BAY-DELTA CONSERVATION PLAN

DELTA SCIENCE PROGRAM PANEL
SECOND REVIEW OF THE "LOGIC CHAIN" APPROACH

Prepared for
BDCP Steering Committee

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Summary Findings and Recommendations

Panel findings and recommendations are summarized below according to the three primary goals of the logic chain approach.

Develop reasonably achievable BDCP objectives and conservation measures that contribute to broader species recovery goals.

The logic chain structure could be simplified to reduce the number of objective statements and to focus BDCP objectives. Recommended changes to the logic chain structure are shown in Figure 2. Specific findings and recommendations include:

- The identification of "BDCP" goals and objectives, versus global goals and objectives, is very important. The structure of the upper portion of the logic chains needs to be agreed upon for the logic chains to be effective.
- Identify stressors prior to the development of BDCP objectives. BDCP objectives should be linked to specific stressors, and stressors to both BDCP and global goals.
- Explicitly identify stressors that are outside of BDCP's management zone in the logic chains.
- Whenever possible, focus BDCP objectives on measures of individual and population-level performance, such as habitat-specific estimates of growth and survivorship, quantitative estimates of abundance, and quantitative measures of movement and/or distribution.
- Consider developing logic chains for selected key community and ecosystem properties to capture outcomes associated with certain conservation measures that are not obvious from piece-wise presentation among species-specific logic chains.
- Include estimates of magnitude and certainty to facilitate prioritization of conservation measures and to aid in future adaptive management. Estimates of both the magnitude of effects and their associated certainty can be done in narrative form with supporting documentation.
- Retain flexibility to tailor logic chains for each species, recognizing the trade-off between consistency and uniqueness. For example, although the four Viable Salmonid Population (VSP) characteristics should be important in conserving most fish populations, a simpler structure may provide more biologically realistic logic chains for species like delta and longfin smelt.
- Consider a workshop with technical experts for each species, with the goal of preparing a simpler "influence diagram".
- Adjust the format and presentation of the chains to make them more readable.
- Minimize "insider" information and poorly-defined jargon in the logic chains. Terms like "productivity", as used in the logic chains, are generic terms, and not sufficiently specific to ensure clear goals or objectives.

Describe possible metrics designed to monitor and evaluate the effectiveness of implementing the BDCP conservation measures.

- Great care should be used when populating the compliance and performance monitoring boxes in the logic chain. Three levels need to be considered separately: 1) the level that addresses the Global Goal, 2) the "covered activity" level, and 3) compliance monitoring, which measures implementation of the planned conservation measure.
- Although the Panel sees a distinction between annual abundance indices and BDCP performance metrics, the Panel strongly recommends that the BDCP performance metrics be related to fish vital rates (reproduction, growth, mortality).
- Contribute funding to creating and maintaining a repository of data, similar to the National Science Foundation's Long-Term Ecological Research site network.
- Identify the key unknown biological attributes of covered species, and commit to long-term sampling and focused studies on fundamental biology and ecology of species to be paired with that centered on solving immediate problems related to water management.

Link implementation of conservation measures, through monitoring and evaluation, to the adaptive management program.

- Clearly identify the management goals that can be addressed via adaptive management (sensu Walters 1986) in the draft Plan (i.e., by November), those that can be addressed during the subsequent refinement phase (prior to the formal permit issuance), and those that can only be addressed during implementation.
- A programmatic approach to research should be developed for early adoption, even prior to permitting, and the post-permitting adaptive management approach must be described and finalized as soon as possible, so that conservation measures and post-implementation monitoring can be refined and developed using that research.
- Consider an objective process for developing an implementation plan that acknowledges: (1) the certainty of achieving expected outcomes; (2) that not all measures can be implemented immediately; (3) that not all will achieve their ultimate outcomes immediately, and (4) that some are contingent on the success of others (perhaps using optimization or other approaches as suggested by the first Logic Chain Panel) to provide more realistic expectations of how the system might change as a result of the Plan.
- Consider using a formal decision support system (one that allows for incomplete information, generalized relationships, uncertainties etc.) to identify high priority measures and those for early implementation.
- Develop an adaptive management plan in sufficient detail for the November Draft Plan so it is clear to all participants which procedures will be used to revise BDCP objectives and how additional information, especially reduced uncertainty, will be incorporated into the Plan during implementation (i.e., revisiting the logic chains).
- Comprehensively articulate conservation outcomes based on the logic chains, including their spatial distribution, at decadal intervals to provide a realistic expectation of the changes expected as a result of plan implementation.

1. Background

The Bay Delta Conservation Plan (BDCP) is being prepared through a collaboration of state, federal, and local water agencies, private enterprise, state and federal fish agencies, environmental organizations, and other interested parties to obtain permits under federal and state endangered species acts. The plan will identify a set of conservation measures that will provide for changes in conveyance and operations of the State and federal water projects, operations of Mirant power generation, reductions of other stressors, and habitat restoration actions to contribute to the recovery of endangered and sensitive species and their habitats in California's Sacramento-San Joaquin Delta. The goal of the BDCP is to provide for both species and habitat protection and improved water supplies.

The logic chain approach has been developed by the BDCP Steering Committee to provide a framework and planning tool for:

1. Developing reasonably achievable BDCP objectives and conservation measures that contribute to the broader (global) species recovery goals;
2. Describing possible metrics designed to monitor and evaluate the effectiveness of implementing the BDCP conservation measures; and
3. Linking implementation of conservation measures, through monitoring and evaluation, to the adaptive management program.

An earlier version of the Logic Chain approach was reviewed in March 2010 by a panel convened by the Delta Science Program (Dahm et al., 2010). This second Review Panel was also convened by the Delta Science Program on August 4 and 5, 2010 and was supported by Delta Science Program staff, including Cliff Dahm and Elizabeth Soderstrom, and BDCP support contractors including Bruce DiGennaro of the Essex Partnership, Wayne Spencer of the Conservation Biology Institute and Kateri Harrison of Swale Consulting. The agenda for the second review meeting is included as Attachment 1.

2. The Charge

This Review Panel was charged with focusing on:

1. Assessing populated logic chains to evaluate internal logic, measurability, linkages between plan components, and consistency in approach;
2. Recommending alternative strategies or metrics for identifying progress towards meeting goals and objectives or alternative ways of framing goals and objectives such that they are practicable; and
3. Offering advice on constructing an integrated monitoring and evaluation program linked to the logic chains.

Other topics suggested by the BDCP and included in the charge to the Panel were:

4. Discussion and review of metrics and how they provide a context for design of measureable, practicable BDCP Objectives and Stressor Sub-objectives.
5. Discussion of current and potential future monitoring within this system to create a context for objectives that will be measureable and practicable that will support adaptive management in the future.

The Panel members were asked to review four logic chains: longfin smelt (*Spirinchus thaleichthys*), winter-run Chinook salmon (*Oncorhynchus tshawytscha*), and white and green sturgeon (*Acipenser transmontanus* and *A. medirostris*). The Panel focused their efforts on reviewing the longfin smelt and Chinook salmon logic chains because these were the most complete. Although no members of the Panel currently conducts research specifically on any of these species, several have previous experience working in these environments and with estuarine species, and so represent an experienced group of fish biologists and natural resource scientists. Therefore, the Panel reasoned that the logic chain architecture and presentation should be clear and apparent to them, with minimal additional information required and the comments and recommendations provided in this report are based on that reasoning. This report includes some general observations on progress since the previous logic chain review panel and provides some recommendations on logic chain structure, content and use within the BDCP planning process. Key comments and recommendation are shown in bold italics in the text.

3. Progress to Date

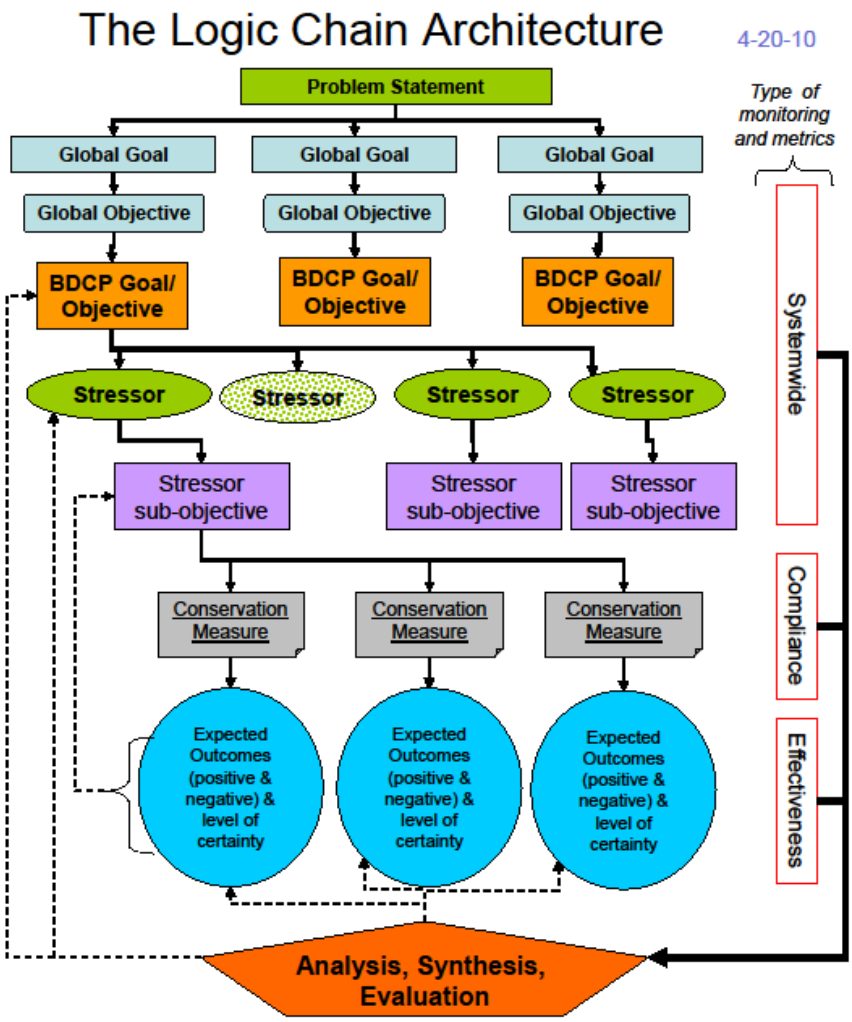
The Panel was impressed with the tremendous amount of work and detail that went into development of the two example logic chains. Conceptually, the logic chain approach will aid in identifying how conservation measures influence the key stressors affecting fish populations in the Delta as well as those affecting the ecosystem as a whole. The Panel appreciated that the logic chain structure enables the chains to capture many of the potential factors affecting the species involved. The two examples reviewed in detail by the Panel (longfin smelt; winter run Chinook salmon) seemed to be relatively complete in terms of accounting for possible stressors, and how conservation measures fit into the overall Bay Delta Conservation Plan. The example logic chains were well thought-out and documented, given the data available.

The Panel also noted that the BDCP team was responsive to the earlier review of the logic chain approach (Dahm et al., 2010). In particular, the two examples and the presentations made by the BDCP team members reflected steps 1-3 proposed in the earlier review. These recommendations were: detailed preparation of logic chains for 2-3 species, development of upper portion of the logic chain (additional comments on this aspect are provided below), and collaborative development of the middle portion of the logic chain. The Panel notes that other comments in the earlier report also were considered, such as the use of metrics that were clearly linked to biological functions for evaluating conservation measures and the inclusion of, and distinction between, compliance and performance monitoring. The use of the conceptual models from the DRERIP evaluation as one of the building blocks for the logic chains, at least at this stage of their development, is endorsed by the Panel.

4. Logic Chain Structure

The Panel recommends several changes to the original logic chain structure (Figure 1) which are described below and in Figure 2. In order to clearly illustrate our suggested revisions, we prepared a hypothetical (and overly simplified) logic chain for longfin smelt (Figure 3) that includes one possible conservation measure.

Figure 1. Logic Chain Structure presented to the Review Panel

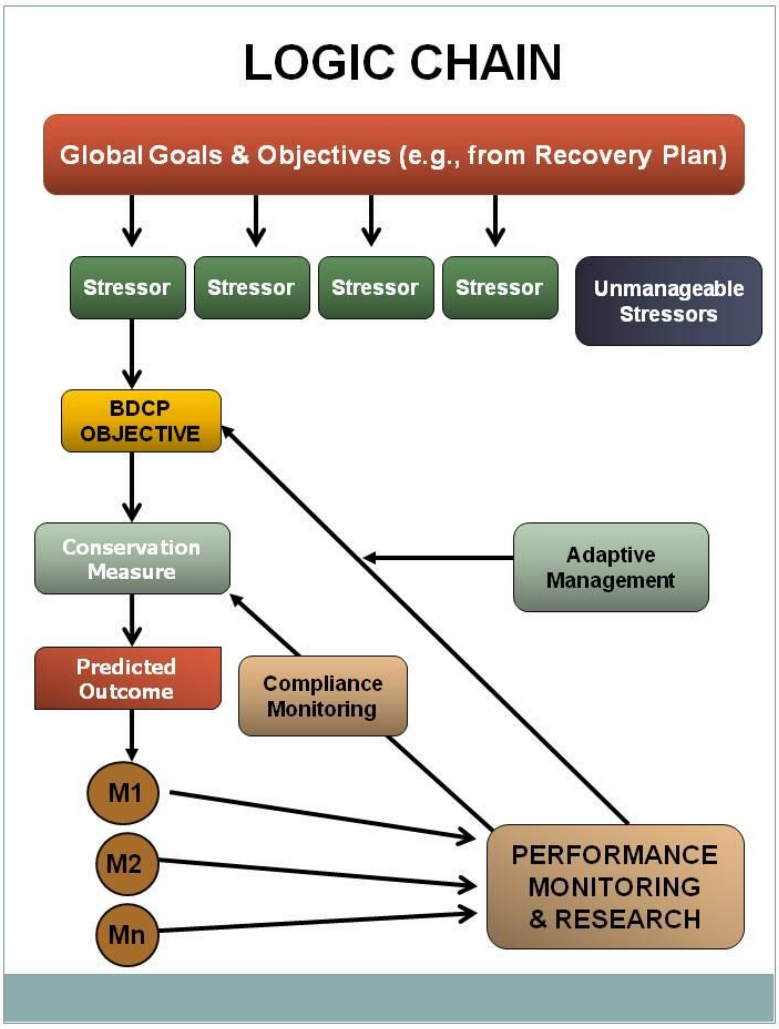


Schematic of the Logic Chain architecture for one species. One stressor (dappled green) is outside of the BDCP purview; thus it has no associated BDCP goal. In this example, stressors and steps below this level refer to one of the BDCP objectives; other BDCP objectives would be developed simultaneously. Similarly, for illustration purposes, only one stressor sub-objective is developed here. Dashed lines refer to different types of evaluations (based on monitoring data) that will be used to adaptively manage within the conservation strategy.

4.1 Goals, Objectives and Stressors

The structure of the upper portion of the logic chains needs to be agreed upon or else the logic chains will be ineffective. The Panel recognizes the importance of all parties agreeing upon a clear statement of goals and objectives and identifying the role of BDCP in achieving them. As presented to the Panel, the logic chains included a problem statement as well as both global goals and objectives and BDCP goals/objectives (Figure 1); this resulted in difficulties in identifying

Figure 2. Proposed Revised Logic Chain Structure. See text for explanation. M1, M2 and Mn refer to an indeterminate number of metrics developed for use in monitoring of the conservation measure and predicted outcomes.



the scale at which conservation measures were to be evaluated (i.e., the global context or a BDCP context). It also appeared to the Panel that the BDCP team was having difficulty resolving some of the wording of the goals and objectives – a very important element of the logic chain approach in that it sets expectations regarding the scope of BDCP 'responsibilities' for meeting the conservation outcomes. The responsibility for species recovery is determined by the ESA, and how recovery is measured is determined by the US Fish and Wildlife Service (USFWS) and NOAA Fisheries. How is the global goal for recovery of endangered species (set by the agencies) linked to the BDCP goals? These links need to be made explicit.

The Panel endorses the recommendation of the previous logic chain review panel (Dahm et al., 2010) concerning the placement of the stressors within the logic chains, and expands on that earlier recommendation here. In the logic chains, BCDP objectives should be linked to specific stressors, and stressors to global goals. For example, for the stressor of "insufficient flow through the Yolo Bypass", the conservation measure would be to increase flows and the BDCP objective(s) could be to increase survival and successful migration of juvenile Chinook salmon, and increase juvenile foraging habitat for sturgeon.

It is important to recognize within the logic chain structure that BDCP will not address all of the stressors identified by the recovery plans. Those not addressed can be grouped together in the logic chain and identified as "unmanageable stressors." It should be clearly stated whether they are unmanageable because BDCP has not identified any appropriate conservation measures, because they are simply not influenced by any management actions under the auspices of BDCP (e.g., they are associated with ocean, or upstream factors), or they are not under management control (e.g., droughts).

To address these issues the Panel recommends the following changes to the upper sections of logic chain structure:

- ***Distinguish between Global goals and objectives set by agencies and "BDCP" goals and objectives.***
- ***Stressors linked to the global goals and objectives should be considered prior to the identification of BDCP objectives.***
- ***Stressors not potentially influenced by BDCP should be explicitly listed in the logic chains.***

The Panel's recommended structure reduces four levels (Problem, Global Goal, Global Objective and BDCP Goal and Objectives) to two levels (Figure 2). The problem in general will be described elsewhere in the Plan and Global Goals and Objectives should be derived from existing recovery plans or provided by resource agencies.

4.2 Monitoring Metrics

The Panel discussed at length compliance and performance metrics for monitoring. It was not clear that the monitoring approach within the logic chains focused on vital demographic rates and population-related parameters that are directly related to rates of population change. The global goals and objectives will relate to the recovery of the species, which the Panel assumes will be assessed by the agencies and that will include some sort of annual abundance index. Compliance and performance metrics would be the responsibility of BDCP. Compliance monitoring is designed to confirm that the conservation measure was achieved, whereas performance monitoring is designed to evaluate how well the expected outcomes of the conservation measure are being achieved[1]. It is critical to utilize performance metrics that reflect the spatial and temporal scales of the specific conservation measure and its expected local biological effect. This not only allows for the success of the conservation measure to be evaluated as part of adaptive management, but also provides information on possible causes of changes in the abundance indices when such changes are detected. However, the Panel does recognize that, in some cases, performance metrics can be based on the annual abundance indices if that is appropriate for evaluation of the effects of a specific conservation measure. Ultimately, local performance measures must be considered in the context of trends in abundance indices to assess the population-level effects of the conservation measure.

Within the revised logic chain structure, multiple monitoring metrics are shown related to each conservation measure and its expected outcome. This performance monitoring can then be used within an adaptive management framework to evaluate BDCP objectives (Figure 2). The revised structure also specifically notes the need for compliance monitoring to determine that conservation measures were implemented as expected. In addition to these clarifications within the logic chain, the Panel recommends that:

- ***Whenever possible, objectives of the chains should focus on measures of individual and population-level performance, such as habitat-specific estimates of growth and survivorship, quantitative estimates of abundance, and quantitative measures of movement and/or distribution.***
- ***The BDCP performance metrics must relate to fish vital demographic rates.***

[1] See Science Advisors Report on Adaptive Management (Dahm et al., 2009) for more on different types of monitoring.

4.3 Explicit Treatment of Uncertainty

The logic chains appeared to take a static approach to ecosystem processes, and did not explicitly consider uncertainty. Yet everyone recognizes that conditions in the Delta are not at equilibrium. The logic chains will likely need to consider variation in physical and biological factors for wet, dry, and "average" years. The concept of tailoring performance metrics to the water year type adjusted for flow variation seems promising. The example logic chains presented to the Panel do not include estimates of either the magnitude or uncertainty associated with a given conservation measure and its expected outcome. Some information on magnitude and uncertainty was presented in the logic chains provided to the Panel as part of the DRERIP evaluations, but it was unclear how this information was to be incorporated into the BDCP logic chains.

The Panel recommends that:

- ***Given the 50-year projected life of the BDCP, issues like climate change and continued invasion by non-native species need to be considered.***
- ***Magnitude and uncertainty estimates should be included to facilitate prioritization of conservation measures and aid in future adaptive management. Estimates of both magnitude of effects and their associated uncertainty can be done in narrative form with supporting documentation.***

4.4 Focus of Logic Chains

The current logic chains are species - based, which is appropriate given that the species involved have different life histories and ecological requirements; however, this separation can only result in successful management when the ecosystem context of the species is explicitly recognized. In addition, there may be both positive and negative effects at the community and ecosystem levels associated with certain conservation measures that are not obvious from piece-wise presentation among species-specific logic chains. This could be achieved by including the community and ecosystem aspects in each species logic chain but broader implications could be lost.
The Panel recommends that:

- ***In addition to covered species, the BDCP Steering Committee should consider developing logic chains that focus on key community or ecosystem properties.***

4.5 Example of Revised Structure

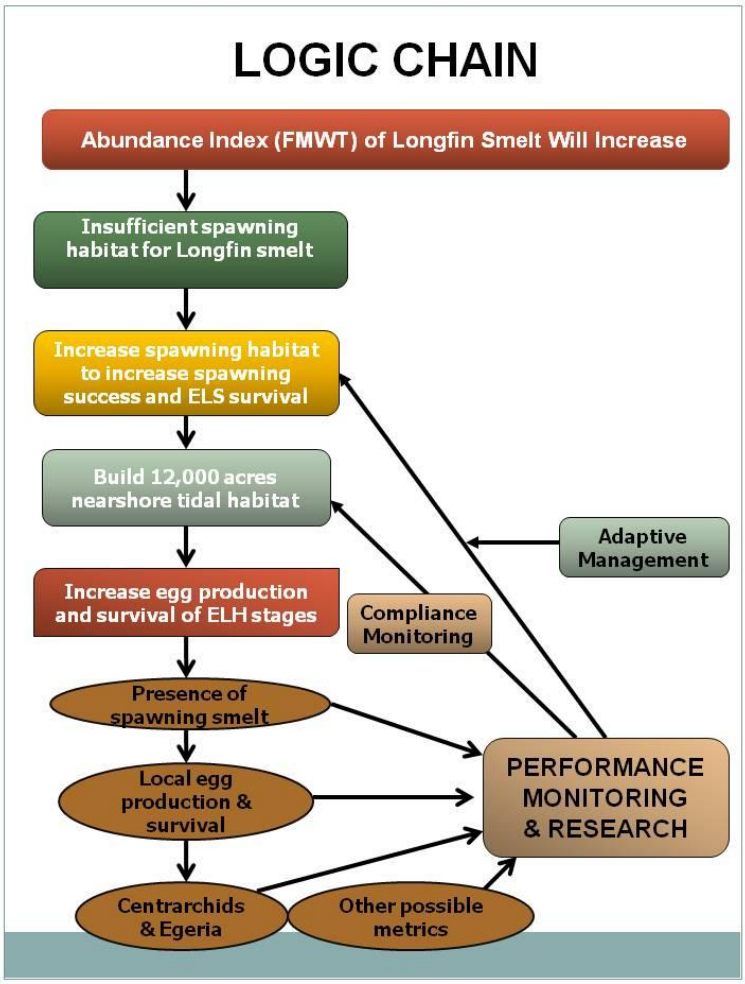
To illustrate the different levels in the revised structure and the linkages among them, the Panel outlined an example application for one line in the chain (i.e., one stressor, one BDCP objectives, one conservation measure for that objective, etc.). This is shown in Figure 3. A completed logic chain would have multiple branches from each stressor, objective, conservation measure and outcome. This example does not include uncertainties as recommended above. These could be identified on the diagram using a color coded key or in supporting narrative.

In our example logic chain (Figure 3), the global goal is to increase the Fall Mid-Water Trawl index and a stressor is insufficient spawning habitat for longfin smelt, and underneath this in the chain is a potential BCPD objective of creating nearshore tidal habitat. The conservation measure deemed to meet that objective was to build 12,000 acres of nearshore tidal habitat to increase spawning, overall egg production and survival of early life stages. Compliance monitoring would involve measuring how many acres were built. Performance monitoring would measure the presence of spawning smelt (i.e., smelt did use the new habitat), quantifying local egg production and survival (i.e., the new habitat is suitable for spawning), and determining whether the new habitat also resulted in increases in invasive competitors and predators such as centrachids and *Egeria* (i.e., were there negative consequences?).

5. Logic Chain Content, Format and Knowledge Base

After evaluating the general structure of the logic chains, the Panel examined the information required to populate (i.e., assign information) and interpret the logic chain. These comments and recommendations pertain to how the information is presented, its sources and how knowledge should be organized to support development and evolution of the logic chains.

Figure 3. Outline Example of Revised Logic Chain Structure for longfin smelt. Refer to text for additional explanation.



5.1 Logic Chain Content

Although the four characteristics that form the basis of the viable salmonid populations (VSP) approach are important in conserving most fish populations, a simpler structure, where some characteristics are combined or down - weighted in importance, would aid in creating more biologically realistic logic chains for species like the two smelts. There may also be other aspects of the logic chains that require a tradeoff between consistency and uniqueness among species. The Panel suggests that greater flexibility be used so that the logic chains can be tailored to each species. The use of the VSP (McElhany et al. 2000) as a framework for the logic chains is good, but may not be ideal for all species. The four parameters highlighted in the VSP are population size, population growth rate, spatial structure, and life history and genetic diversity. The VSP approach is useful because it focuses on the intersection of spatial and temporal scales around which managers make water resource decisions, and over which fish populations and metapopulations carry out their life cycles (e.g., Fausch et al. 2002; Fausch 2010). However, the use of the VSP framework for all species may result in forcing a salmonid-based framework on species for which it is inappropriate. For example, what is known about life-history diversity for Delta smelt, and how important is it?

Terms like "productivity", as used in the Logic Chains, are generic terms, and not sufficiently specific to ensure clear goals or objectives. Clear terms are needed for clear communication. The term productivity allows users to conjure up their own specific meaning. It becomes clear on further reading that the goals really involve vital demographic rates (e.g., reproduction, survival, and growth). The term "production" has a specific meaning in fish population biology. This term refers to the total increase in biomass (fish tissue) within the fish population during a time interval, including that lost through mortality (Chapman 1978). In practical terms, it is the product of the mean biomass in the population times its growth rate, usually measured at rather frequent intervals, especially during the season that fish are growing rapidly. Thus, the units of production are g/m^2/year of tissue produced. Avoid vaguely defined terms and define what is meant.

Great care should be used when populating the compliance and performance monitoring boxes in the logic chain. Three levels needs to be considered separately: 1) the level that addresses the Global Goal, such as measuring adult sturgeon returning to spawning areas or the FMWT index for smelt, 2) the "covered activity" level (e.g., Yolo Bypass), to assess how a specific conservation measure action at a local-to-regional scale affects appropriate abiotic and biotic variables, and 3) compliance monitoring, which measures that the conservation measure was implemented as planned. Dealing with the specifics of the monitoring will have a great influence on the adaptive management and evaluation of the BDCP. The revised logic chain tries to emphasize this by delineating measurements at these three levels. Often, measurements for the first level are used by the USFWS and NOAA-Fisheries to monitor the status of the species. At the second level, although physico-chemical variables can be used as performance metrics, variables that directly relate to fish processes and vital rates must also be included.

In most cases, measuring vital demographic rates as part of performance monitoring is possible, though technically and analytically challenging. For example, for the Yolo Bypass, Chinook salmon smolt output downstream, and adult salmon and sturgeon passage upstream, could be explicitly measured. For smolts, capture-recapture methods (i.e., marking and recapturing individuals) focused explicitly on estimating abundance and survival (where appropriate), and the uncertainty in these parameters (i.e., confidence intervals), have been available for more than two decades (see Burnham et al. 1987; White and Burnham 1999), but application of these methods requires trained field biologists, often large field sampling programs, and biometricians with expertise in analyses of these data (for an example with spotted owl management, see Burnham et al. 1996).

5.2 Logic Chain Format

The logic chain should provide a mechanism by which biologists and decision makers can easily grasp the information, while retaining supporting documents that provide the details about all possible stressors and conservation measures. One solution would be a workshop with technical experts for each species, with the goal of preparing a simpler "influence diagram". In their deliberations, the Panel worked with the example logic chains, and found the extensive and complicated supporting materials challenging to both read and understand. This certainly is a consequence of trying to abstract the critical features from a complex and variable system. Nonetheless, the massive tables of goals, objectives, stressors, conservation measures, and expected outcomes hamper understanding and indentifying key issues for each species, and hence make it difficult for general users to prioritize conservation measures. For example, for winter-run Chinook salmon, restoration of floodplain rearing habitat in the Yolo Bypass is likely a key conservation measure which, if addressed, might have the largest positive effect that could contribute to recovery. Such information needs to be readily identified by logic chain users. This problem could be addressed by the development of a simpler 'influence diagram" (a term borrowed from decision theory, such as use of Bayesian Belief Networks; see Jensen 1996; Marcot et al. 2006) for each chain. The diagram could include: 1) the *key* factors that influence habitat, growth, and survival of the target species at the most important life stages, 2) the *key* stressors that reduce these physical and biological attributes, 3) the options for altering these factors, and 4) how these coalesce to influence the key population performance measures (e.g., persistence of the species or stock). Peterson et al. (2008) provide an example application in a much more circumscribed system.

The Panel suggests adjusting the format of the logic chains themselves to make them more readable. The Logic Chain tables presented to the panel used a vertical format in which the reader attempted to work linearly from top to bottom within a "stressor" column, but soon was faced with Expected Outcomes and Risk Factors that did not seem to belong in the column. For example, in the winter-run Chinook salmon table, Stressor 3 addresses Predators and Invasive/non-native species, with a Sub-objective of reducing predation on juveniles by a given percentage by a certain date from Sacramento to Rio Vista. However, the next item working down the table (an Expected Outcome) states "Removal of old structures was not evaluated by DRERIP", which initially the panel did not understand. Likewise, the metric under the next

Expected Outcome down (OCSM13-P4: Reduce predation) includes two statements "Change in biovolume of *Egeria densa* relative to control areas (#20)," and "Change in areal coverage of water hyacinth relative to control areas (#21)". Overall, it was not clear why old structures, *Egeria densa*, or water hyacinth would influence predation, nor was it very clear that Risk Factors encompassed the idea that various conservation measures might have unanticipated negative effects that would cause problems elsewhere. Although it is possible that some of these things are explained elsewhere in material that the Panel did not read, it would be wise to clarify them more for new users.

The Panel recommends minimizing "insider" information and poorly-defined jargon in the logic chains. If the logic chains are expected to present important information in a way that is accessible to the many parties interested in BDCP, it would seem wise to use simpler and more direct statements that the average biologist or policy maker can understand, rather than codes and terms that are familiar only to BDCP personnel (e.g., OCSM13-P4, or Metric #20). Likewise, one could clearly label Risk Factors as Possible Negative Effects of conservation measures, or something similar. However, it is certainly advisable to hyperlink these simpler statements to documents where codes and details used by BDCP from past analyses and plans are found.

5.3 Knowledge Base for Logic Chain Development

Funds need to be targeted to create and maintain such a repository of data, similar to the National Science Foundation's Long-Term Ecological Research site network. The credibility and usefulness of the logic chains are dependent on the quality of the information used to populate them. There is apparently no centralized repository of data and analysis for species covered by the BDCP, and much is unpublished. This prevents reanalysis of past data, and synthesis of new and past data into useful models. The Panel was struck by the realization that data are often in the hands only of the original investigators, multiple versions of the same dataset exist, and data are susceptible to either physical loss (computer crashes, media deterioration) or retirements (the investigator leaves or dies, and much information and interpretation is lost). Given that these data are all that we have from the expenditure of millions of dollars of research and monitoring over many years, this modest investment in standardizing and protecting that irreplaceable knowledge seems self-evident. Although we acknowledge the need for publication by the primary collectors of the data, a central repository will facilitate subsequent analyses by a variety of scientists that will result in the quickest assessment of the biological processes being described.

The Panel recommends that technical experts identify the key unknown biological attributes of covered species, and a concerted effort be made to provide stable funding to address these knowledge gaps. These studies will require long-term efforts, with adequate funding, but will reap long-term rewards. Availability of information for some species and stressors is limited, and this will ultimately limit the usefulness of the logic chains. The logic chains are only as strong as their weakest link and presently that link is basic life history information for many Delta species. Examination of the example logic chains highlighted how information-limited we are for some species and stressors. The Panel was struck by the lack of key biological

information for some of the covered species and life stages. Key information such as movement patterns and residence times in various habitats (river vs. delta, north delta vs. south delta) for key life stages in a species life cycle, population structure, habitat-specific growth and survivorship rates, diets over the life cycle, and identification of spawning habitat, are essential to populate the logic chains, yet also are missing or weakly known. This is a common problem, and requires a commitment to long-term sampling and focused studies on fundamental biology and ecology of species to be paired with that centered on solving immediate problems related to water management (e.g., survival through pumps and screens).

6. Applying the Logic Chains in the BDCP

The Panel recognizes that the logic chains can provide a useful tool for organizing current ideas and formulating a comprehensive restoration plan to address BDCP goals and objectives. The approach provides more than just a better articulation of the existing goals – it links actions to those goals and lays out expected outcomes. However, to be used as a key building block for the Plan, it is important that the narrative is scientifically credible and that both potential positive and negative outcomes are considered.

To effectively use the logic chains to build the plan, it will be essential to clearly lay out linkages among logic chains, effects analysis, implementation plan, monitoring and research components, and adaptive management. It is clear to the Panel, and those who briefed them, that there need to be feedbacks between the logic chains and the effects analysis. The effects analysis will become a new and important set of data for the Plan, and the process of incorporation of those data in the decision processes and logic chains needs to be described explicitly.

The Panel recommends that BDCP clearly identify the issues raised by the logic chains that can be addressed in the draft Plan (i.e., by November), or addressed during the subsequent refinement phase (e.g., the following year as the Plan is finalized and prior to the formal permit application), and that can only be addressed during implementation. A programmatic approach to research should be developed for early adoption, even prior to permitting, and the post-permitting adaptive management approach must be described and finalized as soon as possible, so that conservation measures and post-implementation monitoring can be refined and developed using that research.

The Steering Committee should consider using a formal decision support system (one that allows for incomplete information, generalized relationships, uncertainties etc) to identify high priority measures and those for early implementation. The panel believes that BDCP will be most successful if an objective process for implementation is developed that acknowledges: 1) the uncertainty of achieving expected outcomes, 2) that not all measures can be implemented immediately, 3) that not all measures will achieve their ultimate outcomes immediately, and 4) that some are contingent on the success of others (perhaps using optimization or other approaches as suggested by the first Logic Chain Panel) to provide more realistic expectations of how the system might change as a result of the implementation of the Plan. Conceptually, developing the BDCP calls for optimization of solutions for multiple objectives, subject to various constraints. Formal optimization, or at least the thinking underlying optimization, can be applied to subsets of measures and specific spatial regions. The Panel recognized that, unless the intent is to implement every conservation measure currently under consideration, some means of discriminating among conservation measures, in terms of their expected outcomes and the certainty of achieving those outcomes, is needed. Such a structured decision process could also consider issues such as cost, feasibility of implementation, and effectiveness in alleviating stressors. At present, the procedures for making decisions are, at the least, unclear. Transparency is especially important due to the complexity of the issues being addressed and the short time

frames within which the Plan is being developed. Although it is unlikely that a formal decision support system could be applied prior to the issuance of the Draft Plan in November 2010, the Draft Plan should include consideration of how such an approach will be used during plan refinement (i.e., post-November 2010).

An adaptive management plan should be developed in sufficient detail for the November Draft Plan so it is clear to all participants which procedures will be used to revise BDCP objectives and how additional information, especially reduced uncertainty, will be incorporated into the Plan during implementation (i.e., revisiting the logic chains). During the Panel meeting there were frequent references to the adaptive management component of the BDCP effort. The nature of the adaptive management plan being proposed by the Steering Committee and how it would be implemented was not clear to the Panel, based on the materials provided. Formal adaptive management, as outlined in Kendall (2001Walters (1986), Stankey et al. (2005), and Nichols et al. (2009), would require clear agreement on the objective to be optimized, and would require specific expertise in decision analysis to apply. As it stands now, adaptive management comes after the Plan has been developed and during implementation, and the Panel is concerned that 'punting' too many difficult issues that far into the future into an undefined process called adaptive management can undermine the credibility of the Plan. Issues deferred to the adaptive management phase should be those which require specific monitoring data, research, and analyses. The more decisions which are left for adaptive management to address, the more important it is that a robust adaptive management plan, in terms of thinking, coordination and funding, be developed.

The Panel recommends a comprehensive articulation of BDCP conservation outcomes based on the logic chains, including their spatial distribution, at decadal intervals to identify targeted outcomes and provide flexibility for changing environmental conditions. Creating appropriate expectations will be important for BDCP. The success of BDCP relies on good science, effective implementation, rigorous monitoring, strong adaptive management, and transparency, and judging the success of the BDCP will be how the results measure up to expectations. On one hand, it is important to emphasize the importance of the positives of the BDCP process. On the other hand, it is also important to ensure that everyone understands what can realistically be achieved and over what time and space scales.

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Attachment 1

Logic Chain Review Panel
August 4-5, 2010
Delta Stewardship Council Office, Bay Room
650 Capitol Mall, 5th Floor
Sacramento, CA 95814
AGENDA

Wednesday August 4th

1. **Advisory Panel meets and reviews charge** (panel only) **8:00 – 8:30**
2. **Presentation on BDCP logic chains, metrics and monitoring** **8:30 – 10:30**
   a. Overview and Context (15 min)
      Laura King Moon, Wayne Spencer
   b. Logic Chains (1 hr)
      Dave Harlow (winter run chinook salmon, longfin smelt)
      Josh Israel (green and white sturgeon)
   c. Metrics and Monitoring (15 min)
      Cliff Dahm

   d. Example Monitoring Framework (30 min)
      Ted Sommer (Yolo Bypass)
      Chris Enright (Suisun Marsh)

3. **Questions and Discussion** **10:30 - 11:30**
   Lunch Break **11:30 –12:30**
4. **Advisory Panel further reviews materials, begins to draft recommendations, and formulates questions** **12:30 – 5:30**

Thursday, August 5th

1. **Advisory Panel meets with BDCP Team with further questions** **8:00 – 10:00**
2. **Advisory Panel refines recommendations** **10:00 – 12:00**
   Lunch Break **12:00 – 1:00**
3. **Advisory Panel Reports out to BDCP Team and takes comments** **1:00 – 4:30**
4. **Advisory Panel discusses next steps and writing assignments** **4:30 – 5:00**