THE LOGIC CHAIN AND ITS USES IN THE BAY DELTA CONSERVATION PLANNING PROCESS
User's Guide – v.3.0

BACKGROUND AND NEED

The San Francisco Bay-Delta and its watershed are home to numerous imperiled species, including (but not limited to) those that are officially protected by the federal or state Endangered Species Acts. The watershed is also the source for much of California's agricultural, municipal, and industrial water supply. Planning efforts to reconcile these two, often competing, demands are underway (e.g. BDCP).

The process of developing and implementing a plan that would allocate sufficient water to meet these different needs 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.

The Logic Chain architecture is designed to (1) standardize terminology used in the planning process, (2) increase clarity and specificity regarding expected outcomes of plan implementation (e.g. to allow evaluation of a conservation plan prior to its implementation), and (3) develop the inputs that will be necessary for a conservation plan's adaptive management program to evaluate efficacy of the plan (post-implementation) and adjust efforts accordingly. This document serves to describe and define teirs of the Logic Chain so there is a shared understanding of terminology, the questions underlying different parts of the architecture, and expectations of a comprehensive plan description.

The Logic Chain articulates a pathway from a plan's Goals and Objectives, to the specific measures designed to achieve those aspirations, to the monitoring, research, and metrics that will capture the effects of the conservation measures, and through an adaptive management process that adjusts conservation effort in light of progress made towards Goals and Objectives. The logic chain captures the underlying rationale and assumptions for the conservation measures that comprise the overall conservation strategy ("the plan") and establishes benchmarks against which progress can be measured. This approach increases specificity and clarity regarding:

- goals and objectives for recovery of covered species;
- the stressors assumed to impede attainment of goals and objectives;
- the plan's intentions for stressor-reduction
- the conservation measures and their projected outcomes
- the metrics that will be monitored and studies performed to assess plan success.

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 conservation strategy is trying to accomplish and how it intends to achieve its objectives, the Logic Chain architecture facilitates both evaluation of the initial plan and assessment of its efficacy during implementation.

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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.

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 a given conservation strategy intends to address those challenges. These questions and their position within the Logic Chain are described below. *The Logic Chain does not identify specific legal obligations (e.g. as spelled out in permit terms or water rights decisions); rather, it forms the basis for determining those obligations*. As our knowledge base grows (through initial evaluation and subsequent implementation of a 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.

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. For each imperiled species and for the ecosystem as a whole, *problem statements* provide a concise declaration of the various ecological issues that the conservation strategy 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.

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 There may be more than one Goal associated with each problem statement. 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 any single plan. Still, identification of these global goals is important to create a context for the overall conservation plan. Global goals and objectives are delineated by the fish and wildlife trustee agencies (e.g., as identified in the various conservation/recovery plans).

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 a particular plan; their function is to define the magnitude of the problems so that recovery activities can be appropriately scaled.

What currently prevents us from attaining the global 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 *stressors* 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.

Our knowledge base (data, publications, conceptual and quantitative models) identifies stressors and will be used to organize these stressors by both the likelihood and magnitude of their impact; the Logic Chain records this essential information. Describing the stressors (and assumptions about them) is a key step in constructing a 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.

Some stressors are beyond our control or beyond what we choose to control. For example, annual weather patterns (unimpaired hydrology) and ocean conditions cannot be impacted by local or regional conservation measures. Similarly, some problems may be beyond the geographical or legal scope of any given conservation plan. These *unmanaged stressors* are described in the planning process for two reasons: (1) so that it is clear that other stressors may ecosystem performance and (2) so that these stressors can be monitored/measured and used to more clearly reveal the true impacts of plan implementation (e.g. they may be used as co-variates in an any analysis of ecosystem performance).

What will BDCP do to reduce stressors? Stemming from the stressors identified for each species and the ecosystem, *Plan Objectives* identify the plan's intent to address perceived problems. As with global goals and objectives, stressor sub-objectives are S.M.A.R.T. statements that clarify the plan's intentions; they articulate a desired outcome resulting from implementation of the conservation measures. These 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).

System-wide monitoring metrics and programs will be identified as a means of tracking progress towards stressor reduction (plan objectives), global goals, and global objectives. Monitoring will also track unmanaged stressors as plan effectiveness will be judged after accounting for variance in these "background conditions" (because, for example, a spate of dry years would be expected to result in low abundance of many species and productive ocean conditions would be expected to contribute to higher returns of anadromous fishes). 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 actions will be taken reduce stressors (achieve the plan's objectives)? The 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).

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, the planning process will convene teams of scientists and technical advisors to make detailed and, where possible, 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 prior to permit issuance and the plan's 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)? Given the uncertainties inherent in managing such a large and complicated estuarine environment, a San Francisco Bay-Delta conservation strategy is expected to employ adaptive management – learning 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 plan 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.

Adaptive management processes are characterized by dashed lines on the attached figure because these processes remain to be defined – the details of how management agencies respond to data and analysis of plan or conservation measure efficacy should be defined as part of the original plan – their description cannot be delayed until plan implementation is under way. In particular, performance targets for conservation measures (*measure targets*), stressor reduction (*stressor targets*), and global goals and objectives (*systemwide targets*) and these targets must be S.M.A.R.T. Procedures for taking action when these measures are not being attained should be defined in advance. For example, how will managers respond when, despite performance-as-expected of conservation measures, stressor reduction targets are not attained?

PRIORITIZATION PRINCIPLES

How should we choose between competing actions? Conservation measures must be prioritized to maximize the effect of limited resources, to provide rapid relief for this ecosystem's imperiled species, and to insure that the conservation strategy is based on the best available information and understanding of the target 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).