CALFED

TECHNICAL REPORT
ENVIRONMENTAL CONSEQUENCES

SUPPLEMENT TO FISHERIES & AQUATIC RESOURCES

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GLOSSARY OF ENVIRONMENTAL VARIABLES

Environmental Variables. Environmental variables include physical, chemical, and biological features of the aquatic ecosystem. Change in environmental variables affects ecosystem processes and structure and associated species within the aquatic ecosystem. Definitions of environmental variables are provided below.

Flow. Flow includes several parameters directly related to flow volume in rivers, streams, and the Bay-Delta estuary. The parameters include instream flow, net channel flow, and tidal flow. Estuarine salinity, primarily a function of freshwater outflow, is discussed under water quality.

> **Instream Flow**. Instream flow is the rate of water movement past a specific point in rivers and streams. Instream flow is affected by weather, reservoir operations, diversions, tributary inflow, groundwater, and drainage.
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> **Net Channel Flow**. Net channel flow is the rate of water movement, not including tidal flow, past a specific point in the Bay-Delta estuary . Net flow in a Delta channel is affected by weather; tides; tributary inflow, including effects of upstream reservoir operations; diversions; groundwater; flow division to Delta channels, including the effects of barriers and channel morphology; drainage; and potential discharge from future in-Delta water storage facilities. Commonly calculated net flows include Delta inflow, San Joaquin River flow past Jersey Point, and Delta outflow.
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> **Tidal Flow**. Tidal flow is the average channel flow, not including net flow, attributable to ebb or flood tides. Variables related to tidal flow include water surface elevation, tidal excursion (movement of a mass upstream and downstream with the ebb and flood tides), and tidal prism (the volume of water that moves past a location as the result of a change in tidal stage). Local factors affecting tidal flow include morphology of the tidal basin, weather, and Delta inflow.

Surface Elevation of Reservoir Water. Surface elevation of reservoir water refers to water surface elevation at a specific time. The elevation of reservoir water is a function of reservoir inflow, including factors affecting instream flow; outflow as affected by reservoir operations; groundwater percolation; evaporation; and reservoir morphology.

Diversions. Diversion refers to water removed from a water body by pumps, siphons, and gravity. Diversions reduce instream and net flows. Diversion facilities have structural components related to channel morphology, intake design and size, fish screens, debris screens, pilings, and other structures associated with protecting the diversion facility and facilitating operations. The effects of diversions and diversion facilities on fish and the aquatic ecosystem are determined by flow; diversion volume; facility design including fish screens; facility location; channel morphology; water quality; and species interactions, such as predation.

Physical Structure. Physical structure represents the shape and form of the ecosystem, including surface contours; elevation; gradient; and surface features, such as trees, woody debris, rocks, boulders, and bridge abutments. Physical structure also includes substrate. Substrate is defined by physical composition, including particle size and shape; chemical composition; density; erodibility; permeability; organic content, including benthic organisms such as Asian clams; and stability.

For reservoirs, physical structure includes shoreline circumference, surface area, depth, depth contours, rock outcroppings and other substrates, woody debris, and vegetation. For rivers and streams, physical structure includes channel pattern (braided, meandering, or straight); width; depth; meander geometry; cross-sectional profiles; riffle-to-pool ratios; boulders and rock outcroppings; gravel, sand, and clay substrates; woody debris; and vegetation.

Physical structure also includes inlets and outlets, channels, islands, fetch, and exposure. Human-created features, such as barriers, bridge abutments, riprap, gabions, pilings, piers, boat ramps, docks, and artificial reefs, are also part of physical habitat. Barriers are any structures that direct or influence the movement of organic and inorganic material along specific pathways. Barriers include dams, temporary physical obstructions of rock and other materials, gated structures, acoustical barriers, electrical barriers, air-bubble barriers, and louvered barriers. Barriers may affect movement of organisms without affecting flow of other material. Barriers are sometimes associated with diversion facilities and the effects of barriers and diversions may be difficult to separate.

Physical structure is affected over the long term by weather, geology, and geologic events and over the short term by weather; flow; biological processes (for example, burrowing organisms); and human modification, including construction and removal of barriers, dredging, cleaning, or adding gravel, levees, and bank protection. Erosion, deposition, and transport processes affect physical structure over the short and long terms.

Water Quality. Water quality is a broad category that includes chemical, physical, and biological characteristics of water that may be attributable to natural and human-induced conditions. Water quality is influenced by municipal and industrial discharge; agricultural and urban runoff; direct application of pesticides; and dredging or filling operations. Accretion of groundwater in riverflow also may affect water quality by altering levels of dissolved oxygen and water temperature and introducing nutrients and toxicants. Other factors affecting water quality include flow; substrate; physical habitat; and other physical, chemical, and biological processes.

> **Estuarine Salinity**. Estuarine salinity is measured as a specific concentration of salt, in parts per thousand or electrical conductivity units, and by geographical location. Estuarine salinity is a function of mixing ocean water (and therefore "salt") with freshwater inflow and does not include land-derived salinity. Delta outflow, tidal flow, and estuary morphology affect the distribution of salinity in the estuary.
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> **Agricultural Salinity**. Agricultural salinity originates from dissolved salts in agricultural runoff.
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> **Water Temperature**. Water temperature refers specifically to the temperature of water in stream channels, including water released from storage reservoirs. Water temperature is affected by weather; reservoir operations, including operation of multilevel release structures; flow; tributary inflow; groundwater; and physical habitat, including shading by riparian vegetation.
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> **Thermal Pollution**. Electricity-generating plants, sewage treatment plants and other facilities, and agricultural return flows discharge water at temperatures that may exceed the temperature of the receiving water. Discharge from future in-Delta water storage facilities also could exceed the temperature of the receiving water.
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> **Dissolved Oxygen**. Low dissolved-oxygen levels may result from the discharge of organic material, such as treated sewage, to Delta channels. Changes in levels of dissolved oxygen in rivers and streams may result from reservoir discharge drawn from anoxic reservoir strata, reservoir discharge that supersaturates oxygen levels, and accretion of groundwater.

Nutrient Availability. Inorganic nutrients enter the aquatic ecosystem through agricultural runoff and sewage discharge. Nutrients also can enter the ecosystem through natural processes associated with physical processes such as flood events that inundate terrestrial and wetlands habitats, or natural runoff from storm events; chemical processes such as dissolution of substrates; and biological processes such as organic decomposition.

Toxicants. Toxicants have acute and chronic effects and therefore reduce the survival of fish and other aquatic organisms. Toxicants include pesticides, metals, and other chemicals that enter the aquatic ecosystem through agricultural runoff, direct application (such as aquatic weed control), industrial discharge, dredging, mine drainage, sewage discharge, and urban runoff.

Transparency. Transparency is the ability of light to penetrate water. Transparency is a function of the concentration and the chemical and physical properties of inorganic and organic sediments, algae, other organic particles, and dissolved materials. Natural processes (such as flow- and wind-driven mixing and erosion, decomposing vegetation, and algal populations) and human-induced processes (such as dredging, dredge disposal, sewage discharge, and boat wakes) affect transparency.

Species Interactions. Species interactions depend on a broad range of biological factors. Species interactions may change substantially in response to other changes in the environmental variables discussed above.

Predation. Predation occurs naturally; however, fish and other aquatic organisms that are already stressed by toxicants, elevated water temperature, turbulence created by barriers, and other factors may be more susceptible to predation and therefore to additional mortality. Predation also may increase with the introduction of non-native species.

Competition. Species compete when the use of a resource, such as food or habitat, by one individual reduces the availability of the same resource for another individual. Species compete within their own population as well as with other species. As with predation, fish and other aquatic organisms already stressed by other factors may be less able to compete for limited resources, and species survival could decline. The introduction of non-native species with resource needs similar to those of native species may increase competition for limited resources.

Disease. Disease refers to fungi, bacteria, viruses, and other pathogens that may limit species population abundance. The pathogens may be natural or introduced, and the effects may vary depending on interactions with other environmental variables.

Non-Native Plants. Introduction of non-native plants to aquatic habitats may affect species population abundance by modifying substrate, physical habitat, water circulation, and water quality, and by changing species interactions.

Harvest. Harvest includes commercial fishing, sport fishing, and illegal fishing activities that cause or contribute to the death of individuals in a species population.

Artificial Production. Artificial production is the human-aided production of a species in facilities, such as fish hatcheries and rearing pens, that are isolated to some degree from the natural ecosystem. The individuals are released to supplement wild populations and provide fishing opportunities.

FISHERIES & AQUATIC RESOURCES

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