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THE SALTON SEA: A CONSERVATION CONUNDRUM OR PARADIGM FOR SUCCESS?

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Abstract. Despite current broad support for improving the ecological health of the Salton Sea, the outcome of proposed plans, if adopted, is uncertain. History tells us that the depth of scientific knowledge of an area is not necessarily an accurate predictor of the success of conservation efforts. While the opportunity is ripe for adaptive management to ensure healthy bird and fish populations at the Salton Sea, many challenges must be met to accommodate various, perhaps mutually exclusive, restoration objectives, including providing water of sufficient quality in an arid state with a large and rapidly expanding human population, maintaining the Sea as a repository for agricultural and urban wastewater, controlling salinity, reducing eutrophication, and enhancing recreation and economic opportunities. It will be particularly difficult to return the ecosystem to a self-maintaining state, as intensive long-term management appears to be necessary. Salton Sea restoration should be part of a binational effort to restore lost and degraded wetland, riparian, and terrestrial habitats throughout the entire Colorado River Delta region. For effective management, scientific advancement at the Salton Sea must be coupled with bridging the social and natural sciences via scientific engagement in the political and regulatory processes. Long-term and broadscale conservation of waterbird populations in western North America must involve training of scientists in landscape-level thinking and the ability to apply political solutions and management knowledge to real world problems. Such efforts will be enhanced by addressing the root problems of our environmental crisis—overpopulation and overconsumption. Major paradigm shifts are needed in the scientific community's willingness to directly engage in societal problem solving and in the public's appreciation for intact natural ecosystems as well as highly managed ones that provide alternative habitat for wildlife.

Key Words: adaptive management; connectivity; conservation training; paradigm shift; self-maintaining processes; societal engagement.

EL MAR SALTON: ¿ENIGMA DE CONSERVACIÓN O PARADIGMA DEL ÉXITO?

Resumen. A pesar del amplio apoyo actual en favor de mejorar la salud ecológica del Mar Salton, es incierto el resultado que tendrán los planes propuestos si éstos se adoptan. La historia nos dice que la profundidad del conocimiento científico de un área no permite necesariamente predecir acertadamente el éxito de los esfuerzos de conservación. A pesar de que existe una buena oportunidad para un manejo adaptativo que asegure la presencia de poblaciones saludables de aves y peces en el Mar Salton, deben superarse muchos desafíos que implican consensuar múltiples objetivos de restauración, tal vez mutuamente excluyentes. Éstos incluyen la provisión de agua de buena calidad en un estado árido con una gran y creciente población humana, el mantenimiento del mar como un sumidero de agua de desecho de las actividades urbanas y de la agricultura, el control de la salinidad, la reducción de la eutrofización y la mejora de las oportunidades económicas y de recreación. Será particularmente difícil retornar el ecosistema a un estado de auto-mantenimiento, dado que parece necesario desarrollar un intenso plan de manejo a largo plazo. La restauración del Mar Salton debería ser parte de un esfuerzo binacional para restaurar los humedales, las áreas riparias y los ambientes terrestres perdidos y degradados en toda la región del delta del Río Colorado. Para un manejo eficiente, el progreso científico en el Mar Salton debe combinarse con la interacción de las ciencias sociales y naturales a través de la participación científica en los procesos políticos y regulatorios. La conservación a largo plazo y en gran escala de las poblaciones de aves acuáticas en el oeste de América del Norte debe involucrar el entrenamiento de los científicos en pensar a nivel de paisaje y en la habilidad de aplicar soluciones políticas y conocimientos de manejo a los problemas del mundo real. Estos esfuerzos se verán beneficiados si se refieren a los problemas de raíz de nuestra crisis ambiental: sobrepoblación y consumo desmedido. Se necesitan cambios importantes de paradigma en la predisposición de la comunidad científica a involucrarse directamente en resolver problemas sociales y en el aprecio público por ecosistemas naturales intactos y sistemas manejados que provean ambientes alternativos para la vida silvestre.

Palabras clave: cambio de paradigma; compromiso social; conectividad; entrenamiento en conservación; manejo adaptativo; procesos de auto-mantenimiento.

Within the Colorado River Delta region (Figure 1 in Patten and McCaskie *this volume*) there has been extensive loss and degradation of wetland, riparian, and terrestrial habitat on both sides of the U.S.-Mexico border, particularly in the Salton Sink (Patten et al. 2003) and the Delta itself (Anderson et al. 2003, Cohen et al. 2003). This diminishment of wetland and riparian habitat stems mainly from water diversions and development to meet the agricultural and urban needs

of ongoing human population expansion in the southwestern United States, northwestern Mexico, and the coastal plain of southern California (Cohen et al. 2003). Overallocation of water has left remaining wetland and riparian habitats in the lower Colorado River region dependent on wastewater returns or irregular releases of floodwaters that exceed upstream diversion capacities. Beyond inadequate water supplies and direct habitat destruction, known and potential threats to the region's birds and habitats include salinization, eutrophication, contamination, introductions of exotic plants and animals, elevated occurrence of diseases, and human disturbance (Anderson et al. 2003, Cohen et al. 2003, Mora et al. 2003, Rocke and Friend 2003). Because the water supply and threats to wildlife transcend international borders, there is a recognized need for binational management and conservation planning to restore wildlife habitat in the Colorado River Delta region (Anderson et al. 2003, Cohen et al. 2003). Although to date such binational cooperation has been limited, the opportunities for it are great, and some progress is being made at the local and regional level on both sides of the border.

A series of events in the 1990s, including large-scale bird die-offs that aroused extensive media attention coupled with the death of a congressman championing environmental cleanup and economic development, catalyzed renewed interest in restoration of the Salton Sea (Garrett et al. *this volume,* Molina and Shuford *this volume*). Regardless of whether people considered the Salton Sea a natural ecosystem or an artificial one maintained by agricultural wastewater (Patten and Smith-Patten *this volume*) but serving as *de facto* mitigation for extensive wetland loss and degradation in the region, there soon developed widespread support for managing this ecosystem to counteract increasing salinity, eutrophication, large-scale bird die-offs from diseases and unknown causes, and potential risks from contaminants of agricultural and urban runoff (Tetra Tech 2000). The blueprint for successful management, however, is still being developed. Because of the massive scale of proposed projects and competing restoration goals, it remains unclear if efforts at the Salton Sea will serve as a model for successful restoration throughout the Colorado River Delta region or whether because of the ecological and political complexities it will remain an unsolvable conservation conundrum.

HISTORICAL PERSPECTIVE

Historically, there was limited knowledge of the status of birds at the Salton Sea (Patten et al. 2003, Garrett et al. *this volume*). Jehl (1994) concluded from a review of avifaunal changes at eight saline or alkaline lakes in western North America, including the Salton Sea, that scanty historical records precluded detailed analyses of faunal changes, and even if data existed they would be poor indices of changes at the population or species level. In California, it is clear that historical efforts to document the status of the state's avifauna by Grinnell and others did not focus on large inland lakes. Of the various avifaunal monographs produced in the first half of the 20th century (e.g., Tyler 1913, Grinnell 1923) none dealt specifically with the waterbird fauna of any of the state's large inland lakes, such as Lower Klamath Lake, Tule Lake, Goose Lake, Honey Lake, Eagle Lake, Lake Tahoe, Mono Lake, Owens Lake, Tulare Lake, or the Salton Sea. For the sites most severely degraded—Tulare Lake and Owens Lake—we do not even really know what was lost. Of those that remain, the avifauna of many is still either poorly known or poorly documented in the literature. Given the wide variation in the extent of degradation of California's large lakes, history suggests that prior scientific knowledge alone is not a good measure of the likelihood of conservation success, as societal or political realities may trump faunal or ecological understanding.

OPPORTUNITIES AND CHALLENGES AT THE SALTON SEA

Unlike many contentious environmental issues, there currently is a broad consensus for the need to improve the health and sustainability of the Salton Sea ecosystem on behalf of its bird populations while enhancing opportunities for human recreation and economic development. The challenge, given the great loss of historic wetlands in California and adjacent Mexico, is to manage habitats such as the Salton Sea that rely on wastewater so in the long term they can sustain avian populations and diversity. Although many important ecological questions will remain unanswerable in the short term, particularly the ecosystem-level remedies for disease events and transmission, the quest for sustainability must rely on action rather than waiting for research to solve problems (Cairns 1999). Key problems at the Salton Sea are caused by increasing salinity—from upstream diversions of the Colorado River, agricultural use in the Imperial Valley, and, particularly, by evaporation in the Sea itself—and by eutrophication from inflows of nutrients from agricultural and urban sources (Tetra Tech 2000, Holdren and Montaño 2002, Schroeder et al. 2002). Although the role of increasing salinity and eutrophication in large-scale bird die-offs at the Salton Sea are unknown, the recent drastic increase in bird

mortality there appears to reflect an ecosystem in severe stress (Rocke and Friend 2003). Current initiatives to transfer water from the Imperial Valley to meet increasing demands in urban centers throughout southern California, if realized, will lessen the inflow of fresh water to the Sea, thereby exacerbating the difficulties of reducing its salinity (CH2M HILL 2002). Reduction of salinity will likely require innovative technological and engineering solutions at the Sea and the continued importation of fresh water. Providing additional water of sufficient quality to the Salton Sea will be especially challenging in a state with a large and rapidly expanding human population and a federal mandate to reduce its reliance on Colorado River water. Severe impacts on bird reproduction from concentrations of selenium and heavy metals from agricultural drain waters at Kesterson National Wildlife Refuge and agricultural evaporation ponds in the San Joaquin Valley (Skorupa and Ohlendorf 1991) provide cautionary tales of the difficulties of dealing with imported and degraded water in enclosed water systems in arid regions with high evaporation rates. Although contaminants are not known to have caused large-scale reproductive harm to birds nesting at the Salton Sea, potential impacts should be monitored periodically, given that DDE, selenium, and boron occur in levels of concern in birds foraging in the Salton Sea and the Imperial Valley (Setmire et al. 1993). Such monitoring should be conducted on a regional scale encompassing the entire Colorado River Delta ecosystem (Mora et al. 2003).

The Salton Sea's setting—alternately stark, seasonally very harsh, at times odiferous, and far from a large conservation constituency—is an additional impediment to be overcome to increase public support for restoration. Although efforts to increase recreation at the Salton Sea should provide economic benefits and broaden support for restoration, advanced planning is needed to avoid increased human disturbance at isolated river mouths and other sites where large numbers of birds or sensitive species concentrate (Shuford et al. 2000, 2002b).

One of the desirable attributes of an ecosystem is the ability to maintain natural processes, such as succession, energy flow, and nutrient cycling, without constant management intervention (Cairns 1999). Proposed alternatives to maintain or reduce the salinity of the Salton Sea currently all call for large engineering projects and intensive long-term management (Tetra Tech 2000). It is likely that a self-maintaining system at the Salton Sea will not be possible unless salinities are allowed to increase to the point where the food chain will be devoid of fish and dominated by brine shrimp (*Artemia* spp.) and brine flies (*Ephydra* spp.). Although such a system might not serve the highest biological diversity, it might in the long term be the only viable alternative given ecological, financial, and political constraints.

CONSERVATION SUCCESS STORIES

Mono Lake serves as a conservation success story (Hart 1996), yet knowledge of its avifauna was poor when activists began to raise consciousness about its plight. Expansion of scientific knowledge closely paralleled increasing activism, contention, and education about the lake's important wildlife and aesthetic values; the latter proved crucial in building broad public support. From a scientific standpoint, the recipe for success at a single site involves a combination of ongoing data collection, analysis, and publication, a willingness to work with conservation groups, and the dedication to engage in political, judicial, and regulatory processes.

At the Salton Sea, science has begun to make great strides via funding of reconnaissance studies and research and monitoring of disease events, and by providing a strong voice in the Salton Sea Restoration Project via the Salton Sea Science Office. It remains to be seen, though, whether scientists will engage extensively over the long haul in all crucial steps in the process.

CONNECTIVITY AND LONG-TERM SUCCESS

There is an increasing understanding of the need to conserve the extensive and often disjunct wetland systems upon which waterbirds depend, wetlands that may span extensive areas of one or more continents (Haig et al. 1998). Protection of Eared Grebes (*Podiceps nigricollis*) at one site, such as Mono Lake, will not suffice if tens of thousands die at the Salton Sea or elsewhere. Consequently, we need to understand the suite of sites needed, linkages among sites, and the ecology of individual sites. This is particularly so in the arid West where fluctuating climate conditions can shrink or expand wetlands in short time frames. Survey efforts will have to encompass the entire range of key sites, as declines or increases at particular sites may just reflect geographic shifts of relatively stable populations (e.g., interior Snowy Plovers, *Charadrius alexandrinus*; Page et al. 1991). Similarly, ecological processes that sustain populations may vary greatly among sites.

In the long run, landscape-level thinking will have to be supported by both landscape-level training and active engagement in conservation issues. Noss (1996, 1997) bemoaned both the loss of naturalists and the failure of universities

to produce conservation biologists. These problems stem from increasing scientific reliance on computers and statistics, at the expense of extensive field knowledge, and on insistence in training in academic paradigms when what may be needed is the ability to apply political solutions and management knowledge to real world problems. Our point is that even if we are willing to get into the trenches in conservation battles we may be ill-equipped for success. Cairns (1999) discussed the importance of the coming together of the social and natural sciences despite the often bitter fragmentations of human society and isolation of disciplines in educational institutions. While this may sound utopian, he emphasized that visions of a better future can be very powerful and produce major paradigm shifts. Likewise, further education is needed to increase the public's appreciation both for intact natural ecosystems and highly managed ones that provide alternative habitat for wildlife.

Another key avenue for scientists to enhance chances for long-term conservation success is to speak out on the root problems of our environmental crisis—overpopulation and overconsumption. Some leading scientists are outspoken in this arena (e.g., Ehrlich and Ehrlich 1990), whereas many others, surely very aware of the problems, are silent. To speak out one must be willing to take the heat. For example, the lead author of a poster on the relation of population growth to the possibility of Salton Sea restoration, presented at another recent symposium, was quickly labeled a racist for bringing up the issue of immigration. Scientists need to define the biological basis for solutions even if at first these prove unpopular.

CONCLUSIONS

Whether the Salton Sea proves to be an intractable environmental issue because of greater value placed on other human needs or desires, or a model for conservation success will depend in part upon whether scientists continue to add needed knowledge via research and, just as importantly, engage environmentalists, bureaucrats, managers, politicians, and the public in devising creative solutions to improving the ecosystem's health. A failure to do so will not bode well for the long-term conservation of waterbird communities in western North America. Decades ago, Linsdale (1930) noted the passive approach of ornithologists to bird conservation in California. Will we scientists sit by and chronicle the demise of the bird life of the vast and highly-productive ecosystems of the Salton Sea region without actively promoting conservation efforts? We hope not.

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