Delta Vision

Context Memorandum: Delta Ecological Principles

This context memorandum provides critical information about the Delta ecological principles to support policy making. As they are developed, the context memos will create a common understanding and language about the critical factors in establishing a Delta Vision.

This is an iterative process and this document represents the beginning of a dialogue with you about how best to understand these lessons and to inform recommendations by the Delta Vision Blue Ribbon Task Force. You have two weeks to submit comments that may be incorporated into the next iteration.

You may submit your comments in two ways: either online at dv_context@calwater.ca.gov or by mail. If you are using mail, please send your comments to: Delta Vision Context Memo: Delta Ecological Principles, 650 Capitol Mall, 5th Floor, Sacramento, CA 95814.

Your attributed comment will be posted on the Delta Vision web site (http:www.deltavision.ca.gov). Please cite page and line number with specific comments; general comments may be keyed to sections.

Your participation in this iterative process is valuable and important and is greatly appreciated. Thank you for your comments.

Context Memorandum: Delta Ecological Principles
Executive Summary

Iteration 1: July 17, 2007

Executive Summary

The Sacramento-San Joaquin Delta and the Suisun Marsh are important components of the San Francisco Estuary, which is the largest estuary on the Pacific coast and one of the largest in the United States. The Delta is formed by the convergence of the Sacramento, San Joaquin, Calaveras, Cosumnes, and Mokelumne rivers, which drain over 40 percent of the State's land area and convey 47 percent of the State's annual runoff. The Delta is a critical hub in California's statewide system of water management and redistribution, providing drinking water to 23 million Californians and irrigating billions of dollars in crops. Cities and towns around the margin of the Delta are among the fastest growing urban regions in California and many of these cities and towns get their water from the Delta. The Delta is also an important recreation area for this growing population and for millions of visitors.

Besides food, water and a place to play, the Delta provides an array of environmental services to the people of the region and of California as a whole including waste disposal, detoxification and recycling, transportation corridors, recreational and commercial fishing/hunting. The ecological services of the Delta, which are critical to human health and wellbeing, and the unique ecosystems and species of the Delta are threatened by unsustainable use. New, more holistic approaches to the human/environment relationship in the Delta are needed if the loss of services and species is to be halted and reversed. Our concept of the Delta also needs to change from one of a stabile and relatively uniform system to one of a diverse and variable system. This memo describes the ecological foundation for such a new conceptualization. The memo is built around twelve key ecological principles, which are summarized below together with their main policy implications.

Principle 1: The physical environment (hydrology, climate, chemistry, landforms) of the Delta and associated lands establishes the template within which the ecosystem mosaic of the Delta is formed.

Main Policy Implication: Desired species and ecosystems in the Delta cannot be sustained without ensuring that the necessary physical structures and processes are in place to accommodate them.

Principle 2: The natural environment of deltas/estuaries is dynamic and variable and the organisms that live there are adapted to that variability.

Main Policy Implication: Management of the Delta/estuary needs to incorporate enough of the natural variability of estuaries to provide the necessary physical environmental template for native species. Human uses of large parts of the Delta/estuary may have to be changed to accommodate the necessary variability.

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Principle 3: Climate and weather are primary drivers of the physical environment of the Delta/estuary. Due to accumulating greenhouse gases in the atmosphere, global and local climates are changing. California is likely to be warmer and dryer in the future, precipitation in the mountains will shift from snow to rain, storms are expected to be more frequent and more severe, and sea level will rise. These changes in climate and weather will have dramatic effects on the physical template of the Delta/estuary.

Main Policy Implication: Management of the Delta/estuary will need to be robust to change and uncertainty and designed to respond to conditions that may change rapidly. Management tools, such as adaptive management, that recognize uncertainty and use management as a means to learn about the system as well as to influence it need to become standard procedure.

Principle 4: Individual species have particular tolerances for habitat variables like temperature, dissolved oxygen, and toxic substances. These variables have changed in the past (naturally and by human activity) and will continue to change in the future (by climate change, population growth, changing industrial/agricultural practice). Species seasonal cycles (e.g., reproduction, migration) may also be cued by different environmental variables (e.g., day length, temperature, flow, soil moisture). These variables will change in different ways as global climate change proceeds (e.g., temperature and flow patterns will change a lot, day length will not change). The future environment of the Delta/estuary may exceed the tolerance limits of some species or important processes that were cued by different signals (e.g., spring plant growth and the arrival of migratory species) may become uncoupled.

Main Policy Implication: Loss of some species from the ecosystem may be inevitable. However, this should not be an excuse for abandoning policies to conserve native biodiversity. Rather it implies a need for more creative forms of biodiversity conservation, such as establishment of refuge populations where conditions remain suitable.

Principle 5: Humans and human created landscape units are integral to the ecosystem mosaic of the Delta and have profound influence on the overall ecosystem dynamics.

Main Policy Implication: Management of human activity and uses of the landscape and water is integral to successful management and conservation of desired species, ecosystem types and biodiversity in the Delta/estuary.

Principle 6: Primary production (the generation of new carbon compounds through photosynthesis) is the foundation of ecological production and food webs supporting fish and birds in the Delta. Sources of carbon compounds include local production as well as carbon transported into the ecosystem from upstream and from the ocean. Aquatic primary production in the estuary is unusually low for a delta/estuary ecosystem.

Main Policy Implication: Existing levels of aquatic primary production in the Delta/estuary must be maintained and increased if possible.

Principle 7: The potential energy established by primary production can follow a number of pathways in the ecosystem. It can be exported from the system or buried in sediments and effectively lost from the ecosystem. It can be consumed by primary consumers or cycled through microbial decomposition. The primary consumer path provides the most direct route to organisms higher in the food web, such as fish or birds. The microbial decomposition path is a longer, more indirect route in which most of the energy is dissipated through respiration before reaching larger organisms. In the aquatic communities of the Delta, a high proportion of primary production is cycled through the less efficient microbial pathway.

Main Policy Implication: Management and restoration for natural communities should emphasize ways to enhance the direct pathway for energy transfer in the aquatic community.

Principle 8: Competition and predation are fundamental processes structuring the biological community. The effects of these processes tend to cascade down through the food web so that some species near the top of the food web can have a large influence on the structure and dynamics of the community as a whole (keystone species). Humans can act as a new kind of top predator (keystone species) when they exploit commercially or recreationally valuable species in an ecosystem and/or can disrupt system dynamics and structure by introducing non-native species that play a keystone role.

Main Policy Implication: Human actions in an ecosystem always have multiple consequences. Exploiting some species and/or introducing others have far reaching implications for the ecosystem. Constructing roadways or dredging channels have impacts far beyond the local area. Management policies need to be framed in the context of their consequences for the ecosystem as a whole not just in terms of their effects on an immediate perceived problem.

Principle 9: The dynamics of a species is determined by the balance between births and deaths within the population. Populations may decline if birth rates fall or if death rates rise. Birth rates can be influenced by many factors including past levels of nutrition (affecting growth rates and development of reproductive organs), current levels of nutrition (affecting number and quality of offspring that can be produced) and past or present exposure to toxic substances/endocrine disruptors/mimics (affecting both the ability to reproduce and/or the viability of offspring). Quality of the breeding environment (e.g., presence of appropriate cues to stimulate breeding behavior, such as nest building in birds) and, if populations are small, the ability to find a mate can also influence birth rates. Death rates can be increased by exposure to toxic substances (both acute and chronic toxicity), extremes of environmental variables to which the organism is sensitive (e.g., temperature, salinity), being transported to an unsuitable environment (e.g., the export pumps), poor feeding conditions, increased exposure to predators or efficient competitors, and an outbreak of disease. Disentangling the multiple potential causes of a decline (or increase) in abundance of any species is very complex and can be virtually impossible in some circumstances.

Main Policy Implication: Multifactorial, ecosystem based approaches to species conservation are more likely to be successful than approaches that address single high profile "causes". Maintaining ecosystem structure and function appropriate for the species of interest is essential.

Principle 10: The Delta/ estuary is a mosaic of terrestrial and aquatic ecosystems that interact in important ways (e.g., they exchange materials, energy and species). The size, shape, arrangement, and connections among ecosystem patches is critical to the way the Delta/estuary functions. The Delta/estuary itself is an ecosystem patch within the larger ecosystem mosaic of the Central Valley, Sierra and Coastal mountains and the coastal ocean. This concept of ecosystems as a mosaic of patches nested within larger patches has important implications for the way humans manage and interact with the landscape. Human activity changes patch character (marshes are converted to farm land, farm land to urban land), patch size (small farm patches are combined to form large farm patches, urban lands expand, roads and other transportation corridors fragment large patches into smaller patches, etc.), patch connectivity (formerly contiguous patches are separated by a new patch type, formerly isolated patches are connected, etc.) and physical and chemical dynamics within and between patches (discharge of contaminants, organic and inorganic nutrients, etc.).

Main Policy Implication: Management plans and decisions need to be informed by a landscape perspective that recognizes the interrelationship among patterns of land and water use, patch size, location and connectivity, and species success. The landscape perspective needs to be developed at several physical and temporal scales (e.g., patches within the delta, delta within the valley and temporal scales of patch dynamics and evolution). Achieving a sustainable balance of ecosystem services and biodiversity

conservation in the Delta is likely to involve allocating considerably more land and water to support natural and semi-natural systems than is presently the norm.

Principle 11: Invasive species are capable of disrupting ecosystem processes and can have serious negative effects on native species. The Bay-Delta ecosystem is already one of the most invaded ecosystems in the world. The planktonic community of San Francisco Bay has been described as essentially Asian in character with virtually no native species present any more. Particularly damaging invaders in the Bay-Delta (in terms of their effects on the native community) include the overbite clam (*Corbula amurensis*), the Asian clam (*Corbicula fulminea*), Brazilian water weed (*Egeria densa*), water hyacinth (*Eichhornia crassipes*), perennial pepperweed (*Lepidium latifolium*), and the giant reed (*Arundo donax*). A recent arrival that is likely to become a problem is the New Zealand mud snail (*Potamopyrgus antipodarum*) and waiting in the wings are zebra mussels (*Dreissena polymorpha*) and quagga mussels (*Dreissena bugensis*). Invasive species represent one of the most serious obstacles to preservation and restoration of listed native species.

Main Policy Implication: An aggressive approach is needed to address the serious and growing problem of invasive species in the ecosystem. As recommended under the United Nations Convention on Biodiversity, a multibarrier approach should be adopted including effective regulation and monitoring to prevent new introductions, an aggressive program of eradication for newly arrived invaders, and development of efficient control programs for established invaders.

Principle 12: Ecosystems are complex, dynamic, and self-organizing. The Bay-Delta ecosystem is human dominated and any sustainable vision for the Bay-Delta needs to incorporate both the human and the non-human dimensions of the ecosystem. Traditional attempts to manage non-human sub-systems independent of the human sub-system in a sectoral, isolated and incremental manner have inevitably led to a downward spiral of ecosystem services and loss of valued ecosystem components. The current undesirable condition of the Bay-Delta ecosystem is a graphic illustration of this outcome. More holistic approaches to ecosystem management that acknowledge the need to allocate substantial resources to maintain ecosystem integrity and ecosystem services are necessary. This should not be seen as a restatement of the meaningless "jobs vs the environment" cliché. Rather, it is a recasting of the original CALFED vision that we will all get better together. In this case, however, getting better does not mean giving everyone more of what they already have. Rather it means establishing a sustainable balance of ecosystem services and human demands from which everyone will benefit.

Main Policy Implication: Governance for the Bay-Delta should be based on the concept of ecosystem-based management (EBM), a concept that integrates society, economy and the environment. The core elements of this approach were worked out

some time ago (see, e.g., Ecological Society of America, 1995, “The scientific basis of ecosystem management”, Washington, DC). EBM was adopted as the guiding philosophy of CALFED but implementation has been weak. A more aggressive and committed implementation process is needed in the future.