TESTIMONY OF DR. TIMOTHY P. KRANTZ

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To Be Presented to the State Water Resource Control Board
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Ladies and Gentlemen:

I am speaking to you today as the Director of the Salton Sea Database Program (SSDP), a congressionally funded program administered under the auspices of the U.S. Environmental Protection Agency Office of Research and Development in Washington, D.C. The SSDP is administered through the Redlands Institute at the University of Redlands in Southern California. The SSDP was established to provide an information clearinghouse to inform decision makers, stakeholders and the public about restoration planning alternatives for the Salton Sea. The SSDP has compiled thousands of bibliographic citations, photographs, and other records on the Salton Sea from dozens of federal, state and local government agencies, academic institutions, and other research and reconnaissance studies. Data is entered into a geographic information system (GIS), enabling geographic analysis and display of information; and information is disseminated via the Internet and other media.

Personally, I served on the Salton Sea Science Subcommittee, established in 1998 by then-Secretary of Interior Bruce Babbitt and directed by Dr. Milton Friend; and then on the Salton Sea Science Advisory Committee, now operated under the auspices of the Science Office—the only member to have served continuously on both committees. In that capacity, I am familiar with the dozen or so baseline reconnaissance investigations conducted by the Science Office over the past four years.

Geographic Setting

The Salton Sea is situated in the southeast corner of California, and is the State's largest lake with a surface area of 367 square miles at a surface elevation of between 227 and 228 feet below sea level, sustained by 1.34 million acre-feet annual inflow. At its present elevation, the Sea is about 30 miles long and 15 miles wide, but only 51 feet deep, with an average depth of 30 feet—the shallow nature of the Sea making it sensitive to even small reductions of inflow.

Geologic Formation and Lake Cahuilla

The Salton Basin was once connected to the Gulf of California and was characterized by a shallow marine environment (Downs and Woodward 1961). For the past several million years, as the Colorado Plateau was uplifted, the sediments that once filled the Grand Canyon were deposited in the Gulf of California, eventually building a huge delta, blocking off the Salton Basin from the ocean. The deltaic dam is now forty feet above sea level, with a drainage divide about 17 miles south of Mexicali, Mexico (Dibblee 1954).

Periodically, the Colorado River would drain directly to the Gulf of California, and the lake in the basin would recede or evaporate altogether. At other times, the river would flow into the Salton Basin, forming prehistoric Lake Cahuilla, sometimes filling it to the brim at the drainage divide, whereupon it would spill over into the Gulf of California, like a giant oxbow of the Colorado River covering more than 2200 square miles. Evidence of Lake Cahuilla has been obtained from archaeological sites along the ancient shoreline, including fish traps, bones, and other lake-related remains (Wilke 1978; Waters 1981; Schaefer 2000). Other geomorphological features, such as travertine deposits (calcium carbonate), wave cut scarps and erosional degradation at the drainage divide south of Mexicali were located with global positioning systems and delineated in a GIS to establish a precise delineation of the Lake Cahuilla shoreline (Krantz et al. 2000). These archaeological and geomorphological data provide evidence that Lake Cahuilla would periodically fill all the way to the drainage divide before overflowing to the Gulf, removing sediment and cutting down into the deltaic deposits as it did so over hundreds of years. Even when the Colorado River would change its course and meander directly to the Gulf, bypassing the Salton Basin, it would have taken sixty years for the receding lake to dry out, in which time the fickle Colorado would frequently return to the deeper basin once again, creating another stand of Lake Cahuilla. With the construction of the dams on the Colorado River, sedimentation has been reduced by over 90%; and, the river no longer meanders out of its channel.

The periodicity of Lake Cahuilla episodes has been estimated based upon carbon dates of the travertine deposits and other organic archaeological evidence, indicating that the lake was full most of the time over the past thousand years of record (Schaefer op. cit.). Other paleoclimatic data, including fossilized desert packrat middens and tree-ring chronologies, indicate that during the Pleistocene (2 million years to 12,000 years ago), with cooler temperatures and, thus, lower evaporation rates, the lake would have been at least partially full for an even greater proportion of the time (MacDonald 2001).

Historic Salton Sea

Torres-Martinez Desert Cahuilla Indian oral histories describe life on Lake Cahuilla. They told a story of a 'great water' to W. P. Blake, geologist on the Williamson expedition in 1853:

> 'When questioned about the shoreline and water marks of the ancient lake, the chief gave an account of a tradition they have of a great water (agua grande) which covered the whole valley and was filled with fine fish. There were also plenty of geese and ducks. Their fathers lived in the mountains and used to come down to the lake to fish and hunt. The water gradually subsided "poco [a] poco" (little by little) and their villages were moved down from the mountains, into the valley it had left. They also said that the waters once returned very suddenly and overwhelmed many of their people and drove the rest back to the mountains.' (Blake, 1857)

The first map indicating that the Colorado River ran into the Salton Basin is the so-called "Roque map", now in the British Museum, compiled in 1762. 'The map shows a considerable body of water in the Salton Sink, with the Colorado River flowing into it, but no written account accompanies the map.' (Laflin 1995)

After surveying for a route across the desert for the transcontinental railroad in 1853, Lt. R. S. Williamson wrote,

> ‘In 1849 this river broke through it’s banks, and the water flowed inland for some two hundred miles, forming what is known as the New River. In many places it formed lagoons, while in others it confined itself to a narrow channel. The water in the connecting channels having dried up, the lagoons still remain, and are of great benefit to the emigrant.’ (Williamson, 1856)

There are also personal accounts of smaller flood events in 1840, 1849, 1852, 1859, 1867, and 1891 (Salton Sea Authority 2000).

The present-day Salton Sea was formed in 1905, while workers were trying to dig a new channel for irrigation after sediments had clogged the previous one. Flood flows on the river rushed into the new channel, quickly deepening and widening it to more than one half mile in width, capturing the entire flow of the river. The breach was finally filled in 1907. **Far from being an “accidental lake”, it was human intervention that prevented the next stand of Lake Cahuilla from being formed.**

Diversity of Life

Before we go in to the discussion of the impacts of reduced inflows on the Salton Sea, let me take a few moments to describe the rich natural resources that are at stake. The nutrient-rich agricultural drainage that sustains the Salton Sea also supports an incredible diversity of life. More than 400 species of invertebrates, mostly single-celled floating plants and animals called plankton, have been identified in the Sea (Hurlbert et al. 2000). These provide the food base supporting the Sea’s productive fishery—with an estimated 200 million fish, one of the most productive fisheries in the world (Riedel, Helvenston, and Costa-Pierce 2001). The fish, in their turn, are consumed by fish-eating birds. The Salton Sea supports over 80% of American white pelicans, the only North American inland breeding colony of brown pelicans, and more than 90% of the North American population of eared grebes. With more than 400 species—more than two thirds of all species of birds in the continental United States—the Salton Sea supports one of the richest avifaunas in the world (Shuford et al, 2000; Patten 2001).

Of the eight or nine species of fish in the Sea, only the diminutive desert pupfish (*Cyprinodon macularius m.*) is native. Thriving during Lake Cahuilla episodes, it retreated up slow-moving creeks in the Salton Basin during dry periods. Today the pupfish occur in shoreline pools and in the agricultural drains (Sutton 2000). They were listed as an endangered species in 1980 (State) and 1986 (Federal). The other species were introduced from the Gulf of California or escaped from aquaculture.

The Salton Sea is of critical importance for many species of birds. As stated previously, the Sea supports over 90% of the North American population of eared grebes, with as many as three million individuals during migration. Numbers are up dramatically for other fish-eating birds over the past 10-15 years, with as many as 30,000 American white pelicans, 2,000 brown pelicans, and double-crested cormorants (Yoshihara 2000; Shuford et al, 2000). The Sea hosts 40,000 ruddy ducks during migration—half of the ruddies on the Pacific Flyway, more than 120,000 shorebirds of 44 species, 25,000 snow and Ross’ geese, the largest breeding colony of gull-billed terns in Western North America, 45% of endangered Yuma clapper rail habitat, and substantial breeding populations of Caspian terns and black skimmers.

Analysis of 20,000 leg bands of birds banded at the Salton Sea and recovered elsewhere, or birds banded elsewhere and recovered at the Sea, indicates that the Sea is of great international importance to migratory birds (Krantz and Strout, research in progress). Researchers expected to see the importance of the Pacific Flyway illustrated by these results, but were surprised to find that many of the birds fly across the Great Basin to breeding grounds on the Prairie Pothole country of the northern Great Plains and south central Canada. From there, these birds may migrate south to the Texas Gulf Coast, or return back to the Salton Sea. Eighty-five bands were recovered from Nunavut and the Arctic Islands of northern Canada, 175 from Alaska, 22 from northern Siberia and Russia, 30 bands from Mexico and Central America, one from Peru, 5 from the Caribbean, and three wayward birds were recovered from Hawaii! The Salton Sea is truly an international airport for migratory birds.

Economic Values

The frost-free climate with temperate winters and dry summers allows for year-round crop production, making the Imperial and Coachella Valley farmlands some of the most productive in the world. Providing a bounty of winter fruits and vegetables for U.S. markets, the Imperial Valley alone generates more than a billion dollars of annual revenues to the region. Agricultural acreage covers more than 572,000 acres in Imperial Valley, and about 56,600 acres in Coachella Valley (Imperial County 2001).

The Salton Sea is within a 90-minute drive of more than 20 million people in Southern and Baja California. During the 1960s and ’70s, the Sea hosted more visitors than Yellowstone or Yosemite National Parks (Horvitz 1999). Visitor use has increased in the past four years to an average of 250,000 visitors per year (ibid.). New fishing jetties, a boat launch, harbor facilities, upgraded campgrounds, day use areas, parking areas and visitor centers are planned for the Salton Sea State Park and Recreation Area, the Sonny Bono Salton Sea National Wildlife Refuge, and other recreation developments.

Bird watching, hunting and fishing are very popular activities at the Sea, supporting a thriving ecotourism industry.

Watershed Hydrology

The Salton Sea lies at the bottom of a 7,851 square mile watershed, draining a huge area extending from the Peninsular Mountain Range on the west, to Mt. San Gorgonio and the Banning Pass to the north, east along the south slope of Joshua Tree National Park, and south along the Chocolate Mountains to the Mexicali Valley. The Sea lies in a closed basin, with no outlet to the ocean. Over 85% of the water entering the Salton Sea results from agricultural run-off, 77% from the New and Alamo rivers and 8% from agricultural drains that discharge directly into the Sea. The Whitewater River provides 7% of total inflow. With annual rainfall of only 2.5 inches, less than 3% of inflow to the Sea today is from precipitation.

After an initial high stand of the Salton Sea from the 1907 flood at about 217 feet below mean sea level, the Sea receded to about –250’ by 1920. Since then, with the expansion of agriculture and increased agricultural run-off, the surface elevation of the Sea has steadily risen to its current elevation of about 227 feet below sea level. The elevation of the Sea has remained relatively stable at its current level since the 1980s, indicating that the inflow of about 1.34 million acre-feet (maf) is equal to evaporation losses at that elevation—or about 15% of the total volume of the Sea lost to evaporation each year.

Once diverted to the Salton Basin, urban and agricultural practices concentrate dissolved salts and minerals already in the Colorado River water and add more nutrients and salts. Approximately four and a half million tons of salts are added to the Sea annually. Because there is no outlet from the Sea, but for evaporation, the dissolved salts, nutrients, and minerals that enter the Sea remain there, and have accumulated over the past century to the point at which the Sea is now about 25% saltier than the ocean.

Reduced Inflow Calculations

The proposed water transfer of 300,000 acre-feet (af) from the Imperial Irrigation District (IID) to San Diego may result in reductions of inflow to the Salton Sea. Other actions that may reduce inflow include a Mexicali wastewater treatment plant, in which Mexicali may keep as much as 65,000af of water presently discharged into the New River, lining of the All-American and Coachella Canals (20,000af), and salinity control measures that may remove as much as 110,000af (the amount of Salton Sea water containing the equivalent of the annual salt load). Altogether, these losses may result in a reduction of as much as 500,000af of total annual inflow from the approximately 1.34maf currently entering the Salton Sea.

The SSDP has calculated the results of reduced inflow volumes to the Salton Sea, using the U.S. Bureau of Reclamation sonar bathymetric data and IID flow rates, as reported in the Salton Sea Restoration Project Draft EIS/EIR (Salton Sea Authority 2000). Using our GIS, a grid calculation process was performed to generate the resultant shorelines and surface elevations.

The Draft EIR/EIS for the proposed water transfer (Imperial Irrigation District 2002) uses a baseline elevation for the Salton Sea of 228 feet below sea level. This is consistent with our calculations of –227 to –228, based upon seasonal variability. As mentioned earlier, this elevation has been relatively stable for the past decade; therefore evaporation equals inflow through this period at about 1.34maf. The Transfer EIR/EIS assumes that the baseline elevation will be lowered to –235 by certain entitlements and other actions independent of the water transfer (ibid. pg. 3.0-15). ***This is equivalent to a reduction of inflow of 160,000af, with or without the implementation of the water transfer!***

For the purpose of this presentation, we present two reduced inflow scenarios: one for a 300,000af reduction (the water transfers), and one for 500,000af (transfers plus other reductions discussed above). The baseline elevation used is 227 feet below sea level. The –227 shoreline was delineated on one-meter resolution digital orthophotographic quarter-quadrangles (DOQQ) images, calibrated with elevation for the dates of those photographs taken from USGS gauging stations on the Sea. The baseline evaporation rate is 5.78 feet per year (Hely et al, 1966). The baseline inflow volume is 1.34maf. Baseline salinity is 44,000mg/l, consistent with the SSA Draft EIR/EIS (the transfer EIR/EIS uses 46,000mg/l).

- **A reduction of inflow by 300,000af as a result of proposed water transfers would lower the lake by 19 feet to 246 feet below sea level, exposing 54,900 acres (nearly 86 square miles) of land.**
- **A reduction of inflow by 500,000af from all causes would lower the lake by 30 feet (more than half of total depth) to 257 feet below sea level, exposing 89,500 acres (almost 140 square miles) of land.**

If one includes the initial drop to a baseline lake elevation of –235 (160,000af additional inflow reduction independent of the transfer) as described in the Transfer EIR/EIS, then the resulting shoreline from a 300,000af withdrawal would be –251, with an exposure of about 110 square miles of land.

Areas near the mouths of the rivers would be most affected, as they are shallower. Along the southeast portion of the Salton Sea, the shoreline would recede by 4-6 miles (with a 300,000af and 500,000af reduction of inflow, respectively). The Whitewater River delta would be similarly affected. Communities around the Sea, such as Salton City, would be left high and dry; lakefront owners having to haul their boats a mile or more (1-2mi, respectively as above) to the receding shoreline.

Impacts on Wildlife

Salinity tolerances of fish and wildlife vary greatly between species, and laboratory-derived tolerances may differ from actual tolerances because of other variables or environmental conditions. For the purpose of this discussion, a salinity of 60,000mg/l is used as a threshold tolerance for the Salton Sea fishery, consistent with the salinity threshold used by the SSA and the IID in their respective environmental documents (op. cit.). It should be noted that the salinity tolerance of certain keystone invertebrate species, such as pileworms (*Neanthes succinea*), are unknown, and that the collapse of such important species at the base of the food chain would cause a decline in other higher-level species that are dependent upon pileworms for their food supply.

At the present rate of salt loading of about four million tons per year, the Salton Sea would reach the 60,000mg/l threshold in about 50 years, if inflow remains at its present level of 1.34maf/yr. Recent evidence suggests that salinity may be increasing more slowly than previously thought as a result of internal salt precipitation (Amrhein et al. in press).

With reduced inflows, salinity increases rapidly, the contracting lake concentrating a century of salt deposits already in the Sea, while more salts continue to enter the Sea in agricultural run-off. With a reduction of inflow by 300,000af/yr, salinity would reach the 60,000mg/l threshold in about twelve years; and **with a reduction of 500,000af (the transfer plus the baseline reduction assumed in the Transfer EIR/EIS), salinity would reach the limit of tolerance of the fishery in just seven years.**

The sudden collapse of the fishery would represent a serious adverse environmental impact in many respects. The death of 200 million fish would have a cascade effect on the rest of the ecosystem, causing the demise of fish-eating bird populations, exacerbating eutrophication from decomposition of the dead fish, and creating a huge breeding ground for flies and other pathogens in their rotting carcasses.

Many species of birds would be critically impacted. Ground-nesting bird colonies on Mullet Island would be exposed to coyotes, cats, and other predators with a drawdown of only seven feet (the baseline reduction per the Transfer EIR/EIS). Studies of eared grebes have shown that they are already near the limit of their physical abilities to cross the Great Basin deserts to northern breeding grounds without the help of an abundant food supply at the Salton Sea (Jehl 2000); and many other species, from fish-eaters, such as American white pelicans to birds of the adjacent marshes, such as Yuma clapper rails, would experience substantial whole-species population declines.

Impacts on the Regional Economy

Impacts on real estate values on properties on or near the Sea would be severe. Property values would decrease markedly, and have already been adversely impacted simply from the bad press and uncertainty about restoration of the Sea.

Recreation-oriented businesses would experience direct impacts, as camping, hunting, birdwatching, boating, and fishing would decline.

Indirect impacts would extend beyond the immediate area of the Sea. The prospect of 200 million dead fish, with associated flies and odors, would impact the cities of the Coachella and Imperial Valleys for some years until the rotting fish had decomposed and dried.

Other impacts associated with fugitive dust and degradation of air quality from winds blowing across the exposed lake bottom sediments could also adversely affect the economies of the region.

Deposition of dust and salts on crops and fields could represent an adverse impact on agricultural productivity in the Imperial Valley. Prevailing winter winds from the northwest could pick up sediments from the lakebed, depositing them on prime agricultural lands to the southeast, while subtropical cyclones in summer months typically blow from the southeast, depositing dust on the Coachella Valley.

Economic studies have estimated that a restored Sea would support a six billion dollar annual economy for the region. A dead Sea, however, would represent a 1.5 billion dollar loss to the region and to Southern California (Rose Institute 1999).

Impacts on Air Quality

Very fine lake bottom sediments, exposed by the receding shoreline, may become windborne, creating dust storms and impairing air quality and impacting human health. Extremely small, suspended sediments (particles so small they float) settle on the bottom of large lakes. These fine particles—called PM_{10}, or particulate matter less than ten microns—are so small one could fit 200,000 of them in the space of a sugar cube. PM_{10} is an air pollutant, and has been linked to respiratory disease and other human health problems. The microscopic particles penetrate deep into the lungs, increasing the number and severity of asthma attacks and aggravating bronchitis. Other chemical residues in the dust, such as cadmium and arsenic, have been associated with higher incidence of lung cancer and other health problems.

The exposure of large expanses of the lake bottom (86-140 square miles) could create serious PM_{10} emissions. Comparisons may be made to Owens Lake–situated in a similar desert environment east of the Sierra Nevadas. Owens "Dry" Lake was created when the Los Angeles Department of Water and Power diverted flows from Owens Lake to the City of Los Angeles in the 1920s. The lake receded from a surface area of just over 100 square miles to a small brine pool in the middle, with over 20,000 acres of dust generating area of lake bottom sediments. Owens Dry Lake routinely produces large dust storms, and exhibits the worst PM_{10} in the United States (Reheis, In press). Dust storms from Owens Valley occasionally produces huge walls of dust clouds, blanketing downwind communities of Ridgecrest and Palmdale, with Owens dust detected as far south as Riverside County and as far east as the Grand Canyon.

The Environmental Protection Agency has established PM_{10} and $PM_{2.5}$ (ultra-small particles less than 2.5 microns) standards for air quality. Both Imperial County and recently the Coachella Valley have been deemed "non-attainment" zones, failing to meet the air quality criteria for PM_{10}. No air quality model or detailed analysis of potential dust emission has been completed at the Salton Sea. However, given the magnitude of exposure of sediments resulting from water transfers and other reductions of inflow to the Sea (86-140 square miles for the Salton Sea, compared with 31 square miles of dust-emitting surface at Owens Dry Lake), if even a fraction of the Salton Sea lake bottom generates windborne dust, PM_{10} levels would be expected to worsen relative to the basin's already poor air quality.

Impacts on Human Health

The health effects of PM_{10} are well documented, and will not be presented here. Suffice to say that the basin's nonattainment status for PM_{10} is reflected by some of the worst incidence of respiratory disease in the State. Imperial County leads the State in childhood asthma hospitalizations of children aged 0-14 by more than twice the state average (CDHS 2000). This may be correlated to the already high levels of PM_{10} experienced in the dry desert environment of the region. Suffice to say, any additional impacts of reduced air quality on human health will only exacerbate this problem.

Conclusions

Like a doctor advising a patient, I must say we have some good news and some bad news. The good news comes from many reconnaissance studies completed on the Salton Sea in the past four years. Our "diagnostic tests" have shown that the Sea is not "polluted" per se, with low levels or even non-detectable levels of pesticides, hydrocarbons, and other chemical contaminants. Rather, the Sea is "too alive" from nutrient-rich run-off, analogous to taking too many vitamins. This causes over-production of algae, decomposition, and deoxygenation of the water—resulting in the fish kills and stressing bird populations that the Sea is experiencing today.

The good news is that the fishery is thriving—one of the most productive in the world (in part from all those nutrients). Not surprisingly, fish-eating bird numbers are up markedly over the past 10 years; and overall avian species diversity has climbed steadily. The bad news is that salinity is also climbing steadily. Although probably not to blame for the fish die-offs at the Sea today, salinity will approach the limits of fish and wildlife tolerance in the next 30-60 years if nothing is done to control it.

The good news is that several salinity control options have been successfully demonstrated and appear to be economically feasible. These include solar evaporation ponds, enhanced evaporation systems, and desalination technology. The bad news is that salinity control becomes much more difficult, if not impossible, with the prospect of water transfers. Cost estimates for solar evaporation ponds increase from $300-500 million for salinity control at present levels of inflow to as much as $1.6 billion with reduced inflow.

As your doctor, I can say that you have 30-60 years to live and find a solution with inflows remaining at or near present levels, or you have only seven years with water transfers. The choice is yours.

Some things one can know for certain. With reduced inflows on the order of those proposed for the water transfer, together with other possible reductions, the following impacts will occur:

- The Salton Sea will contract, dropping by as much as 30 feet and exposing 86-140 square miles of lake bottom sediments;
- Salinity will increase dramatically, reaching lethal limits for fish and wildlife within 7-12 years;
- The fishery will collapse, resulting in the death within a few years of 200 million fish;
- Bird populations will plummet, with critical declines for many species dependent on the Sea for wintering or breeding habitats;
- The recreation economy will suffer due to declining tourist visitation, and property values will decrease;
- Agricultural productivity may decrease as a result of salt and dust deposition, and less water availability to the Imperial Valley;
- Already poor air quality may worsen dramatically as a result of dust becoming airborne from the exposed lake bed;
- Human health will decline as increased PM_{10} may result in higher incidence of respiratory disease.

That is my diagnosis. We understand the problems and remedies are available, but they will only work if inflows to the Salton Sea are maintained at something close to their present levels. The choice is yours.

References Cited

Amrhein, C., et al. In press. Effect of salt precipitation on historical and projected salinities of the Salton Sea: summary of comments from workshop at U.C. Riverside, January 30-31, 2001. Workshop conducted under the auspices of the Salton Sea Science Office.

Blake, William P. 1857. Report of explorations in California for railroad routes to connect with the routes near the 35^{th} and 32^{nd} parallels of North Latitude, 1853-4. Vol.5, Part II, pp. 94–111.

California Dept. of Health Services. 2000. California County Asthma Hospitalization Chart Book. CDHS, Environmental Health Investigation Branch, August, 2000.

Dibblee, T. W., Jr. 1954. Geology of the Imperial Valley region, California. Jahns, R. H. (ed.) Geology of Southern California, California Division of Mines and Geol. Bull. 170: 21-28.

Downs, T., and G. Woodward. 1961. Middle Pleistocene extension of the Gulf of California into the Imperial Valley (abstract). Geol. Soc. of Am. Special Paper 68: 21.

Hely, A.G., G.H. Hughes, B. Irelan. 1966. Hydrologic regimen of the Salton Sea. U.S. Geol. Surv. Professional Paper 486-C. 32pp.

Horvitz, Steve. 1999. Salton Sea 101. Unpublished primer on the Salton Sea, produced under the auspices of Salton Sea State Park and Recreation Area.

Hulbert, S., D. Dexter, and B. Kuperman. 1998. Reconnaissance of the biological limnology of the Salton Sea. Prepared for the Salton Sea Authority.

Imperial County. 2001. Imperial County-University of California Cooperative Extension. Online annual report summary of agricultural acreages. http://ceimperial.ucdavis.edu.

Imperial Irrigation District 2002. Draft Environmental Impact Report/Environmental Impact Statement Imperial Irrigation District Water Conservation and Transfer Project and Draft Habitat Conservation Plan. January 18, 2002.

Jehl, J.R., Jr. 2000. The migration of eared grebes through the Salton Sea. Paper presented at the 3rd Salton Sea Symposium, Desert Hot Springs, California. January 13-14, 2000.

Krantz, T., J. Buckles and K. Kashiwase. 2000. Reconstruction of prehistoric Lake Cahuilla and early American settlement patterns in Southeast California using GIS. Proceedings of the Twentieth Annual ESRI International User Conference, San Diego, California.

Krantz, T. and N. Strout. Research in progress. Preliminary results of an analysis of Salton Sea bird band data. Salton Sea Database Program, University of Redlands, Redlands, California.

Laflin, P. 1995. The Salton Sea: California's overlooked treasure. The Periscope, Coachella Valley Historical Society, Indio, California. 61pp.

MacDonald, Glen M. 2001. Ice Ages, packrats and ancient trees: climatic environmental change in the Salton Sea region and Colorado River Basin. Report prepared for the Salton Sea Database Program Atlas Project.

MacDougal, D.T. 1914. The Salton Sea—a study of the geography, the geology, the floristics, and the ecology of the desert basin. Carnegie Institution of Washington, Publication #193.

Patten, Michael A. 2001. An overview of birds and their habitats at the Salton Sea. Report prepared for the Salton Sea Database Program Atlas Project.

Reheis, Marith C. In press. Dust deposition downwind of Owens (Dry) Lake, 1991-1994: Preliminary findings: Journal of Geophysical Research.

Riedel, Ralf, Lucille Helvenston, Barry Costa-Pierce. 2001. Final report: fish biology and fisheries ecology of the Salton Sea. Prepared under contract to the Salton Sea Science Office.

Rose Institute. 1999. Report of the Economic Development Task Force. Prepared for the Salton Sea Authority. Claremont/McKenna College, Claremont, California. January 1999.

Salton Sea Authority 2000. Draft Salton Sea Restoration Project Environmental Impact Statement/Environmental Impact Report. Prepared by Tetra Tech, Inc. January, 2000.

Schaefer, Jerry. 2000. An inventory and evaluation of Lake Cahuilla cultural resources along Imperial Irrigation District's SA-Line, San Diego and Imperial Counties, California. Prepared by ASM Affiliates, Inc., Encinitas, California. December 2000.

Shuford, W. D., N. Warnock, K. C. Molina, B. Mulrooney, and A. E. Black. 2000. Avifauna of the Salton Sea: abundance, distribution, and annual phenology. Contribution No. 931 of Point Reyes Bird Observatory. Final report for EPA Contract No. R826552-01-0 to the Salton Sea Authority.

Sutton, Ron. 2000. Final Salton Sea desert pupfish movement study. Prepared under contract for the Salton Sea Authority.

Waters, Michael R., 1981. Holocene lacustrine chronology and archaeology of ancient Lake Cahuilla, California. Department of Geosciences, University of Arizona.

Wilke J. P., 1978. Late prehistoric human ecology at Lake Cahuilla, Coachella Valley, California. Contr. of the Univ. of Calif. Arch. Res. Facility, Berkeley, California: Number 38, May.

Williamson, Lt. R. S. 1856. Report of explorations in California for railroad routes to connect with the routes near the 35th and 32nd parallels of North Latitude. 1853-4, Vol. 5, Part I, page 40.

Yoshihara, S. 2000. Analysis of avian species abundance and distribution using Christmas Bird Count data. Unpublished senior thesis, University of Redlands, Redlands, California.