Goals and Objectives of the Salton Sea Species Conservation Habitat Project

1. GOALS AND OBJECTIVES

The Salton Sea currently supports a wide variety of bird species and a limited aquatic community. Over many decades, the components of the aquatic-dependent community have shifted in response to receding water levels and increasing salinity. The current Salton Sea is a hypersaline ecosystem (~50,000 mg/L or 50 parts per thousand [ppt]) (DWR and DFG 2006). Salinity is expected to exceed 60 ppt by 2018, which is too saline to support fish. Declining inflows in future years will result in collapse of the Salton Sea ecosystem due to increasing salinity and other water quality stresses, such as temperature extremes, eutrophication, and related anoxia due to algal productivity.

The most serious and immediate threat to the Salton Sea ecosystem is the loss of fishery resources that support fish-eating (piscivorous) birds. The birds that feed on invertebrates have more options and resources, because the invertebrate fauna has a wider range of salinity tolerances. Piscivorous birds, on the other hand, are at risk of decline and mortality because of the imminent decline and eventual loss of fishery resources due to increased salinity. To address this immediate need, the California Legislature appropriated funds for the purpose of implementing "conservation measures necessary to protect the fish and wildlife species dependent on the Salton Sea, including adaptive management measurements" (California Fish and Game Code section 2932(b)). Therefore, the Species Conservation Habitat (SCH) Project has been designed to meet two goals, detailed below.

Goal 1. Develop a range of aquatic habitats that will support fish and wildlife species dependent on the Salton Sea

The purpose of the SCH Project is to provide replacement for some of the near-term habitat losses that are expected to occur as surface water levels at the sea decline. Therefore, the target species of the SCH Project are those piscivorous bird species present at the Salton Sea in 2010 that are dependent on portion of the sea and its fishery for essential habitat requirements and the viability of a significant portion of their population (see Section 2 below).

Objectives for Goal 1:

a) **Provide adequate foraging habitat for piscivorous bird species** – The SCH Project would provide sufficient prey necessary to support target piscivorous bird species. These include fish of appropriate sizes and accessibility (i.e., not benthic fish that are difficult for birds to capture). These may include non-native fish species that fulfill a key habitat function, such as tilapia, which are currently the most abundant fish in the Salton Sea and the primary forage for piscivorous birds (DWR and DFG 2006). The exact species composition of prey species is less critical than maintaining sufficient quantity of fish for target bird species (e.g., the size and location of prey items) because of the challenging (or narrow) parameters of the Salton Sea. The SCH would also have ancillary benefits for invertebrate-eating birds that use the Salton Sea.

b) **Develop habitats required to support piscivorous bird species** – The SCH Project would develop appropriate physical structure and microhabitat elements to support life history needs of target piscivorous bird species (e.g., snags or snag-like structures for roosting and nesting, sufficient depth for different foraging needs). Habitat elements that are complementary for other aquatic bird species would be included where feasible, such as suitable slopes and substrate near shoreline for invertebrate-foraging birds. However, habitat components that are associated with the tributaries, drains, and surrounding agricultural lands (e.g., riparian habitat, brackish water wetlands) would not be incorporated.

c) **Support a sustainable, productive aquatic community** – A stable aquatic community is one that can recover and persist in the face of short-lived disturbances, with minimal change in species composition and/or food web dynamics. A stable aquatic community will have persistent populations of prey to support those higher trophic-level fish as well as a variety of water-dependent birds. Maintaining a variety of prey species and prey life stages increases the likelihood of resilience and persistence in the face of harsh and variable environmental conditions. The Salton Sea aquatic food chain is characterized by limited diversity but high abundance (DWR and DFG 2006). Measures of the aquatic community include species composition (individual species and functional guilds), population size of fish species, and age/size structure of population (indicator of demographic dynamics and reproduction).

d) **Provide suitable water quality for fish** – The Salton Sea typically experiences wide fluctuations in water temperature and dissolved oxygen on a daily or seasonal basis, variable salinities across spatial gradients, and high concentrations of nutrients from inflows. The SCH Project would be designed to attenuate variations in water temperature, dissolved oxygen, salinity, and nutrient concentrations, to the extent feasible, to within a range that target aquatic species and their prey can survive and persist and/or include habitat components that provide refugia, such as physical habitat structure and microhabitat diversity.

e) **Minimize adverse effects on desert pupfish** – Desert pupfish are a listed species that are found in the Salton Sea and also occupy and move among freshwater and brackish water habitats in tributaries and drains surrounding the Salton Sea. The SCH would be designed to maintain connectivity among pupfish populations (i.e., designed to not block pupfish movement in nearshore habitats that are currently used by pupfish). The ponds would be designed to minimize impacts on the desert pupfish if they became established in the SCH ponds, to the extent possible while maintaining productive forage resources for birds.

f) **Minimize risk of selenium** – Selenium is present in the brackish water supply, and also the sediments and soils in ponds and the Sea. As a result of biological uptake, selenium could bioaccumulate in aquatic and terrestrial species, possibly resulting in reproductive impacts to birds that prey on fish and invertebrates. The SCH ponds would be designed to minimize risk of selenium bioaccumulation. Examples of measures being considered include reduction of selenium concentrations in the influent river water, removal of high concentration sediments from the ponds, and/or managing salinity gradients in ponds to interrupt selenium uptake by vegetation.

g) **Minimize risk of disease/toxicity impacts -** In the past, botulism and avian cholera have resulted in bird die-offs during some seasons at the Sea. The SCH Project would be designed to minimize the potential for these occurrences, to the extent feasible. Measures include regular monitoring of fish and bird health for early intervention and incorporating easy access to remove sick and dead birds.

Goal 2. Develop and refine information needed to successfully manage the SCH Project habitat through an adaptive management process.

In addition to providing much-needed habitat in the near term, the SCH Project would serve as a proof-of-concept for the long term restoration envisioned for the Salton Sea. The SCH Project would incorporate an adaptive management framework to guide evaluation and improved management of the newly created habitat, as well as to inform future restoration efforts. An adaptive management framework provides a flexible decision-making process for ongoing knowledge acquisition, monitoring, and evaluation, leading to continuous improvement in planning, implementation, and management of the project to achieve specified objectives. The information obtained would be used to measure project effectiveness, to refine operations and management of the ponds, to reduce uncertainties about key issues, and to inform subsequent stages of habitat restoration at the Salton Sea.

Objectives for Goal 2:

a) **Identify uncertainties** in achieving the objectives of providing habitat and prey for piscivorous birds (e.g., maintaining suitable water temperature and dissolved oxygen) and minimizing impacts on species (e.g., selenium ecorisk).

b) **Design science-based means** to test alternatives and reduce uncertainty.

c) **Develop and implement a monitoring plan** that measures key indicators of SCH Project performance. Examples include measures of habitat (e.g., area, depth, physical structure, emergent and aquatic plant species/cover, water quality), target species (richness, diversity, abundance, habitat use), trophic function (e.g., composition and density of forage species), and stressors (e.g., water quality, selenium). Other indicators of general ecosystem health may also be monitored to determine other ancillary benefits (non-piscivorous bird species) and/or stressors.

d) **Develop a decision-making framework** to evaluate data, adjust management, and refine operations and monitoring as needed to achieve Goal 1. Because not all the SCH ponds would be constructed at once, information from the first constructed ponds would be used to refine the design and operations of subsequent ponds.

e) **Provide proof-of-concept for future restoration efforts** to verify that the core ideas are functional and feasible prior to full scale restoration of the Salton Sea. The SCH Project would help establish viability, address technical issues, and provide overall direction, as well as feedback for costs and requirements of construction, operations and management.

2. SPECIES SUPPORTED BY THE PROJECT

2.1 Background

The modern Salton Sea formed in 1904-1907 when water diverted from the Colorado River for irrigation broke through a diversion headworks. The Sea was initially a freshwater lake, primarily sustained by inflows of agricultural drain water, but over time has become more saline than the ocean due to evaporation. As the Sea became saltier, marine fish were introduced, but salinity has continued to increase to above the tolerance-level of the introduced marine species. Tilapia entered the Sea from the agricultural drains and proliferated, although current conditions in the Sea have resulted in large die-offs at times. Desert pupfish once inhabited southern Arizona and southeastern California in the U.S. and northern Baja California and Sonora in Mexico. Prior to formation of the Salton Sea, the species inhabited several saline springs in Imperial County and then entered the Salton Sea from those areas. After the Sea formed, migratory birds began to use the Sea, and a number of species became resident there. Due to loss of aquatic habitats elsewhere in the west, the Sea has become important, and in a few cases, essential for some of these bird species. As the salinity continues to increase, habitat values for species dependent on the Sea will be reduced with the potential for regional and international effects on bird populations.

2.2 Aquatic Species

Aquatic organisms that currently or in the recent past comprise the food web supporting fish in the Sea include phytoplankton, zooplankton, and benthic and water column macroinvertebrates. Macroinvertebrate species include diptera (flies), corixids (water boatmen), benthic polychaetes such as pileworms (*Neanthes succinea*) and a spionid worm (*Streblospio benedicti*), amphipods (*Gammarus mucronatus* and *Corophium louisianum*), ostracods (seed shrimp) and a barnacle (*Balanus amphitrite*) (Detwiler et al. 2002, Miles et al. 2009) while zooplankton is dominated by copepods (Miles et al. 2009). These or other species with similar habitat and food web functions would become established or would be introduced into the SCH Project ponds.

Although a number of fish species were present in the Sea while salinity was in the range of marine waters, those fish were introduced for recreational fishing and not as forage for birds. Tilapia that inhabit the Sea are hybrids between the Mozambique tilapia (*Oreochromis mossambicus*) and Wami River tilapia (*O. urolepis hornorum*) (Costa-Pierce 2001). These fish, called California Mozambique hybrids ("Mozambique hybrid tilapia"), are currently the most abundant fish in the Sea and have been extensively used as forage by birds due to their size (many smaller sizes) and location within the water that make them available for bird foraging.

In order to support piscivorous birds, the SCH Project would need to provide fish of a size and quantity that the birds can use. Many of the plankton and macroinvertebrate components of the aquatic food web that supports the fish will be present in the water used to fill the SCH ponds and would multiply there. For species of macroinvertebrates that are no longer present or present in very low numbers (e.g., pileworms and barnacles), inoculation with those species (or species with similar ecological functions) would be considered. Fish species that are currently present, or have been present in the past, and that would be suitable for the SCH ponds include several species and hybrids of tilapia, sailfin molly, and threadfin shad. These species have been selected as the most likely to survive and have the least potential for adverse effects on the desert pupfish. Other prey species could also be used, with the goal of providing sufficient resources to support bird foraging.

2.3 Piscivorous Birds

The SCH ponds would be designed to serve those piscivorous bird species that would experience significant declines if the amount of Salton Sea habitat was substantially reduced. For many of these species, a significant proportion of their population uses the Salton Sea. Examples of those focal species that the SCH ponds would support are shown in Table 1. If the amount of habitat used by these species at the Sea were substantially reduced, some individuals could use other habitats in the region up to their capacity, but it is unlikely that all of the piscivorous birds using the Salton Sea could find suitable habitat elsewhere.

The SCH ponds would also benefit other bird species (Table 2). These species are either not piscivorous (i.e., invertebrate prey is easier to support than fish) and/or only a small proportion of their population depends on the Salton Sea. There are also some subspecies or population segments that would likely use the created habitats as well, such as the least tern (interior subspecies of the California least tern or Mexican least tern, whichever is present at the Salton Sea) and the Baja population of the California brown pelican, which uses the Salton Sea as a post breeding site. While the SCH ponds would provide ancillary benefits for these species, they are not the principal species served by the SCH Project, and therefore, their habitat needs would not be used as criteria for design.

Table 1 Focal species of piscivorous birds that would be served by the SCH Project

Species	Food	Notes
American white pelican	Fish	33% North American of population winters at the Salton Sea; does not plunge dive - dips bill into water. Favors shallow bays with forage fish and exposed loafing sites. Forages on small to moderately large fish in shallow water 0.3 to 2.5 m deep.
Black skimmer	Fish	Largest breeding population at the Salton Sea. Colony nester in open sandy areas or gravel or shell bars with sparse vegetation. Forages on small fish in water less than 20 cm deep within 2 m of land.
Caspian tern	Fish	Largest breeding population at the Salton Sea. Forages on small fish by plunge-diving, typically along coast or shoreline over waters 0.5 to 5 m deep. Colony nester among driftwood and debris on low flat sandy or rocky islands.
Double-crested cormorant	Fish	Largest breeding population at the Salton Sea. Dive from surface and hunt for relatively small fish underwater. Forage in shallow water less than 8 m, typically less than 30 km from colony. Nest in large colonies. May nest on mats of emergent vegetation and may nest in trees standing in or near water.

Table 2 Other bird species that could use the SCH Project

Species	Food	Notes
Eared grebe	Invertebrates in water, especially nereid worms	90% of population winters at the Salton Sea. Gleans from submerged rocks and vegetation, feeding in upper 9 m or less.
Gull-billed tern	Fish and invertebrates; does not depend on fish.	Breeds only at the Salton Sea and San Diego Bay. Nests on eroded earthen levees and gravel and barnacle islets or on constructed islets in shallow brackish impoundments. May hawk for insects; does not plunge dive but gleans from water surface.
Western snowy plover	Invertebrates at shoreline	Largest wintering population in interior U.S. at Salton Sea; also one of few key interior breeding locations. Needs unvegetated to sparsely vegetated beaches and shore for nesting. May locate nest near some feature such as a piece of kelp or small plant. Feeds in shallow (1-2 cm) water or on wet mud or sand.

Table 2	Other bird species that could use the SCH Project	
Ruddy duck	Invertebrates in water	50% of population migrates through the Sea area; large breeding population at the Sea. Occur in the open water but the majority is near the brackish river mouths. Forage by diving and occasionally by skimming the water surface. Nest is well concealed in dense emergent vegetation.
Black tern	Fish and insects in air	Salton Sea is one of its most important migratory stops. May hover and then dip bill into water to pick insects or fish. May catch insects in the air.
California brown pelican	Fish	Forages in shallow waters. Captures by plunge-diving. Loaf during the day after foraging. It is a postbreeding visitor to the Salton Sea with a small group breeding. The population occurring at the Salton Sea likely comes from the Gulf of California population.

3. REFERENCES

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