats, including the floodplain and marsh would be designed such that the site functions and operates in a manner that avoids stranding. Designers should allow for mostly complete drainage behind the Paradise Cut weir. Although it is recognized that microhabitats such as pools will develop and this might create minimal stranding. This type of minimal fish stranding due to microhabitat is acceptable. Designers should think about areas upstream and downstream. Also, designers should review the SFEI historical ecology materials

Assumption: the potential for stranding will be designed out of this floodplain.

Scientific Justification:

Magnitude: Conceptually stranding is an issue **Low "2".** There is project level mitigation (good design) that needs to happen.

Certainty: High "4".

Outcome N2: Increased Mortality Due to Water Quality Degradation (including water temperature, DO, eutrophication)

General Notes: The downstream area is tidally influenced so might have longer residence time. Between 6,000 to 10,000 cfs water is simply flushing thru the system. Above 10,000 cfs the water is held on the floodplain. There was a lot of speculation about these processes by the evaluators and the consensus was that more modeling is needed.

RWQCB has water bodies on 303d list of impaired water bodies. Also, the soil constituents (residue pesticides) on the restoration site are not currently known.

Above 10,000 cfs temperature might be better or worse, depending on residence time etc. However in corridor 2B, residence time will increase and so water temperatures might be a concern under that other alternative. Floodplain dynamics are not well defined here.

Scientific Justification:

Magnitude for general water quality: The action might benefit water quality given the cold high flows and riparian / floodplain shading. Dam releases in May and June could inundate the floodplain and some evaluators had concerns regarding temperature. However, overall, summer releases will be infrequent. **Low "2"**

Certainty general water quality: The length of time inundation will occur on the floodplain is not certain and may be dependent upon the timing of dam releases. Although not a large problem, it is not certain. **Low "2"**

Outcome N3: Increased Microcystis

Scientific Justification:

Magnitude: The spatial extent is minimal (a few hundreds of acres). **Low "2".**

Certainty: Very little information is available on the dynamics of this floodplain. **Low "2".**

Outcome N4: Increased Exposure to Selenium

Scientific Justification:

Magnitude: Low "2". This restoration will increase phytoplankton production that contains higher levels of selenium and gets carried up the food chain. Heavy selenium loading from San Joaquin watershed will be available to clams. Sturgeon eat clams and via the food chain may bioaccumulate selenium. However, overall effect on native fish species is **Low "2"**

Certainty: Low "2"

Outcome N5: Increased Mercury Methylation

Clarifying Assumptions:
Effects of mercury on terrestrial species, birds, and humans were not discussed during the workshop.

Magnitude: For fish, the effect is minimal because fish are relatively low on the food chain. **Minimal "1"**

Certainty: Medium "3"

Rationale is the same as 2009 DRERIP analysis.

OBJECTIVE: RESTORE HABITATS AND RIVER CONDITIONS (I.E., THE MAGNITUDE AND DIRECTION OF FLOW IN FLUVIAL REGIMES) THAT FAVOR SURVIVAL AND GROWTH OF JUVENILE SALMONIDS, STURGEON, DELTA SMELT, LONGFIN SMELT, AND OTHER NATIVE FISHES

Potential Positive Ecological Outcomes

Outcome P16: Increased Channel Complexity (including in-channel and channel margin riparian vegetation, LWD, and emergent vegetation)

Clarifying Assumptions:

The evaluation team made the following assumptions:

- No grading of the floodplain (except to mitigate for potential fish stranding) or in-channel work. The project includes removal of the levee and passive vegetation restoration.
- The timeline for passive restoration to mature is late long term (30 – 50 years); assume evaluation is for the late long term.
- Once levees are removed, natural geomorphic sediment depositional and erosional processes will occur.
- Within 20 years, some vegetation and trees would be established along the channel corridor.
- When the bank becomes more naturalized, channel complexity will increase.

Magnitude: High "4".

Certainty: Medium "3".

Potential Negative Ecological Outcomes

Outcome N12: Establishment of Invasive Species (SAV, Clams, invasive competitors)

General Notes: This site waters from the back end, up the channel in direction of Fabian Tract. So, the bottom half of Paradise Cut would be wet and top half dry. It will be dry for 3 out of 4 years. When wet it will be from flooding.

Magnitude for SAV: Minimal "1"

Certainty SAV: High "4"

Magnitude for Clams: the bottom half has tidal influence and perennially wet. However, this restoration will not change this situation. Corbicula dies off due to contaminants. If high flows dilute the contamination, the clams may increase in population abundance. San Joaquin River currently has stretches that are clam-free due to contamination. Scoring this is too speculative. Not rated.

Data Gaps & Key Uncertainties

Data Needs *(indicate specific models, DLO relationships, or other information indicating the need):*

- Entrainment and water quality (as related to multi-dimensional hydrodynamics) are of particular interest as they are a key driver in many of the important processes and outcomes considered.
- Details regarding the configuration of the weir, the Old River Corridor (ie the presence or absence of an IROC).

Key Uncertainties and Research Needs *(describe specific research activities that could be employed to increase understanding):*

- Additional information/research on site-specific habitat design considerations that can improve water quality conditions/mitigate potential adverse conditions, generated by creation of tidal marsh habitats in the altered hydrologic conditions of the South Delta. (See also the separate M&I and Agriculture WQ Evaluations in June, 2012)
- Notes, salmon could potentially end up in Fabian Tract which could have marsh. The combo of 2A and 2B should be considered as a coupled pair if in the future this corridor shows promise.

Corridor 2B - Summary

- Assumptions/Changes to Corridor Description made During Evaluation
    - For purposes of this DRERIP evaluation, Corridors 2A and 2B are being parsed such that: 2A+Fabian Tract=2B. Corridor 2A was evaluated previously and separately from this evaluation. The scores below represent both 2A and 2B together.
    - The evaluation team agreed to parse out two viewpoints expressed by the group and assume "two scenarios":
        - Scenario 1 is the approach as described in the Corridor Document and modeled by the consultants; it includes a considerable area of sub-tidal acreage.
        - Scenario 2 would have the marsh designed such that most acreage is emergent tidal marsh. (This assumes that the portion in the yellow elevation range on the map would become emergent tidal marsh that was created by tule planting). This 2 scenario concept provides a better approach to manage/avoid negative outcomes.
    - Phasing will be ignored for purposes of this evaluation; the assumption is that the tules get planted tomorrow and the marsh is in "full affect".
    - The late-long term condition will be analyzed by the evaluations today for both scenarios.
    - The Evaluation Team evaluated Corridor 2B considering both an Isolated Old River Corridor (IROC) and "no IROC"; details on assumptions are presented in each outcome.

- Summary of Key Outcomes Related to Objectives
    - *Objective: Increase the extent of ecologically-relevant floodplain habitat to support reproduction and viability of Sacramento splittail and Chinook salmon & Steelhead*
        - Positive Outcomes
            - New floodplain areas (that transition into marsh habitat) would be available for inundation that would benefit splittail and salmonids
    - *Objective: Increase the spatial extent and connectivity of tidal marsh.*
        - Positive Outcomes
            - New marsh area would be well connected to upstream floodplains, but downstream connection into the Delta links to poor habitat

            - Minimal habitat for smelt; some habitat for splittail spawning and salmonid rearing and white sturgeon rearing.
        - Negative Outcomes
            - Invasive species (clams, SAV) will certainly occur, but adverse effect on fish species is uncertain and likely low magnitude
            - Water quality (especially temperature, potentially DO) may be an issue, but numerical modeling data is lacking
    - *Objective: Restore habitats and river conditions (i.e., the magnitude and direction of flow in fluvial regimes) that favor survival and growth of juvenile salmonids, sturgeon, delta smelt, longfin smelt, and other native fishes*
        - Positive Outcomes
            - Channel complexity will increase with Fabian tract inundated
        - Negative Outcomes
            - Potential for entrainment is an issue yet to be examined quantitatively/with modeling, but conceptually is a large factor that needs to be addressed.

- <u>Key Uncertainties</u>
    - The hydrodynamics (spatially, and temporally [within each water year and by water year type]) of how flows come in from the San Joaquin River as well as how tidal action works within an opened-Fabian Tract. These dynamics influence water quality, residence time of fishes for spawning and rearing, and the distribution of food and out-migrating fishes.
    - How sub-tidal habitat areas within a restored marsh area are either managed or modified in the restoration designs such that they are eliminated, in order to reduce undesirable habitat areas.
    - Related to the above, are sub-tidal areas located in the South Delta beneficial for native fish?
    - What were the historical ecological functions of the South Delta for smelt? Is it feasible to re-create those processes/habitats within the context of BDCP South Delta restoration?
    - A "landscape-scale processes conceptual model" would be helpful in understanding ecosystem dynamics (physical and ecological) that occur across the transition between habitat types (i.e., the gradation from floodplain to marsh).
    - An understanding of habitat conditions and outmigration success for fishes that may rear in an inundated Fabian Tract. Also, the relationship between successful outmigration downstream of Corridor 2B compared to that of Corridor 4.

- <u>Data Gaps</u>
    - Multi-dimensional hydrodynamic modeling (as related to inundation of Fabian Tract, entrainment, and water quality) is of particular interest as it is a key driver in many of the important processes and outcomes considered.

- Additional information/research on site-specific marsh habitat design options that can improve water quality conditions/mitigate potential adverse conditions that might be generated by creation of tidal marsh habitats in the South Delta. (See also the separate M&I and Agriculture WQ Evaluations in June, 2012)

- <u>Potential corridor re-configurations or combinations to increase the worth /decrease the risk of potential implementation.</u>
  - An Isolated Old River Corridor (IROC) would decrease the risk of entrainment of fish and food. This is a key consideration in configuring habitat in Corridor 2B.
  - Modification of the Fabian Tract (Corridor 2B) footprint to address the sub-tidal marsh areas that would be created if the entire tract were opened via full levee breaches. In other words, steer restoration design toward what evaluators assumed as "Scenario 2" during these evaluations.
  - In conjunction with the recommendation above, consider that Fabian Tract could be adaptively restored with the floodplain at upstream end completed first with the downstream, more-tidal areas restored later when uncertainty is resolved.
  - Salmon and splittail could potentially end up in Fabian Tract (after being routed through a lowered Paradise Cut weir) which would have marsh habitat. The combination of Corridors 2A and 2B should be considered as a coupled pair if in the future this corridor shows promise. Consider how Corridor 2B itself might be adaptively phased in to an overall South Delta solution (i.e., later than other areas) given uncertainty.
  - In terms of lower/ecologically-relevant flows, consider reconfiguration of the channel split at Old River-Grant Line Canal to favor more flow thru Old River. This need not preclude channel and floodway sizing in these areas to be optimized for flood conveyance.

Corridor 2B - Detailed Evaluation Notes

Contents

Scientific Evaluation Worksheet & Notes
Corridor 2B

Evaluation Team:
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Note-taker: Kateri Harrison

General opening discussion. Reminder that the approach taken in this worksheet is to assess the magnitude and certainty of the objective statement and its associated outcomes. These are tracked in the accompanying spreadsheet. This represents a slightly different approach from that taken during the 2009 DRERIP Evaluations.

For purposes of this DRERIP evaluation, Corridors 2A and 2B are being parsed such that: 2A+Fabian Tract=2B. Corridor 2A was evaluated previously and separately from this evaluation. A key question is whether there are any ecological benefits that we could realize from removing levees and allowing inundation of Fabian Tract? The scores below represent both Corridors 2A and 2B together. *This is a regional landscape change in the Delta.*

Portions of Fabian Tract would be inundated all the time, other portions would not. The exact configuration is not yet determined and would require modeling to better understand such inundation and tidal dynamics. Breaching levees in a tidally influenced area does create flow/discharge. The likely spatial area of habitat with and without grading was considered. Modelers assumed Fabian Tract could have some grading to extend the intertidal zone. The color codes on the tides are based on existing tides and without grading. So grading (filling) would yield less of the yellow sub-tidal elevation range. BDCP's definition of "tidal marsh" includes both sub-tidal and open water. Evaluators noted that in general, there is a lot of concern about situations similar to Frank's Tract which is open water.

South Delta ROA has been mapped in Appendix E of the Draft BDCP. Appendix E includes effects analysis and it may be useful in this evaluation. The consultant team cautioned that while the ROA is clearly presented in Appendix E, the actual "hypothetical" tidal marsh area within that ROA is **not** the same as Corridor 2B (which is only Fabian Tract). The hypothetical for the effects

analysis is different and includes **none** of Fabian Tract. A homework assignment for the consultant team was to determine if there is any similarity between the modeling assumptions made in Appendix E and the modeling that ESA/PWA used for the South Delta. *[Consultant Team Answer: after conferring with ICF, it appears that the situation is as was suggested by ESA PWA during the evaluation: the hypotheticals are very different, and the outcomes for salmon (as stated in the effects analysis) are limited to only temperature and turbidity, as taken from one node in DSM2 on the lower San Joaquin River and extrapolated across the hypothetical]*

The evaluators then noted that the BDCP's effects analysis modeling creates confusion because the ROA's are depicted as large blobs on a map. However, when the actual modeling of the hypotheticals within those blobs is run, the analysts do not share that subset or any related assumptions. There is very little definition of what BDCP is doing in the South Delta and this has resulted in unvetted assumptions.

The potential effects on salinity of larger tidal prism are very difficult to model in this area. Small increases in salinity have a big impact on the quality of drinking water. However, small increases in salinity have minimal effect on fish. This issue was noted to be more important for the M&I and Agriculture Water Quality Evaluations held in June. A condition with low exports and with low San Joaquin River flow sets the stage for a tidal system with sea water and associated higher salinity. Additional modeling of salinity intrusion is recommended. This salinity will affect both M&I uses and X2. By creating a tidal basin (Fabian Tract in Corridor 2B) it will increase the tidal prism and bring more sea water into this area. Changes in tides will change dynamics. For example, at Liberty Island restoration the tidal range (difference between high and low tide) shrunk.

In conclusion, restoration in corridors 2A and 2B will increase the variation in salinity. The restoration of 2A and 2B might influence south Delta exports.

Overall Clarifying Assumption for All Corridor 2B analysis

Based on existing elevations and interpreted tidal range, one option for Fabian Tract is to have a large area that is sub-tidal (as shown on the figures for Corridor 2B). Another option would be to in some manner block off this subtidal area (located in the generally northwest corner of Fabian tract) via a new levee, plant tules, to raise the elevation (via subsidence reversal techniques and potentially carbon farming), and eventually the terrestrial could be converted to create tidal marsh. The marsh could be created via grading or via tule marsh accretion.

The evaluators wanted to understand whether sub-tidal areas located in the South Delta would provide benefits for native fish?

The evaluators expressed a tension between analyzing a project as described by BDCP or re-writing the project description to make it better. It was noted that oftentimes BDCP planning teams remove parts of project descriptions that do not seem feasible, practical, or beneficial. Many evaluators felt that this DRERIP evaluation should objectively score the entire project as modeled/originally-conceived. Several evaluators felt that restoring sub-tidal areas is not a good idea. Negative outcomes are associated with sub-tidal open water. Open sub-tidal can be colonized by Egeria. The previously-discussed option of levees and subsidence reversal allows engineers to 1) partition; 2) grade; and/or 3) plant tules. Such a strategy would create all emergent marsh habitat within Fabian Tract, or floodplain. The sub-tidal would be minimized or eliminated. This would require cross-levees and tule planting and the design objective would be to minimize open water and sub-tidal.

After much discussion, the evaluation team agreed to parse out the two viewpoints expressed by the group and assume "two scenarios". Scenario 1 is the approach as described in the Corridor Document and modeled by the consultants; it includes lots of sub-tidal acreage. Scenario 2 would be designed such that most acreage is emergent tidal marsh, as per the discussion outlined above. This assumes that the portion in yellow (elevation range) on the map would become emergent tidal marsh that was created by tule planting. Phasing will be ignored for purposes of this evaluation. Assume that tules get planted tomorrow. The late-long term condition will be analyzed by the evaluations today for both scenarios. This 2 scenario concept provides a better approach to manage/avoid negative outcomes. The group noted that this is a good example of two differing professional viewpoints and agreed to move ahead to engage them both.

OBJECTIVE: INCREASE FREQUENCY OF FLOODPLAIN INUNDATION TO SUPPORT REPRODUCTION AND VIABILITY OF SACRAMENTO SPLITTAIL AND CHINOOK SALMON.

Potential Positive Ecological Outcome

Outcome P1: Increased Frequency of Inundation
Clarifying Assumptions: 2,500 acres of sub-tidal would be flooded along with 1,000 acres of floodplain. Note: Additional modeling is needed. Topography is flat and inundation will be shallow, so the channel will be relatively deep.

Scientific Justification: Compared to 2A, this restoration improves many more acres (1,500 acres of floodplain is proposed). This proposed restoration will double the amount of inundated acres in this entire area.

Magnitude Scenario #1 includes sub-tidal: Medium to High "3-4"

Certainty Scenario #1 incldues sub-tidal: The Frequency of flooding is not known (need more modeling). Uncontrolled environmental variables **Medium "3"**

Magnitude Scenario #2 all emergent: Same as sub-tidal. **Medium to High "3-4"**

Certainty Scenario #2 all emergent: Same as sub-tidal. **Medium "3"**

Note: Magnitude scores rounded down in the spreadsheet to remain conservative.

Outcome P2: Increased Spawning Habitat for Splittail

Scientific Justification: Same as Corridors 1A and 2A. Under existing conditions there are no ecologically significant benefits on Fabian Tract. The consulting team developed a table explaining the floodplain details. 6,095 acres of floodplain is misleading. There was no 2-D modeling. If you peal out the 1500 acres of floodplain and this is similar to 1A and 2A. We assume fish will not use the tidal marsh based on Dutch Slough studies. Tidal marsh does not serve as splittail spawning habitat

Magnitude Scenario #1 sub-tidal: **Medium "3"**

Certainty Scenario #1 sub-tidal: Same as 1A and 2A, **Medium "3".**

Magnitude Scenario #2 all emergent: Not scored by the group

Certainty Scenario #2 all emergent: Not scored by the group

Outcome P3: Increased Rearing Habitat for Salmon

Magnitude Scenario 1 sub-tidal: Higher than Corridor 2A. If 30-50% of the fish that emerge from San Joaquin gravels and travel downstream to the flow split onto Old River. Splits at Grant Line, so breach there, too. At the flow split there will be a lot of cues. Perhaps fish do not move only with the flows but respond to these cues. If only 50% of fish would by Paradise Cut and get swept into this area. Is 50% sig for the population? Probably minor. However regionally, this is likely the largest area. 1500 new acres of floodplain. **Magnitude: Medium "3"**

Certainty Scenario 1 sub-tidal : Medium "3"

Magnitude Scenario 2 all emergent: Not scored by the group

Certainty Scenario 2 all emergent: Not scored by the group

OBJECTIVE: INCREASE THE SPATIAL EXTENT AND CONNECTIVITY OF TIDAL MARSH.

Un-numbered Outcome: Increase the spatial extent and connectivity of tidal marsh (Note: the group chose to take this entire objective and make it an "outcome" as related to corridor function [see corridor tab in spreadsheet]).
Magnitude Scenario 1 sub-tidal: Not scored by the group. **Certainty Scenario 1 sub-tidal:** Not scored by the group. **Magnitude Scenario #2 all emergent:** Connectivity downstream does not follow a natural gradient. Connectivity to other marshes in interior delta (i.e. regional connectivity) is poor. East Delta and West Delta ROA have issues too. Old River is called "West Canal". Natural gradients are important from both an ecological community perspective and a landscape perspective. There is also an internal site habitat gradient from floodplain upstream to marsh downstream, which appears beneficial but is not well-described because there are no "landscape" conceptual models in DRERIP. There is good connection on this Fabian Tract site between floodplain and mash. Currently this site does not support tidal marsh. The proposed restoration will add several thousand acres of tidal marsh. **Medium "3"**
Certainty Scenario 2 all emergent: The tidal range situation is not clear. Changes to the tidal range could reduce the extent of the marsh. This could be mitigated via design. **Low "2".**

Outcome P6: Increased Spawning Habitat for Splittail

Magnitude Scenario #2 all emergent. Splittail will spawn in marsh. The frequency is not as important. Tidal marsh is not as desirable habitat as compared to floodplain) **Low "2"**

Certainty Scenario #2 all emergent**: Low "2"**

Magnitude Scenario 1 sub-tidal: Not scored by the group.

Certainty Scenario 1 sub-tidal: Not scored by the group.

Outcome P7: Increased Rearing Habitat for Salmonids

Clarifying Assumptions:

- Lower weir. For this outcome, the group reiterated the assumption that Corridor 2A was in effect and the weir would be lower.

Magnitude Scenario 2 all emergent
This habitat is available every single year and if 50% of the San Joaquin River salmon travel down here. In the past, this area was a bottle neck for salmon. The restoration will be a big improvement. **Medium "3".**

Certainty Scenario 2 all emergent: **Low "2".**

Magnitude Scenario 1 sub-tidal: Not scored by the group.

Certainty Scenario 1 sub-tidal: Not scored by the group.

Outcome P8: Increased spawning habitat for Delta smelt

Clarifying Assumptions:

- Currently, the South Delta is a sink for delta smelt. Refer to BDCP effects assessment for additional information on smelt ecology and this phenomenon.

Magnitude Scenario 2 all emergent: **1 minimal**. Ignores sink (this part of the outcomes is captured as a negative outcome, below).

Certainty Scenario 2 all emergent: **1 minimal.**

Magnitude Scenario 1 sub-tidal: Not scored by the group.

Certainty Scenario 1 sub-tidal: Not scored by the group.

Outcome P10: Increased spawning for Longfin smelt

Scientific Justification:

Magnitude Scenario 2 all emergent: Similar to 2009 DRERIP but lower magnitude and certainty. **Minimal "1"**

Certainty Scenario 2 all emergent: Low "2"

Magnitude Scenario 1 sub-tidal: Not scored by the group.

Certainty Scenario 1 sub-tidal: Not scored by the group.

Outcome P12: Increased rearing habitat for Juvenile and Sub-adult White Sturgeon

General Discussion: Sturgeon could be residents year-round. If this is not an isolated (protected) from the facilities, then fish will get entrained.

West Canal is an agricultural canal. Old River is a natural channel of the San Joaquin River, but it has to go past West Canal. West Canal has negative flows right to the facilities. This area has terrible habitat conditions. However, in the future, if we imagine this without entrainment (ie with an IROC), then the quality of the habitat is somewhat better; however, at this time an isolated corridor is not part of the project. If the project changes to incorporate an IROC, then evaluators should return to re-analyze the situation. Hopefully, the project proponents will improve the project description later to alleviate / mitigate the negative effects. There are reports on the IROC, but BDCP has not incorporated it yet. The BDCP proposal in the South Delta appears vague to the evaluators. The hydrodynamics of an IROC were not clearly explained in the description and are generally not well understood. It is important to think of this holistically.

Currently today, the South Delta does not have tidal marsh or riparian habitat. Any habitat that does exist is located within the zone of entrainment. The areas downstream of the South Delta are not particularly good habitat (this is the case for <u>all</u> of the corridors). This is a consistent assumption that applies to all corridors.

Magnitude Scenario 2 all emergent: Even with an isolated facility, still have limited downstream connectivity. Sturgeon are here year round. If water quality conditions were appropriate and if they were outside the zone of entrainment. Overall this restoration represents a small contribution of tidal marsh acreage to the Delta system. Conceptual model is that sturgeon use subtidal, not intertidal **Low "2"**

Certainty Scenario 2 all emergent: Low "2"

Magnitude Scenario 1 sub-tidal: Not scored by the group.

Certainty Scenario 1 sub-tidal: Not scored by the group.

Potential <u>Negative</u> Ecological Outcomes

Outcome N12: Clams & SAV

Scientific Justification:
Note that the evaluators referenced back to the 2009 DRERIP evaluation related to Corbicula establishment that could limit, if not eliminate, the productivity befits of the restoration to native fish. Similarly established of SAV and centrarchid predators could lead to predation rates on the site that eliminate any net benefits at a population level. A worst case scenario is that clams eat every bit of production.

Clam - Magnitude Scenario 1 – sub-tidal, all fish species: The habitat in this region is generally in very poor condition. **Minimal "1"**

SAV Magnitude Scenario 1 – sub-tidal all fish species: **Low "2".**

SAV & Clams Certainty Scenario 1 - sub-tidal: We have high certainty that clams and SAV will invade (4) and low certainty that this will impact the fish species. **Low "2"**

Clams Magnitude Scenario 2- all emergent, all fish species: Clams and SAV will not be in the emergent marsh. However, if food is exported off the marsh, we will see well-fed clams. **Minimal "1"**

SAV Magnitude Scenario 2 all emergent all fish: SAV will grow in adjacent channels, but not grow in marsh. **Low "2"**

SAV & Clams Certainty 2 – all emergent: **Low "2"**

Outcome N3C: Invasive fish / Predators [note that *zero magnitude* meant that this outcome was not included in the spreadsheet]

Magnitude Scenario 2 – **all emergent for salmon and splittail**: this restoration action (and any tidal habitat) will create more habitat for invasive fish species. Predation is currently high (already at 97%) and this rate will stay the same. More complex habitat will create more places for native fish to hide from predators. Tidal marsh will provide a net benefit, even with predation.

This is a wash "**zero" 0 magnitude** or a small net benefit.

Certainty Scenario 2 – **all emergent**: Evaluators are fairly certain that increased abundance of invasive predators will occur. However, the effect of this increase in predation on salmon and other native fish populations, given the already high rates, is less certain. **Low "2"**

Outcome N7a: Increased Mortality Due to Water Quality Degradation (including water temperature, DO, eutrophication)

Scientific Justification: This restoration will increase residence time and therefore may increase water temperature. If there were no Isolated Old River Corridor there might be better water quality due to flow thru of San Joaquin River (?). This restoration will be increasing the tidal prism and pulling in more water from the sea. Higher tidal velocity in the river downstream of Fabian Tract. Solar radiation on subtidal areas would increase temperature. If water temperatures increase just a little bit, then predators will eat more due to bioenergetics.

An example is Mildred Island where temperatures did increase in the sub-tidal zone 5 ft. depth. The overall south Delta will have an increased residence time, which will influence temperature.

Magnitude for Scenario 1 sub-tidal: Splittail are resident fish species but moving to western Delta. Smelts are sensitive to temperature and therefore would experience greater impact. It is not a High 4 magnitude because there may be some pools of cooler temperature refugia. Fish may avoid high temperature areas. Sustained minor population effect. **Medium "3".**

Certainty: We do not understand the timing or magnitude of the temperature changes. Habitat Suitability Index (HSI) for temperature flattens for a while and then drops. Spring season is the time of most concern for some species. **Minimal "1"**

Magnitude for Scenario 2 – all emergent all fish: Less solar radiation and temperature increase would be less. Some discrepancy regarding whether the "Chris Enright hypothesis" about cooling via marsh vegetation applies here in the south Delta. It was noted that the tules do have a lot of surface area and evaporative cooling. **Low "2"**

Certainty for Scenario 2 – all emergent all fish: Minimal "1"

Outcome N7b: Low Dissolved Oxygen (note, because this is a sub-part of Outcome N7, and scores in that outcome were higher [more negative], those scores were retained in the spreadsheet for conservatism)

Clarifying Assumptions:
Vegetation will die back. More nutrients released. Frank's Tract dissolved oxygen problems may not have been measured. Big dissolved oxygen problems are Suisun and Stockton DWSC. Longer residence time. SAV and higher temperatures contribute to a lower dissolved oxygen.

Comparatively Frank's Tract is not a good area to compare to because it has better flows. Snodgrass Slough on the east side is better example.

Magnitude Scenarios 1 and 2 all native: Problem during summer and fall. Salmon are present in April. The modeling shows dissolved oxygen is suitable, but this modeling is constrained and may not apply here. The RWQCB has water quality objectives for dissolved oxygen, if the water quality objective and this scenario reduces the water quality objective, then that is a problem. **Low "2"**

Certainty Scenarios 1 and 2 all native: The low dissolved oxygen is a hypothesis. **Minimal "1".**

Outcome N3F: Increased Microcystis (Not applicable to the aquatic species being evaluated; no score in spreadsheet)

Clarifying Assumptions:
Longer resident time and warmer temps will increase occurrence of Microcystis. Microcystis is present in Aug and Sept. Fish are not present at this time. However, this is a key water quality issue for M&I. See June 2012 M&I / Agricultural Water Quality Evaluation.

Scientific Justification:

Magnitude: N/A to fish but see note above regarding M&I

Certainty: N/A.

Outcome N10: Increased Mercury Methylation

Magnitude for scenario 1: sub-tidal and open water will demethylate mercury via photo-demethylation. The site will be a sink for mercury and that is a positive thing. **Minimal to low "1-2".**

Certainty: **High "4"**

Magnitude for scenario 2 all emergent: Most of the emergent marsh will be low marsh. High marsh would be more of a problem. **Minimal to low "1-2.**

Certainty: For fish, certainty is **High"4".**

(Note, for other species, there is less certainty Minimal "1" and this is not directly applicable to today's evaluation)

Outcome N9: Increased Exposure to Selenium

Clarifying Assumptions:

- Higher residence time. Selenium is bio-accumulated by clams. More opportunities for selenium to get into food chain for those fish that eat clams. The fish have plenty of clams to eat.
- There are selenium clean-ups in progress and so the situation could improve

Magnitude for scenario 1 sub-tidal: Higher concentration within San Joaquin River water (as compared to Sacramento River water) so would have a higher concentration of selenium. Residence time is the mechanism. If the clams have a higher selenium concentration, this is not an issue for salmon. Bio-accumulation of selenium in sturgeon may reduce their reproductive capacity. Daily dose level has been exceeded. Sturgeon are already past the selenium threshold, so the additional 3% more is the proverbial drop in the bucket. Score for most native fish is **Low "2**". However for salmon magnitude is a **Minimal "1".**

Certainty for scenario 1 sub-tidal: Minimal to Low "1-2"

Magnitude for scenario 2 all emergent: Tules no net change in # of clams. However, will be increased residence time in the tidal marsh. Pumping pattern also increases residence time.
Score for most native fish is **Low "2**". However, score for salmon magnitude is **Minimal "1".**

Certainty for scenario 2 all emergent: Minimal to Low "1-2".

OBJECTIVE: RESTORE HABITATS AND RIVER CONDITIONS (I.E., THE MAGNITUDE AND DIRECTION OF FLOW IN FLUVIAL REGIMES) THAT FAVOR SURVIVAL AND GROWTH OF JUVENILE SALMONIDS, STURGEON, DELTA SMELT, LONGFIN SMELT, AND OTHER NATIVE FISHES

Potential Positive Ecological Outcomes

Outcome P16: Increased Channel Complexity (including in-channel and channel margin riparian vegetation, LWD, and emergent vegetation)

Scientific Rationale: Currently the channel is constrained between two levees and it is a low energy environment and fish biologists often recommend more channel complexity. However, if levees are removed natural channel erosion, deposition, migration and related ecological processes will be rehabilitated. Channel complexity will increase over time due to big flow events moving thru with depositional features. Re-vegetation will occur. Flow goes thru Grant Line. Junction is an issue. There is an expanded Paradise Cut. Flows to the Delta would increase with concurrent higher discharge and increased velocity through Paradise Cut.

Bathymetric evolution; there is a balance. Physical habitat needs to be coupled with hydrodynamic flow regime. Rate of natural channel evolution will be slow in Corridor 2B (in-Delta environment, not the San Joaquin River). It will take a long time to develop this into a complex sediment balance. This will be a low velocity area. Physical complexity has to come with the right flows. Slow flows, so slow geomorphic change. Could allow rafting of large woody debris, which would be valuable.

Magnitude on intermediate outcome – physical only: Low "2"

Certainty for physical only: Fairly well understood condition is a **medium "3"**

Magnitude on native fish: Minimal to Low "1-2"

Certainty for all fish "**minimal "1**"

Outcome NX Entrainment (unnumbered outcome; added at end of spreadsheet and not counted in roll up scores because of lack of data)

Clarifying Assumptions:

- Entrainment will increase a lot if there is habitat in Corridors 2A and 2B that ends up adjacent to the pumps.
- Restoration will increase native fish population abundance so overall, a greater number of fish would get entrained. The Evaluation Team recognizes that rate or % of population entrained is a better metric.

Any fish that goes down this channel will get entrained in the pumps if they are operating. If Paradise Weir is not improved (via this restoration), these fish may have stayed in than San Joaquin River. Depends on operations such as amount of pumping in the south Delta and water year type, and the configuration of the Weir and any operable barriers (at Paradise Weir, in the mainstem San Joaquin River, or elsewhere).

Magnitude without Old River corridor: Caveat: Magnitude depends on the operations. This could have a high adverse effect on salmon, but there is not enough information available to make a specific determination. This negative outcome is a **medium to High "3-4"**

Certainty without Old River corridor: Medium "3"

Magnitude Scenario 2 with isolated Old River corridor. Fewer fish will be entrained. May have significant effects on pelagic fish, but we do not have enough data. The entrainment zone may shift to Middle River; but there have been several hypotheses on this. **Minimal - Low "1-2"**

Certainty Scenario 2 with isolated Old River corridor: Modeling runs should be available for this somewhere. **Minimal "1"**

Notes: This may affect water supply or OCAP BO's RPA.

Data Gaps & Key Uncertainties

Data Needs *(indicate specific models, DLO relationships, or other information indicating the need):*

- Multi-dimensional hydrodynamic modeling of Fabian Tract inundation. This plays into water quality, entrainment of food and individuals of certain species, and also influences habitat itself. This is a key driver.

Key Uncertainties and Research Needs *(describe specific research activities that could be employed to increase understanding):*

- Is sub-tidal areas located in the South Delta beneficial for native fish?

- Does it matter exclusively on entrainment and water quality?
- What were the historical ecological functions of the South Delta for smelt? Is it feasible to re-create those processes/habitats within the context of BDCP South Delta restoration?
- A "landscape-scale processes conceptual model" would be helpful in understanding ecosystem dynamics (physical and ecological) that occur across the transition between habitat types (ie the gradation from floodplain to marsh).
- An understanding of habitat conditions and outmigration success for fishes that may rear in an inundated Fabian Tract. Also, the relationship between successful outmigration downstream of Fabian Tract compared to downstream of Corridor 4.

Corridor 4 - Summary

- <u>Assumptions/Changes to Corridor Description made During Evaluation</u>
  - The late-long term condition was analyzed for these evaluations.
  - Fish stranding locations are assumed to be "designed-out" of restoration actions.
  - Sturgeon are assumed to be potential year-round residents of this corridor.
  - Floodplain inundation *was modeled without HORB as the HORB was not a part of the original corridor assumptions*. With HORB, most of the fish move through Corridor 4.

- <u>Summary of Key Outcomes Related to Objectives</u>
  - *Objective: Increase the extent of ecologically-relevant floodplain habitat to support reproduction and viability of Sacramento splittail and Chinook salmon & Steelhead*
    - Positive Outcomes
      - New floodplain areas (that transition into marsh habitat) would be available for inundation that would benefit splittail and salmonids—and all outmigrating fish would go through this corridor if the HORB is in place. Low risk of stranding.
  - *Objective: Increase the spatial extent and connectivity of tidal marsh.*
    - Positive Outcomes
      - New marsh area would be well connected to upstream floodplains, but downstream connection into the Delta links to

poor habitat—Stockton Deep Water Ship Channel (SDWSC; which negating the pumps is worse than downstream of Fabian)
                - Minimal habitat for smelt; some habitat for splittail spawning and salmonid rearing and white sturgeon rearing.
            - Negative Outcomes
                - Water quality (especially DO and temperature) is likely an issue with the downstream SDWSC , but numerical modeling data is lacking
    - *Objective: Restore habitats and river conditions (i.e., the magnitude and direction of flow in fluvial regimes) that favor survival and growth of juvenile salmonids, sturgeon, delta smelt, longfin smelt, and other native fishes*
        - Positive Outcomes
            - Channel complexity will increase with the new setback floodplain and an unconstrained, erodible left-bank.
        - Negative Outcomes
            - Risk of invasive species (clams, SAV) similar to other corridors.
    - *Objective: Reduce entrainment mortality of juvenile salmonids, smelt, sturgeon, splittail, and other native fishes*
        - While entrainment was conceptually-evaluated and was scored for this corridor, it was not used in the rollups because the other corridors do not have scores for entrainment.

- <u>Key Uncertainties</u>
    - The marsh at the downstream end of the corridor will have longer residence times. Any increase in organic matter loading will contribute more to the problem of already-low levels of DO in the SDWSC, and the proximity of this corridor to the SDWSC is a concern. A potential mitigating effect is greater velocities due to the increase in the tidal prism.
    - A "landscape-scale processes conceptual model" would be helpful in understanding ecosystem dynamics (physical and ecological) that occur across the transition between habitat types (i.e., the gradation from floodplain to marsh).

- <u>Data Gaps</u>
    - Multi-dimensional hydrodynamic modeling (especially as related to water quality) is of particular interest as it is a key driver in many of the important processes and outcomes considered.
    - Examine runoff into Corridor and evaluate potential for water quality impacts

- <u>Potential corridor re-configurations or combinations to increase the worth /decrease the risk of potential implementation.</u>
    - Analyze the effects of potential HORB operation and integrate into future corridor evaluations. There is a need to examine potential negative effects of HORB outside Corridor 4.

Corridor 4 – Detailed Evaluation Notes

Contents

Scientific Evaluation Worksheet & Notes

Corridor 4

Evaluation Team: Facilitator: Bruce DiGennaro

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Note-taker: Kateri Harrison

Date: Thursday, February 2, 2012

For this analysis, the group assumed that:

- Corridors 2A and 2B are not going to be restored.
- The Head of Old River Barrier (HORB) is installed and is operational at low flows (<10,000 cfs), year round.
- Active channel margin enhancement occurs in specified locations.
- All outmigrating fish pass by this location, unless they travel down Old River at a flow higher than 10,000 cfs.

Floodplain inundation was modeled without HORB as the HORB was not a part of the original corridor assumptions. The manifestation of this is that the discharge/area of inundation curves in the corridor document are accurate to how this corridor is being evaluated for flows above 10,000 cfs, which is when there is no HORB [i.e. it is not operational above 10,000 cfs]. For flows less than 10,000 cfs, then the curve in the corridor document is not accurate due to lack of HORB in the model (and would tend to underestimate the floodplain inundation in Corridor 4 because that extra flow would be routed down the mainstem of the San Joaquin River, not Old River). With HORB, most of the fish move through this corridor. We assume some improvements to the right (eastern) bank, and that that the left (western) bank will be allowed to naturally evolve once the levees are set back. Currently the channel is trapezoidal in shape through this reach.

OBJECTIVE: INCREASE THE EXTENT OF ECOLOGICALLY-RELEVANT FLOODPLAIN HABITAT TO SUPPORT REPRODUCTION AND VIABILITY OF SACRAMENTO SPLITTAIL AND CHINOOK SALMON & STEELHEAD

Potential Positive Ecological Outcome(s)

Outcome P1: Increased Frequency of Inundation

Scientific Justification:
Under existing conditions, Corridor 4 is constrained by levees on both banks. Levee setbacks would provide up to 6,000 acres of habitat. It is anticipated that this will have a sustained population effect for target species. This corridor spans a larger topographic gradient than other corridors, allowing a diversity of habitat types from floodplain at the upstream end to tidal marsh at the downstream end. It was noted that the northern edge of the proposed left bank levee setbacks may not be optimally configured according to one evaluators understanding.

The group pondered if there would be incremental improvements to habitat based on the location of the proposed setbacks, and if would there be a landscape level effect. The consensus was: yes. Alternative 1A has a larger footprint; however, Corridor 4 has more potential for tidal marsh habitat restoration. The group was reminded that this outcome is specifically concerned with floodplain habitat.

Based on evaluations, 15,500 cfs is the recommended ecologically-relevant flow for salmon, and 11,600 cfs is the recommended ecologically-relevant flow for splittail. For salmon, these flows occur for a minimum duration of 14 days every 4 years, for splittail these flows occur for a minimum duration of 21 days every 4 years. At these flows, there would be 4,000 acres (at flows of 15,500 cfs), and 3,500 acres (at flows of 11,600 cfs) of floodplain, riparian, and tidal marsh habitat. The group was concerned

about the limited temporal effects on fish populations associated with this evaluation. If the hydrology were different then we may see a different (and potentially improved) ecological benefit.

It was also mentioned that the current topography is less than optimal, and that natural channel morphology changes could change the distribution of habitats along the corridor substantially.

Magnitude Physical Only – Intermediate Outcome: Low "2"

Certainty: High "4".

Outcome P2: Increased Spawning Habitat for Splittail

Scientific Justification:
Same as Corridors 1A and 2A: Larger amounts of inundated floodplain, as proposed here, will benefit the species.

Magnitude: Medium "3"

Certainty: Medium "3"

Outcome P3: Increased Rearing Habitat for Salmon

Scientific Justification:
The group thinks the magnitude of benefit in terms of rearing habitat for salmon will be greater than that for Corridor 2A because there will be a greater frequency of inundation (due to lower topography and more accessible floodplain areas).

Magnitude: Medium "3"

Certainty: Medium "3"

Potential Negative Ecological Outcome(s)

Outcome N1: Increased Stranding

Scientific Justification:
Stranding not an issue in tidal marsh habitats; however in floodplain habitats this can be an issue that was assumed to be mitigated through design.

Magnitude: Low "2"

Certainty: High "4"

OBJECTIVE: INCREASE THE SPATIAL EXTENT AND CONNECTIVITY OF TIDAL MARSH HABITAT

Potential Positive Ecological Outcome(s)

Outcome Px: Increase the spatial extent and connectivity of tidal marsh habitat (Note – evaluators scored the objective as an outcome.)

Magnitude (intermediate outcome – physical only): Acreages are similar to 2B. **Medium "3".**

Certainty: Changes to the tidal range could reduce the extent of the marsh habitat. This could be mitigated through design. **Low "2".**

Outcome P6: Increased Spawning Habitat for Splittail

Scientific Justification:
Splittail will spawn in marsh habitats. The frequency is not as important. Tidal marsh is not as desirable habitat as compared to floodplain, but floodplains exist in Corridor 4.

Magnitude for the tidal marsh portion: Low "2"

Certainty for the tidal marsh: Low "2"

Outcome P7: Increased Rearing Habitat for Salmonids

Scientific Justification:
This habitat will be available every year, with high probability that at least 50% of the SJR salmon travel through this corridor and could potentially utilize this habitat. In the past, this area was a bottle neck for salmon. The restoration will be a big improvement.

Magnitude for tidal marsh portion: Medium "3".

Certainty: Low "2".

Outcome P10: Increased spawning habitat for Longfin smelt

Clarifying Assumptions:
See 2009 DRERIP

Scientific Justification:
Similar to 2009 DRERIP but with lower magnitude and certainty. The South Delta could have significant negative outcomes for delta and longfin smelt depending on the actual configuration of flood and ecosystem restoration actions.
Magnitude: Minimal "1"

Certainty: Low "2"

Outcome P12: Increased rearing habitat for White Sturgeon

Clarifying Assumptions:

- Sturgeon could be resident year-round.

Scientific Justification:
Downstream connectivity is a concern. Sturgeon are here in this corridor year-round. If water quality conditions were appropriate and if they were outside the zone of entrainment, then they might benefit. Overall this is a small contribution of tidal marsh to the total quantity of marsh habitat in the Delta. Juvenile and sub-adult sturgeon will rear here. Corridor 4 has tidal exchange.

Magnitude: Low "2"

Certainty: Low "2"

Potential Negative Ecological Outcome(s)

Outcome N7: Increased Mortality Due to Water Quality Degradation (including water temperature, DO, eutrophication)

Scientific Justification:
With the HORB in place, there will be shorter residence time in the channels and floodplains and this should yield fewer water quality impacts. The marsh at the downstream end of the corridor will have longer residence times. There are low levels of DO in the Stockton DWSC and any increase in organic matter loading will be contributing to this problem. The proximity of this corridor to the Stockton DWSC is a concern.

RWQCB would like to see some modeling about the potential impacts for this water quality concern. A mitigating impact is

greater velocities due to the increase in the tidal prism. As you progress past the WWTP the channel gets deeper. Dissolved oxygen problems are dependent on flow. Stockton upgraded their WWTP in 2006 and their nutrient loading has declined; however dissolved oxygen problem still remains June to October.

Magnitude: Medium "3"

Certainty: Evaluators are unable to understand the timing or magnitude of the temperature changes because the screening-level modeling does not provide for that type of data. Spring season is the time we are most concerned about for some species. **Minimal "1".**
Recommendations for future study: Analyze the effects of the HORB and integrate into the corridor evaluations. Need to look at potential negative effects of HORB outside corridor 4.

Outcome N8: Increased Microcystis

Clarifying Assumptions:

- Longer resident time and warmer temperatures will increase occurrence of Microcystis. Microcystis is present in August and Sept. Fish are not present at this time. However, this is a key water quality issue for M&I.

- Restoration will slow down water and heat up water temperatures. This might affect timing of microcystis bloom and etc. Microcystis occurs in turning basin and part of the Stockton ship channel. Tidal marsh could worsen the microcystis situation.

Scientific Justification:

Magnitude: N/A to fish but see above re: M&I. Microcystis does occur near Stockton DWSC. **Not scored by group.**

Certainty: Not scored by group.

Outcome N9: Increased Exposure to Selenium

Clarifying Assumptions:

- Higher residence times of water in critical habitats can lead to selenium exposure.
- Selenium is bio-accumulated by clams.
- More opportunities for selenium to get into food chain from those fish that eat clams.

Scientific Justification:

Higher concentrations of San Joaquin River water (as compared to Sacramento River water) would lead to higher concentrations of selenium. Residence time is the mechanism. If the clams have a higher selenium concentration, this is not an issue for salmon. However, bioaccumulation in sturgeon will reduce reproductive capacity. Sturgeon have already past the selenium threshold.

For Corridor 4, delivering selenium to the Bay Area is a concern, so allowing bioaccumulation may prevent distribution downstream. This might be a "sink" for selenium.

Magnitude: For most fish **Low "2**". However for **salmon** magnitude is a **Minimal "1".**

Certainty: Minimal to Low "1-2".

Outcome N10: Increased Mercury Methylation

Scientific Justification:

Sub-tidal and open water will facilitate photo-demethylation. High marsh would be more of a problem.

Magnitude: Minimal to Low "1".

Certainty: For fish, certainty is **High "4".**

Note, for other species, certainty would be Minimal "1"; however this is not directly applicable to today's evaluation.

Outcome N11: Increased Mobilization or Re-suspension of Toxics (including pesticides)

Clarifying Assumptions:

- Increased residence time creates higher probabilities for re-suspension.
- Corridor is likely a sink for toxics.

Scientific Justification:

Corridor #4 is adjacent to urbanized areas. There is runoff from urban neighborhoods as well as I-5.

Note: Stockton has raw sewage overflow into Mosher Slough, and Stockton DWSC. The northern part of this corridor might experience this issue, but that is speculation; nothing definitive. In general, urban land-use is something to be aware of. Fish kills along dead end sloughs in Stockton might be related to sewage spills. BDCP-related restoration will not change those sorts of issues. There is high population density along the eastern bank. Will these urban uses impact the fish?

Recommendation: In future planning, examine runoff into Corridor 4 and evaluate potential for water quality impacts

Magnitude: Not scored by group.

Certainty: Not scored by group.

OBJECTIVE: RESTORE HABITATS AND RIVER CONDITIONS (I.E., THE MAGNITUDE AND DIRECTION OF FLOW IN FLUVIAL REGIMES) THAT FAVOR SURVIVAL AND GROWTH OF JUVENILE SALMONIDS, STURGEON, DELTA SMELT, LONGFIN SMELT, AND OTHER NATIVE FISHES

Potential Positive Ecological Outcomes

Outcome P16: Increased Channel Complexity (including in-channel and channel margin riparian vegetation, LWD, and emergent vegetation)
Clarifying Assumptions: Compare assumptions stated for Corridor 1A to Corridor 4
Scientific Justification: The right bank protects the adjacent urbanized area. Because of the location of Corridor 4, it is more constrained than Corridor 1A. However, the channel is fairly wide. **Magnitude:** Score is **Medium "3"** **Certainty:** Score is **Medium "3"**

Potential Negative Ecological Outcome(s)

Outcome N12: Establishment of Invasive Species (SAV, Clams, invasive competitors)

Scientific Justification:
See 2009 DRERIP

Clam - Magnitude all fish species: Compared to other sites, Corridor 4 will have more scour. The habitat in this region is generally in very poor condition. **Minimal "1".**

SAV Magnitude all fish species: **Low "2".**

SAV & Clams Certainty: We have high certainty that clams and SAV will invade and low certainty that this will impact the fish species. **Low "2".**

OBJECTIVE: REDUCE ENTRAINMENT MORTALITY OF JUVENILE SALMONIDS, SMELT, STURGEON, SPLITTAIL, AND OTHER NATIVE FISHES

Potential Negative Ecological Outcome(s)

Outcome Nx: Entrainment

(Note: entrainment was not scored for any of the other corridors because of a lack of data. While entrainment was conceptually-evaluated and was scored for this corridor, it was not used in the rollups because the other corridors do not have scores for entrainment.)

Clarifying Assumptions:

- For this particular habitat, it is assumed that HORB will be installed. HORB might prevent entrainment?
- During wet years, there will be pumping from the north Delta facilities.
  If the barrier at head of Old River (HORB) is operational year-round, this is different than Scenario 6. Scenario 6 assumed that 50% leaky between June to October. Unintended consequences for smelt?

Scientific Justification:
HORB in place, so San Joaquin River salmon are OK, but other fish may suffer. More modeling is needed to look at the entrainment issue.

Magnitude for corridor 4: **Minimal to Low "1-2".**

Certainty for corridor 4: It's been analyzed a lot, **Low "2".**

DATA GAPS & KEY UNCERTAINTIES

Data Needs:

- M&I water quality impacts from restoration

Key Uncertainties and Research Needs:

- Examine runoff into Corridor and evaluate potential for water quality impacts
- Analyze the effects of the HORB and integrate into the corridor evaluations. Need to look at potential negative effects of HORB outside corridor 4.
- The marsh at the downstream end of the corridor will have longer residence times. There are low levels of DO in the Stockton DWSC and any increase in organic matter loading will be contributing to this problem. The proximity of this corridor to the Stockton DWSC is a concern. RWQCB would like to see some modeling about the potential impacts for this water quality concern. A mitigating effect is greater velocities due to the increase in the tidal prism.
- The South Delta could have significant negative outcomes for delta and longfin smelt depending on the actual configuration of flood and ecosystem restoration actions.