SECOND DRAFT

Strategic Plan

Long-Term Disease Prevention and Control at the Salton Sea

BACKGROUND

Avian disease at the Salton Sea is a chronic problem resulting in an annual loss of several thousand birds. Major epizootics, that have occurred during the 1990's with increased frequency relative to past decades, greatly increase the level of losses. During 1992, more than 150,000 eared grebes (Podiceps caspicus) died during a single event of undetermined etiology. The deaths of thousands of white pelicans (Pelacanus erythrorhynchos) and more than 1,000 endangered California brown pelicans (P. occidentalis) during 1996 from type C avian botulism focused national attention on the Salton Sea. That event served as a catalyst for initiation of the current Salton Sea Restoration Project. Other diseases impacting birds of this ecosystem are avian cholera, Newcastle disease and salmonellosis. Algal toxins are a suspect but unproven cause of grebe mortality. Avian cholera is an annual event and appears to be primarily impacting waterfowl and eared grebes. Newcastle disease has devastated the Mullet Island double-crested cormorant (Phalacrocrax auritus) breeding colony at least twice during the 1990's. Salmonellosis has primarily been a cause of mortality in breeding colonies of egrets. Several other diseases have also been diagnosed as contributing to avian mortality at the Salton Sea.

Efforts to combat disease at the Salton Sea have in the past been largely crisis response by the U.S. Fish and Wildlife Service (FWS) with support also provided by the California Department

of Fish and Game (CDFG). Those reactive efforts of the past have been replaced by an initiative of the Salton Sea Restoration Program to provide early detection of disease emergence as a critical first step for minimizing losses. That effort is collaborative with the Sonny Bono Salton Sea National Wildlife Refuge and is structured by the conditions of the Memorandum of Understanding (MOU) established for that purpose. An additional MOU was entered into between the Salton Sea Authority (SSA), on behalf of the Restoration Program, and the U.S. Geological Surveys National Wildlife Health Center (NWHC). That MOU provides essential technical assistance such as disease diagnostic support and disease control guidance.

OBJECTIVE

The efforts and activities identified above are important first steps but by themselves are not sufficient to address disease impacts relative to the Restoration Project Goal to:

"Provide a safe, productive environment for resident and migratory birds and endangered species."

A fully integrated approach towards disease that provides a continual interface between environmental monitoring, disease surveillance and response and scientific investigations of diseases ecology is needed. The added dimension of wildlife rehabilitation must also be provided for because of the avian botulism problem in pelicans at the Salton Sea. Therefore, the goal for the long-term disease control effort is to:

Provide an integrated approach to wildlife disease (including fish and birds) at the Salton Sea through methodical monitoring of environmental conditions; early detection,

diagnosis and response to disease events; collection and rehabilitation of afflicted wildlife and development of enhanced understanding of disease ecology at the Sea in a manner that enhances opportunities for management actions to minimize disease occurrences and the magnitude of losses associated with disease events.

APPROACH

Disease is an outcome rather than a cause. The basic model for considering diseases has three primary factors: susceptible hosts; agents capable of causing illness or death; and environmental factors that facilitate or cause host-agent interactions in a manner that results in disease. Disease prevention and control is generally oriented at defining the relations between those primary factors for the purpose of identifying what types of intervention will be most effective and cost efficient (Figure 1). The rather straightforward concepts just noted are often complicated by interactions that can effect any of the primary factors and must be understood for effective intervention to occur in addressing disease. Thus, effective disease prevention and control generally requires a multi-functional integrated approach.

The level of success in combating disease will be largely dependent upon the cumulative capabilities and knowledge gained from a balanced, fully integrated approach. Each program component (Table 1) provides unique contributions but individually, none of those components can accomplish what is needed. As individual efforts, each component becomes a perpetual activity of varying but limited impact. However, the collective contributions from an appropriately integrated program effort will result in the type of synergistic contributions needed for minimizing losses from disease at the Salton Sea. That type of cohesive approach is also

cost-effective and efficient because it minimizes duplication of effort and facilitates methodical and timely evaluations for guiding Restoration Project efforts. Organization and the conduct of that type of program must fully take into account the stewardship roles of the multiple agencies with responsibilities for species and habitat management within the Salton Sea ecosystem.

PROGRAM COMPONENTS

<u>Disease Surveillance</u>: Early detection of wildlife mortality events is a critical first step for minimizing losses that may occur. Methodical, on-site observations conducted at appropriate locations and within scheduled time intervals facilitates detection at the most manageable time for disease events. The size of the Sea, weather and other factors requires the employment of multiple methods to accomplish this labor-intensive activity.

<u>Diagnostic Services</u>: Observations of sick or dead wildlife must be translated into a determination of the disease agent. Rarely will field observations be sufficient to adequately assess the disease present. Disease spread rather than containment may be the outcome from improper judgments relative to the disease present because different approaches are often needed to contain different types of diseases. Disease diagnostic laboratories provide the types of evaluations needed. The rapidity in which disease can spread requires timely receipt of appropriate specimens by the laboratory and timely response back to those at the Salton Sea.

<u>Field Response</u>: Timely field evaluations and some organization of disease control efforts can be initiated prior to a preliminary or final diagnosis being received from the diagnostic laboratory.

That should be done by disease specialists. The major burden for the highly labor intensive disease control effort is borne by management agencies with responsibilities for the species involved. When major disease events erupt the field response can last weeks to months and involve large numbers of people and have major equipment needs to support the disease control effort.

<u>Wildlife Rehabilitation</u>: Avian botulism is a major disease problem affecting pelicans and other fish eating birds at the Salton Sea. When sick birds are collected early in the disease process a high percentage of those birds can be successfully treated and returned to the wild. The number of pelicans retrieved from the Salton Sea is high (Figure 2) and substantial numbers of those birds have been successfully rehabilitated. The success obtained has been due to early detection of outbreaks, timely collection of sick birds, veterinary and other clinical care provided, special facilities built at the Refuge to handle those birds and the collaboration established with private sector wildlife rehabilitation programs. Further development of this component of the program is being pursued by the U.S. Fish and Wildlife Service.

<u>Focused Investigations</u>: Research on the ecology of the various diseases present at the Salton Sea, monitoring environmental factors for disease risk assessments, development of enhanced capabilities for disease control and other solution oriented investigations are among the activities associated with this program component. Findings from the other program components guide what focused investigations need to be undertaken (Figure 3).

<u>Environmental Management</u>: The insights gained from the collective findings of the other components of the long-term disease prevention and control program are applied in the environmental evaluations, adaptive management and other Restoration Project goal oriented activities undertaken. This component of the long-term disease program includes ecosystem modeling and evaluations of the impacts of management actions on reducing losses from disease and minimizing the probability for disease outbreaks to occur (Figure 3).

PROGRAM COORDINATION

The Salton Sea Science Office will serve as the coordinating body for the long-term disease prevention and control program. The Science Office will provide general guidance for program direction in the context of achievement of the Salton Sea Restoration Project goals. A great deal of coordination and inter-organization collaboration will be required for program success (Figure 4). Various committees and advisory groups will assist the Science Office in carrying out that task. Strategic planning documents in the form of a disease prevention and control plan with 5 and 10 year benchmarks and an Annual Work Plan that integrates the disease program coordination will also be facilitated by the development of a common-use Science Office field facility at the Sonny Bono Salton Sea National Wildlife Refuge.

PRIORITIES

Avian botulism is the disease of highest priority for the Salton Sea Restoration Project. It is important that a sound understanding of the ecology of that disease at the Salton Sea be obtained as fundamental knowledge for management of the Sea in a manner that minimizies the potential

for avian botulism outbreaks. Wetland development, modification of existing wetland areas and fluctuating water levels are all situations likely to occur that will need to be addressed by the Project. In addition, the existing water chemistry will be a focus for change. All of the conditions just noted have been associated with avian botulism. Therefore, guidance must be provided relative to how to address those and other conditions to minimize the potential for avian botulism outbreaks..

Type C avian botulism has been present at the Salton Sea since at least the mid-1920's. The spores of <u>Clostridium botulinum</u> are widely distributed throughout this environment and are dependent upon appropriate environmental conditions and co-factors for their germination and processes leading to disease events. However, the Salton Sea is unique in having an aberrant expression of type C botulism involving pelicans and perhaps some other fish-eating birds. Different biological processes are involved in classical outbreaks of type C botulism than are involved for this disease in fish-eating birds. In addition, type E toxin has also been detected in sediments of the Sea. Far less is known about the ecology of type E than type C botulism. An added dimension is that type E is a human pathogen. Thus, avian botulism presents a complex situation and is directly related to environment conditions at the Sea. Unless the ecology of this disease in its various forms is adequately understood efforts to provide a safe and productive environment for birds could result in the opposite outcome. Also, actions taken to address other goals of the Restoration Project could result in increasing problems associated with avian botulism.

The second highest priority relative to avian disease is resolving the continual attrition of eared grebes and ruddy ducks (<u>Oxyura jamaicensis</u>). The Salton Sea is an important wintering area for both species, and both are experiencing substantial losses. Avian cholera is responsible for some of that loss, but in general, the true magnitude of losses, their causes and periodicity of mortality are poorly understood.

An additional high priority is the need to determine the epizootiology of Newcastle disease at the Salton Sea. Outbreaks appear to be confined to double-crested cormorants nesting on Mullet Island. Snag-nesting cormorants at other locations at the Sea have not been diagnosed with Newcastle disease. Mullet Island is the only island at the Sea for ground nesting birds and has been used by species other than cormorants, including attempts by brown pelicans to colonize the island. Hazards posed for other species are unknown, despite their susceptibility to Newcastle disease virus. Also, if water levels recede much at the Sea, Mullet Island will be lost as an area for breeding birds because of predation that will occur due to a land bridge being formed with the shore. Developing new islands to provide replacement breeding habitat could be done. However, if Newcastle disease is likely to be a problem on such islands that approach becomes highly questionable. Understanding the ecology of Newcastle disease at the Sea is important for informed risk assessment to guide management actions.

The remaining avian disease problems currently identified at the Salton Sea, while in need of study, are of lower priority than the priorities just noted. As progress is made towards gaining the understanding needed to manage the Sea in a manner that minimizes losses associated with the three high priority situations, greater attention should be given to salmonellosis. In the

interim, surveillance should be maintained to determine whether the pattern of sporadic outbreaks of salmonellosis changes. If frequency increases this disease will need to be given greater attention because it is a human pathogen. Similarly, it is important to maintain adequate surveillance of disease occurrence to provide early detection of emerging new disease problems and enhancement of existing diseases.

DISCUSSION

The Salton Sea Restoration Program is addressing a major ecosystem health problem that is inpart expressed through occurrences of mortality events among the wildlife inhabitants of that ecosystem. Wildlife mortality is an important indice for evaluation of the success or failure of the Restoration Program. However, the Restoration Program cannot, and should not, replace the functional and wildlife stewardship roles of the agencies with statutory responsibilities at the Salton Sea. Therefore, unless those agencies also place high priority on combating wildlife mortality at the Sea through the investment of their resources, significant progress in minimizing losses from disease will not occur until the Restoration Project has advanced well beyond the initial phases of the restoration effort.

The majority of costs associated with response to disease outbreaks lies with the natural resources agencies and involves necessary reactive actions on behalf of our wildlife resources. Those actions do not resolve the causes resulting in the outcomes of disease. However, there is great value in integrating those activities with a broader approach towards disease. The enhanced information gained and applications of that information provide for greater capability for combating disease from a preventive as well as a response mode. Fiscal resources of \$500,000 annually are needed by the Science Office to provide the enhanced effort just noted. In

addition, there is need for a one-time appropriation of one million dollars to construct and provide equipment for a common use field facility at the Sonny Bono Salton Sea National Wildlife Refuge. That facility will provide physical support capabilities needed for the longterm disease prevention and control program.

Component	Basic Requirements	Primary Contributions
Disease surveillance	Methodical, timely on-Sea monitoring.	Early detection of problems; important initial step for combating disease.
Diagnostic Services	Team of specialists in appropriate scientific disciplines; specialized facilities.	Timely and accurate evaluations of causes of mortality events.
Field response	Work force and equipment for carcass clean-up and disposal; disease specialists for guidance.	Disease control to minimize losses.
Wildlife rehabilitation	Work force, equipment and facilities for bird retrieval, handling and housing; specialists for clinical treatment.	Recovery of substantial numbers of birds that would otherwise die; endangered species are involved.
Focused investigations	Scientists with appropriate expertise, facilities, equipment and support base.	New information, enhanced understanding and capabilities for addressing diseases of concern.
Environmental management	Capabilities to alter environmental conditions and evaluate results through measurements and other means.	Application of technical knowledge to address disease problems.

Table 1. Program components for long-term disease prevention and control at the Salton Sea.



Figure 1. Susceptible hosts, agents capable of causing disease and environment are the basic factors generally involved in disease events. (A) disease (hatched area) is an outcome of environmental conditions that facilitate host-agent interactions in a manner that causes disease. Disease prevention and control generally focuses on: (B) making the host immune to the disease agent by the use of various barriers (i.e., vaccines); (C) destroying the disease agent (i.e., disinfectants); or (D) environmental management that minimizes the potential for host-agent interactions.



Figure 2. Numbers of sick and dead pelicans retrieved from the Salton Sea, 1996-2000.



Figure 3. Functional relations between components of a long-term disease prevention and control strategy and between that strategy and Salton Sea Restoration Project goals.



Figure 4. Inter-organization collaboration and coordination needed to overcome (\longrightarrow) disease problems and achieve Restoration Project goals and objectives. Lack of collaboration and coordination (\longrightarrow) will result in disease being a major barrier obstructing goal achievement.