THE LOGIC CHAIN AND ITS USES IN THE BAY DELTA CONSERVATION PLANNING PROCESS
User's Guide – Draft April 20, 2010

BACKGROUND AND NEED

The Bay Delta Conservation Plan (BDCP) is intended to increase water supply reliability for contractors of the State and federal water projects, while simultaneously contributing to the recovery of threatened, endangered, and imperiled ("covered") species that occur in the Sacramento-San Joaquin Delta. The process of developing and implementing such a plan is extremely complex. Restoration planning is complicated by the number and diversity of covered species[1], the physical complexity of the Delta, and uncertainty about the nature and strength of cause-effect relationships operating in this ecosystem. Furthermore, the ecosystem is changing in ways that are relatively well understood (e.g. sea level rise), incompletely understood (e.g. pelagic organism decline), and those that are unknown. Measures designed to facilitate BDCP's dual goals have been, and continue to be, developed and described.

The Logic Chain architecture captures the underlying rationale and assumptions for the conservation measures that comprise BDCP's conservation strategy ("the plan") and establishes benchmarks against which progress can be measured. This approach is intended to increase specificity and clarity regarding: goals and objectives for recovery of covered species; BDCP's contribution to recovery; the assumptions underlying restoration approaches; and the conservation measures and their projected outcomes. Increased clarity and specificity in these components of the Logic Chain will improve our understanding of the data collection, analysis, synthesis, and evaluation processes that enable adaptive management. By articulating what the plan is trying to accomplish and how it intends to achieve its objectives, the Logic Chain architecture facilitates evaluation of the initial plan and assessment of its efficacy during implementation. The Logic Chain sets a context within which adaptive management is applied to achieve BDCP's goals of species restoration and improved water supply reliability.

THE LOGIC CHAIN – HOW IT WORKS

By capturing the answers to a set of standard questions, the Logic Chain architecture provides a means for explaining the challenges facing covered species and how BDCP intends to address those challenges. These questions and their position within the Logic Chain are described below. *The Logic Chain is <u>not</u> designed to identify BDCP legal obligations (e.g. as spelled out in permit terms); rather, it provides the conceptual foundation upon which negotiated permit terms and conditions will be developed*. As our knowledge base grows (through initial evaluation and subsequent implementation of the plan and as a result of ongoing research) the "answers" to these questions will become more specific and accurate, allowing increased efficiency and efficacy in allocation of conservation effort.

LOGIC CHAIN QUESTIONS AND ASSOCIATED TERMINOLOGY

Below are examples of the questions that drive various levels of the Logic Chain. Each question calls for a particular type of information; labels for these Logic Chain components are indicated with underlining and italics and also appear on the attached schematic diagram. Where possible, hypothetical examples illustrate the type of information required at each level of the architecture.

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[1] Twelve "covered" species are identified including: four distinct populations of Chinook salmon, steelhead, two smelt species, two sturgeon species, two lamprey species, and one species of minnow.

As with all "examples" in this user's guide, the specifics are intended for purposes of illustration only

What's the problem? Numerous fish species in the Sacramento-San Joaquin Delta ecosystem are officially endangered or otherwise imperiled; collectively, they reflect a decline in various ecosystem functions. Ecosystem processes (such as flooding, primary and secondary productivity, sediment production) have been radically altered in this ecosystem. _Problem statements_ provide a concise declaration of the various ecological issues that the BDCP is trying to address. Problem statements are general and objective descriptions of the problem(s) and do not assume particular drivers of, or solutions to, those problems.

Example: *Spring run Chinook salmon population abundance, spatial distribution, life history diversity, and productivity have declined substantially from historic levels; as a result, they are listed under state and federal Endangered Species Acts*.

What outcome(s) will solve the problem? The Logic Chain describes species and process-specific *global goals* – general statements that disaggregate the problem statement into its various components. Goals represent desired outcomes that will solve the issue(s) identified in the problem statement. Again, these are simple, factual statements (that rely on the agencies expert opinion) and do not pre-suppose a mechanism for solving the problem. The goals are "global" because they describe outcomes that may be partially or completely beyond the scope of the BDCP. Still, identification of these global goals is important to create a context for the overall conservation plan. Global goals and objectives will be identified by the fish and wildlife trustee agencies (e.g., as identified in the various conservation/recovery plans).

Example: *Global goals for spring run Chinook salmon include substantial increases in their 1) abundance, 2) spatial distribution, 3) life history diversity, 4) population productivity.*

How will we know then the global goal has been attained (what does solving the problem look like)? *Global objectives* provide specific values that describe the desired outcome (goal). Objectives are specific, measureable, attainable, relevant to the goal, and time-bound (S.M.A.R.T.) statements of what level of restoration constitutes attainment of the goal. Global objectives provide a clear standard for measuring progress towards a goal. Again, global objectives may be only partially relevant to the activities of the BDCP; their function is to define the magnitude of the problems so that recovery activities can be appropriately scaled.

Example: *Attainment of the spring run Chinook salmon global spatial distribution goal will occur by 2025 with restoration of self-sustaining populations in _ (# of) watersheds in the Sacramento River drainage and _ (# of) watersheds in the San Joaquin River drainage*.

How does BDCP intend to contribute to recovery of the covered species/ecosystem? Some of the covered species complete most or all of their life cycles in the Delta, whereas other species migrate through the Delta to complete their life cycles in different habitats. As a result, BDCP may not address every one of the global goal/objective pairings for each of the covered species. *BDCP Goals* are those global goals that BDCP intends to address, either partially or fully.

As with global objectives, *BDCP Objectives* are S.M.A.R.T. statements that define attainment of the (BDCP) goal. By presenting a detailed description of BDCP's intention for each species, BDCP objectives will insure that the overall plan is adequate and that conservation measures are prioritized by their ability to contribute to the objective.

Example: <u>BDCP goal</u>: *Improve spatial distribution of spring-run Chinook salmon consistent with that described in the Draft recovery plan.*

<u>BDCP objective</u>: *By 2020, reduce in-Delta physical and/or water quality barriers to migration of spring run adults and smolt to and from their historic spawning grounds by ___%.*

What currently prevents us from attaining the BDCP objectives? Physical, chemical, and biological attributes of the Delta have changed dramatically over the past several decades (and that change is expected to continue into the future). Some of these changes are *<u>stressors</u>* to covered species and important ecosystem processes. However, the precise contribution of each stressor to a species' population decline is uncertain and there is some disagreement over whether particular changes are stressors at all. Also, many of the stressors are interdependent. Because of these uncertainties and the probability that multiple stressors are affecting the ecosystem, BDCP seeks to reduce many stressors simultaneously.

Our knowledge base (data, publications, conceptual and quantitative models) identifies stressors and will be used to organize these stressors by the likelihood and magnitude of their impact. The Logic Chain records the relative likelihood and importance of stressors that are believed to impair populations of the covered species and ecosystem processes. Describing the stressors (and assumptions about them) is a key step in constructing the overall conservation plan and in managing adaptively as the plan is implemented. For example, clear statements regarding where a stressor occurs, which species it impacts, and how certain we are that the stressor is important will help focus BDCP on the relevant stressors and prioritize conservation measures.

Examples: ***1)*** *Entrainment of juveniles at in-Delta water diversions is a stressor to spring-run distribution (and productivity and abundance);*

2) *Low dissolved oxygen levels in the Stockton deepwater ship channel is a stressor to spring-run Chinook salmon spatial distribution;*

3) *Impassable structures on tributary streams are a stressor to spring-run Chinook salmon spatial distribution. Etc.*

[*In this example, stressor #1 and #2 fall within the geographical purview of BDCP and development of solutions might continue through lower sections of the logic chain; stressor #3 is not in the geographical purview of the BDCP, so that thread would not be developed further*]

What will BDCP do to reduce stressors? Stemming from the list of stressors identified for each species and the ecosystem, *<u>stressor sub-objectives</u>* identify the plan's intent to address perceived problems. As with global and BDCP objectives, stressor sub-objectives are S.M.A.R.T. statements that clarify the plan's intentions with regard to different stressors as they articulate a desired outcome resulting from implementation of the conservation measures and the specificity of sub-objectives will increase over time. These sub-objectives reveal the relative effort dedicated to alleviating each stressor and provide a basis for assessing whether the conservation measures will (cumulatively) achieve the stressor reduction objective (see *expected outcomes* below).

Example: *1) BDCP's stressor reduction sub-objective regarding entrainment of juvenile spring run Chinook at in-Delta water diversions is to reduce loss to _% of 1995-2005 levels by 2020;*

2) BDCP's stressor reduction sub-objective regarding impaired spring-run migration in the lower San Joaquin River is to eliminate (frequency of occurrence = 0) critically low dissolved oxygen levels in the Stockton deepwater ship channel during the months of April through June in all years by 2020;

System-wide monitoring metrics and programs will be identified as a means of tracking progress towards plan objectives and sub-objectives. Data from monitoring plans will be collected, synthesized, and evaluated by a special entity (to be defined) that is charged with evaluating plan effectiveness and advising policy-makers about ongoing adaptive management actions.

What will BDCP do to achieve its goals and objectives? The BDCP conservation strategy consists of a number of different actions that address one or more of the stressors identified above for one or more of the covered species (or for the ecosystem as-a-whole). These *conservation measures* must be described in terms of their expected contribution to stressor reduction. In addition, potential negative impacts and other unintended consequences of the conservation measures should be described in the same detail as intended (positive) impacts. Furthermore, the logic chain requires an indication of the likelihood (certainty) that conservation measures will produce their anticipated effects (both positive and negative).

Example: *Conservation Measure __ is highly likely to support the sub-objective of "eliminating critically low dissolved oxygen levels in the Stockton deepwater ship channel during the months of April through June by 2020"; negative biological outcome are believed to be unlikely and low magnitude.*

How will these actions achieve the goals and objectives? In order to understand the value of each action (e.g. to prioritize implementation) and to assess the strength of the entire proposal, BDCP will convene teams of scientists and technical advisors to make detailed quantitative estimates of *expected outcomes* (positive and negative/unintended outcomes that are anticipated) from each conservation measure. Expected outcome magnitudes will be accompanied by estimates of the *uncertainty* surrounding the magnitude. In this way, the potential efficacy of the proposed plan can be evaluated and the plan's actual accomplishments can be assessed as implementation proceeds.

The magnitude of expected outcomes and uncertainties surrounding those outcomes will be based on explicit hypotheses about how we expect conservation measures to work. To the extent possible, conservation measures will be designed, implemented, and monitored in a way that allows testing the hypotheses upon which they are based. Information gathered from *compliance and performance monitoring* will be synthesized and evaluated to assess the validity of different hypotheses and the efficacy of the conservation measures and the overall plan; conservation effort and the array of conservation actions will be adjusted to make continuing progress towards stressor-reduction sub-objectives and overall plan objectives.

How will we know if it's working (and adjust if it's not)? The BDCP conservation strategy is an adaptive management plan; we learn to manage by managing in order to learn. Monitoring at various levels (system-wide, compliance, and measure performance) will capture physical, chemical, and biological changes in the ecosystem in order to determine the effectiveness of the overall plan and its component parts as well as ongoing changes in response to other drivers (e.g. climate change). *Data collection, analysis, synthesis, and evaluation* are critical to BDCP's success. Appropriate methods and management structures for each of these processes will be established as part of the initial plan proposal. Furthermore, the means by which new information (e.g. lessons learned during early stage implementation) is incorporated into adaptive management decisions will be described in detail prior to plan implementation as part of the BDCP governance process.

PRIORITIZATION PRINCIPLES

How should we choose between competing actions? Conservation measures must be prioritized to maximize the effect of limited resources and to insure that the plan is based on the best available information and understanding of the covered species and the Delta ecosystem. Factors that influence the prioritization of conservation measures include:

- Likelihood of positive and negative outcomes
- Magnitude and breadth (number of species affected) of positive and negative outcomes
- Time required to develop and document positive outcomes
- Ability to implement the action (e.g. financial, legal, and logistical constraints).
- Reversibility

These principles are covered in more detail in the plan and are explicitly described as justification for each plan element (conservation measure).