STRATEGIC PLAN 12 UNCERTAINTIES

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The following is an excerpt from the ERP Strategic Plan. The Interim Science Board (ISB) is using these as a basis for developing recommendations for the FY 2001 Implementation Plan. The ISB is further defining these uncertainties and identifying specific research questions associated with each. Their recommendations will be presented at the Feb 9, 2000 Ecosystem Roundtable meeting. The ISB recommendations and Roundtable comments will be forwarded to BDAC prior to the Feb 17, 2000 meeting.

ADDRESSING CRITICAL UNCERTAINTIES AND IMPEDIMENTS TO RESTORATION

Decades of scientific study about the Bay-Delta ecosystem have yielded considerable knowledge about ecological relationships and functions. However, significant uncertainties about Bay-Delta ecosystem dynamics still remain, and they hamper our ability to adequately define some ecological problems or to design effective restoration actions for known problems. The following list of issues indicates substantial uncertainties about Bay-Delta ecosystem dynamics that can be addressed by designing actions to test current assumptions and competing hypotheses about ecosystem structure and function. Many of the following issues deal with uncertainty resulting from incomplete information and unverified conceptual models, sampling variability, and highly variable system dynamics. Developing a better understanding of how these factors affect the ecosystem early in the program will help resource managers to design later restoration actions with greater confidence in their ability to produce desired effects.

These issues are not the only ones to consider but must be taken into account to help ensure a successful program.

1. **NONNATIVE INVASIVE SPECIES.** Nonnative Invasive species have had a significant impact throughout the Bay-Delta ecosystem, but it is unclear exactly how they have affected Bay-Delta ecology, such as foodweb productivity, hydrological processes, and populations of native species. It is also unclear to what extent introduced species can be eradicated or controlled effectively. And it is uncertain to what extent introduced species may preclude achieving restoration objectives. In order to minimize the risk of potentially massive ecological and biological disruptions associated with non-native species—disruptions that could threaten to negate the benefits of restoration efforts—it is important to initiate an early program that meets the following goals:

   Prevent new introductions and establishment of NIS into the ecosystems of the San Francisco Bay-Delta , the Sacramento/San Joaquin rivers and their watersheds,

   Limit the spread or, when possible and appropriate, eliminate populations of NIS through management,

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Reduce the harmful ecological, economic, social, and public health impacts resulting from infestation of NIS through appropriate mitigation, and

Increase our understanding of the invasion process and the role of established NIS in ecosystems in the CALFED region through research and monitoring

2. **NATURAL FLOW REGIMES.** Native habitats and species in the Bay-Delta ecosystem evolved in the context of a highly variable flow regime punctuated by extreme seasonal and inter-annual changes in flow. The construction of dams and the diversion of water from Bay-Delta tributaries and the Delta have reduced the variability of the flow regime, especially by reducing peak flows and altering Bay-Delta hydrodynamics. The decrease in the variability of the flow regime is one factor that may be contributing to the explosion of exotic and invasive species, so it is hypothesized that restoring variable flows will help create habitat conditions that favor native species. However, a completely natural flow regime for a river reach below a dam is not possible (because of human water demand) and may not even be desirable since the pre-dam sediment supply has been cut off. The desired conditions below every major dam are likely to be different, suggesting a need for experimental manipulations of flows, including moderate annual floodflows, and habitat to find the right combination of factors that will maximize ecosystem benefits or assist endangered species in ways that are compatible with other uses of water and river corridors.

3. **CHANNEL DYNAMICS, SEDIMENT TRANSPORT, AND RIPARIAN VEGETATION.** There is growing recognition that dynamic river channels, free to overflow onto floodplains and migrate within a meander zone, provide the best riverine habitats. The dynamic processes of flow, sediment transport, channel erosion and deposition, periodic inundation of floodplains, establishment of riparian vegetation after floods, and ecological succession create and maintain the natural channel and bank conditions favorable to salmon and other important species. These processes also provide important inputs of food and submerged woody substrates to the channel. The most sustainable approach to restoring freshwater aquatic and riparian habitats is by restoring dynamic channel processes; however, restoration of natural channel processes is now hampered by the presence of levees and bank protection along many miles of rivers. Below reservoirs, the reductions in high flows, natural seasonal flow variability, and supply of sand and gravel have further exacerbated the constraining effect on rivers with levees and rock banks. It is therefore a priority to identify which parts of the system still have (or can have) adequate flows to inundate floodplains and sufficient energy to erode and deposit, and to identify floodplain and meander zone areas for acquisition or easements to permit natural flooding and channel migration. Sediment deficits from in-channel gravel mining should also be identified and the feasibility or efficacy of augmenting the supply of sand and gravel in reaches below dams should be evaluated.

4. **FLOOD MANAGEMENT AS ECOSYSTEM TOOL.** The current approach is to control floods using dams, levees, bypass channels, and channel clearing. This approach is maintenance-intensive, and the underlying cause of much of the habitat decline in the Bay-Delta system since 1850. Not only has flood control directly affected ecological resources, confining flows between closely spaced levees also concentrates flow and increases flood problems downstream. Emergency flood repairs are stressful to local communities and resources and fish and wildlife and often result in degraded habitat conditions. An alternative approach is to manage floods, recognizing that they will occur, they cannot be controlled entirely, and have many

ecological benefits. Allowing rivers access to more of their floodplains actually reduces the danger of levee failure because it provides more flood storage and relieves pressure on remaining levees. Valley-wide solutions for comprehensive flood management are essential to ensure public safety and to restore natural, ecological functioning of river channels and floodplains. Integrating ecosystem restoration with the Army Corps of Engineers' and the California Reclamation Board's Sacramento and San Joaquin River Basins Comprehensive Study of Central Valley flood management can help redesign flood control infrastructure to accommodate more capacity for habitat while reducing the risks of flood damage.

5. **Bypasses as habitat.** The Yolo and Sutter Bypasses along the Sacramento River are remarkably successful in reducing flooding in urban areas. They are also important areas for farming. The realization of their relatively low-cost benefits to flood control is leading to the consideration of additional bypasses, especially in the San Joaquin Valley (although flood bypasses are not a natural feature of the San Joaquin Valley, unlike the Sacramento Valley). There is also a growing realization that bypasses can be important habitat for waterfowl, for fish spawning and rearing, and possibly as sources of food and nutrients for estuarine foodwebs. For example, when the Yolo Bypass is flooded, it effectively doubles the wetted surface area of the Delta, mostly in shallow-water habitat. Managing the bypasses for the benefit of fish and wildlife, however, may conflict with their use for flood control and farming. Therefore, there is a major need to evaluate existing bypasses as habitat to reduce management conflicts. New or expanded bypasses and managed floodbasins should also be designed with the needs of fish and wildlife in mind.

6. **Shallow-water tidal and freshwater marsh habitat.** Restoration of shallow-water tidal and freshwater marsh habitat has received substantial support as a method to achieve species restoration goals. The underlying assumption is that physical habitat of the kind and at the locations proposed is limiting to the populations of interest and therefore that additional like habitat will increase these populations. This assumption is fundamental to many ecosystem restoration projects, but it has not been tested for many species in this estuary. Furthermore, it is possible that restored habitat will be used by other than the target species, with unknown consequences for natives. The high degree of uncertainty regarding this important topic makes a strong case for an adaptive management approach in which options for design and location, and the species-specific benefits of such restoration, are assessed. Large-scale pilot projects, accompanied by intensive monitoring of the successional changes in physical conditions, vegetation cover, and species utilization, are most likely needed to resolve these uncertainties.

7. **Contaminants in the Central Valley.** Researchers frequently discover in bioassays that waters and sediments in various parts of the Bay-Delta ecosystem are toxic to fish and invertebrates. Although there is only limited evidence connecting these conditions to reductions in abundance, this chronic condition does not seem conducive to long-term restoration. Furthermore, there is an ongoing debate regarding the long-term consequences to human health of chronic exposure to low concentrations of many organic contaminants. It is important to develop a better understanding of how contaminants affect populations of Bay-Delta species to help guide the design and prioritization of prevention and remediation methods.

8. **X2 Relationships.** Current management of the Bay-Delta system is based largely on a salinity standard (the "X2" standard). This standard is based on empirical relationships between various species of fish and invertebrates and X2 (or freshwater flow in the estuary). As with all empirical relationships, these are not very useful to predict how the system will respond after it has been altered by various actions in the Delta, including altered conveyance facilities. This implies a need to determine the underlying mechanisms of the X2 relationships so that the effectiveness of various actions in the Delta can be put in context with this ecosystem-level restorative measure.

9. **Decline in Productivity.** Productivity at the base of the foodweb has declined throughout the Delta and northern San Francisco Bay. Although some of this decline can be attributed to the introduced clam *Potamocorbula amurensis*, or Asiatic clam, not all of the decline is explained. The decline at the base of the foodweb has been accompanied by declines in several (but not all) species and trophic groups, including mysids and longfin smelt. The long-term implications of this seem to be a reduction in the capacity of the system to support higher trophic levels. This implies a limit on the extent to which Bay-Delta fish populations can be restored unless creative solutions can be found to increase foodweb productivity.

10. **Diversion Effects of pumps.** The entrainment of fish and other biota in the CVP and SWP pumps and agricultural water diversions in the Delta and tributaries stimulate conflicts among stakeholders. However, it is not clear to what extent entrainment affects the population size of any one species of fish or invertebrate (Diversion Effects on Fish Team 1998). The CVP and SWP pumps also affect internal Delta hydrodynamics. Delta channel flows can be modified to such an extent that net flows occur toward the south Delta rather than west toward Suisun Bay. Migration cues and rearing functions for juvenile fish can be adversely affected. More information on the effects of entrainment and altered hydrodynamics will be pivotal in choosing a water conveyance method, because it will help determine to what extent an "isolated facility" can be expected to alleviate any problems. Reducing this uncertainty is also essential to ensure the most efficient allocation of restoration funds because proposed solutions to this problem include potentially tens of millions of dollars spent constructing fish screens and new intake facilities throughout the Bay-Delta system, not all of which may be as effective as intended at reducing population declines.

11. **The importance of the Delta for salmon.** Scientific opinion varies on the suitability and use of the Delta for rearing by juvenile salmon and steelhead. Although chinook salmon use other estuaries for rearing, most research on salmon in the Delta, and resulting protective measures, focus on smolt passage; however, if substantial numbers of salmon fry rear in the Delta and these fish contribute substantial recruitment to the adult population, actions to enhance Delta rearing of fry would be warranted. Current actions to protect migrating smolts (e.g., pulse flows) might be supplanted by actions designed to protect resident fry (e.g., extended high flows to flood shallow areas). This topic requires research, including adaptive probing and pilot projects.
12. **Beyond the Riparian Corridor.** Under development.

In addition, two additional topic areas will be included in the PSP.

Local Watershed Stewardship

Background: Watershed stewardship as a critical component of the Bay-Delta solution. Ecosystem restoration projects which are supported by local groups that are community-based, with active local leadership and the participation of diverse interests have a high likelihood of success. The ERP will facilitate the development of locally appropriate, community-based strategies to maintain and improve watershed conditions. These efforts will be focused in watersheds which have a relationship to the recovery of the ecological health of the Bay-Delta and its tributary watersheds and achieve the objectives of the ERP and Strategic c Plan.

Environmental Education

Background: Education programs are important to develop a broader understanding of natural resource conservation issues at the individual and community level. In particular, increased public understanding of the resource issues that lead to the development of the CALFED Bay-Delta program, will increase awareness of these issues and facilitate creative solutions to environmental problems. CALFED education programs may include support for programs for all age groups in rural and/or urban areas.