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A Preliminary Investigation of the Potential Non-Market Benefits Provided by the Salton Sea

Final Report

prepared for

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Executive Summary

Environmental and natural resources are assets that provide returns to society now and in the future. Therefore decisions regarding the restoration or preservation of such resources should consider not only the costs of preservation but the benefits, as well. Consideration of the benefits of preservation is exceedingly important when the resource in question is unique and when decisions pertaining to the provision of such services can have irreversible consequences. The Salton Sea is one such resource that provides a set of unique natural resource services, including critical habitat to over 400 species of migratory and resident birds, approximately fifty of which have garnered special status as threatened, endangered, or species of concern. As emphasized in Shuford et al. (2002; p. 255), the Sea is a "vital migratory stopover and wintering habitat for species that breed elsewhere in Western North America," and the health of many of the populations that reside, roost, feed, or nest are dependent on the health of the Salton Sea. As succinctly put by Cohen and Hyun (2006), "The Salton Sea provides critically important habitat to a diversity and abundance of birds." Furthermore, the California State Resources Agency (2006; Chapter 1) citing Cooper (2004) suggests that the Salton Sea has "become an internationally significant stopover site for hundreds of thousands of transients moving north and south along the 'Pacific Flyway', and east into the Great Basin/Prairie Pothole region as well as the winter home for hundreds of thousands of individuals of numerous species from around North America."

With rising salinity levels and increasing pollutant loads, the ability of the Sea to continue to serve as a vibrant ecosystem providing habitat for the avian populations currently using it and the fish species that have traditionally relied on it is unlikely. Furthermore, under the Quantification Settlement Agreement (QSA) signed in 2003 that transfers water from agricultural users to urban users, the outlook is even bleaker because salinity levels will increase more rapidly than currently observed and the loss of inflow volume will lead to less shoreline and quality habitat. The outcome of this trend in habitat degradation and loss could be significant, both for the Salton Sea in its ability to serve its historic function as a habitat for both birds and fish, and for the existence and health of particular bird and fish populations themselves.

While discussions associated with restoring and preserving the Salton Sea have traditionally focused on the costs of various options, very little formal discussion has addressed the potential returns of such an investment. Consideration of the benefits of preservation or restoration has precedence at both federal and state levels. At the federal level, agencies have been mandated under executive orders (e.g., EO 12866 under President Clinton) to choose those alternatives that maximize net benefits (i.e., the difference between total benefits and total costs). At the state level, the State of California, under the California Environmental Quality Act (CEQA), may take into account the economic and social effects associated with any project to assist in determining the significance of the physical changes associated with a particular project (CEQA Guidelines, section 15131(b)). And it should be emphasized that even when much of the preservation benefits consists of non-market value, many state and federal agencies have not only acknowledged such benefits, but also quantified them for guidance in their resource allocation decisions. Examples of such agencies include: the U.S. Department of Interior under the Comprehensive Environmental Response, Compensation, and Liability Act (1980), the National Oceanic and Atmospheric Administration under the Oil Pollution Act (1990), the U.S. Army

Corps of Engineers, the U.S. Bureau of Reclamation, the U.S. Water Resources Council, and state fish and game agencies in Oregon, Nevada, California, Idaho, and Maine. Examples of applications include: Glen Canyon Dam, Hell's Canyon, Mono Lake in California, the spotted owl in the Pacific Northwest, and Kootenai Falls in Montana.

The purpose of this report is to provide some preliminary estimates that are suggestive of the potential value associated with preserving the Salton Sea. Indeed, as an advisory arm of the federal government, the National Resource Council (2004; Executive Summary) argued recently that "assigning a dollar figure" to non-market ecosystem services "…are a must to accurately weight the trade-offs among environmental policy options." Failure to include a measure of the value of ecosystem services in benefit-cost calculations will implicitly assign them a value of zero, which we know is incorrect as evidenced by the body of literature that has estimated the monetary value of similar services.[1] This literature is quite extensive and includes values derived for all manner of ecosystems, including tropical rainforests, wetlands, deserts, and a variety of marine environments.

Although time constraints do not permit a primary valuation study or a formal statistical analysis of previous research at this time, this report does provide an estimated range of annual benefits from the Sea using the "value transfer" method. This method involves deriving updated estimates of habitat or species preservation values from previous research that has performed a primary valuation study or meta-analysis, and then transferring these values to the Salton Sea. To derive these updated estimates, we undertook a thorough search of the environmental and natural resource economics literature on ecosystem service valuation, focusing on the services provided by the Sea that tend to benefit geographically dispersed populations rather than just the local population. Our search included the EconLit database, the Environmental Valuation Reference Inventory (EVRI; the largest database on valuation studies), Google Scholar, and our own private collections of literature on natural resource valuation. Our initial searching and screening of these sources and topics produced around 70 studies. Subsequent screenings narrowed the list to 23 studies of which 20 included at least one value with potential relevance for the Salton Sea.

Of these 23 studies, we determined that those addressing wetlands and wildlife in the San Joaquin Valley (SJV) and those addressing the Mono Lake ecosystem are most relevant and provide the most useful benefits estimates for the Salton Sea. Keeping in mind the uniqueness of the Salton Sea—which we believe tends to increase its value while also making it difficult to transfer benefits estimates from previous research—and the caveats we provide throughout this report, we believe that a conservative order-of-magnitude estimate of the non-market benefits provided to the residents of California by a restored and preserved Salton Sea would be in the range of $1-$5 billion annually. This estimated range includes both use and non-use value, but probably mostly non-use value.

Some additional considerations are worth mentioning when interpreting this estimated range of preservation benefits. First, assuming the transferability of the SJV and Mono Lake estimates is high (something we cannot determine with certainty without conducting a primary valuation

[1] Wilson and Carpenter (1999), for example, provide a summary of the economic value of freshwater ecosystem services in the U.S., noting 30 refereed published articles in the scientific literature from 1971 to 1997.

study of the Salton Sea), we are inclined to believe that these value transfers probably underestimate the total non-market value of the Sea. We believe the SJV estimates are low primarily because they value only wetland habitat. The other attributes of the Sea clearly have positive values that are not included in this estimate. We believe the Mono Lake estimate is low primarily because the Sea is significantly larger than Mono Lake and, in our judgment, it is a more important component of the Pacific Flyway. Furthermore, we believe the higher Mono Lake estimates by Loomis (1987, 1989) may be provide better comparison values for the Sea because they are based on a relatively worse no-action scenario. Compared to the no-action scenario considered in the Mono Lake EIR (JSA 1993), we think the no-action scenario considered by Loomis is more similar to that for the Salton Sea.

Finally, we emphasize that these estimates are suggestive. The characteristics of the resources on which our estimates are based, as well as peoples perceptions/values of those characteristics, likely differ from the services provided by the Salton Sea and how these services are perceived/valued. This is what Freeman refers to as differences in "supply side" and "demand side" factors (Freeman 2003; p. 454). Yet based on the results of Loomis (2000) who evaluated six different resource preservation programs, residents within the states where these sorts of unique and threatened resources are located only hold a fraction (approximately 13%) of their national value. Furthermore, as estimated in Loomis and White (1996) through their meta-analysis of valuation studies for rare, threatened, and endangered species, the authors find that even for the most costly endangered species preservation efforts, the benefits are likely to exceed the costs. Hence, while our estimates are suggestive, there are many reasons to believe that these estimates are good first round approximations, and most likely conservative approximations at that, of the value with preserving the Salton Sea.

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I. Introduction

Environmental and natural resources are assets that provide returns to society now and in the future. As such, decisions as to the restoration or preservation of such resources should consider not only the costs of such preservation, but the returns associated with preservation. Consideration of the benefits of preservation is exceedingly important when the resource in question is unique, and when such decisions can have irreversible consequences pertaining to the provision of such services. The Salton Sea provides a set of unique environmental and natural resource services, such as critical habitat for both the endangered desert pupfish and over 400 species of migratory and resident birds, approximately fifty of which have garnered special status as threatened, endangered, or species of concern. While discussions associated with restoring and preserving the Salton Sea have traditionally centered around the costs of various options, very little discussion, at least formally, has involved the potential returns of such an investment. California State Senator Denise Ducheny inferred as much when she emphasized that the merits of any particular restoration strategy should not be based on initial cost estimates alone.[2]

To date, there has been no formal quantification of the existence and preservation benefits associated with the Salton Sea. Indeed, as an advisory arm of the federal government, the National Resource Council (2004; Executive Summary) argued recently that "assigning a dollar figure" to non-market ecosystem services "…are a must to accurately weight the trade-offs among environmental policy options." Failure to include some measure of the value of ecosystem services in benefit-cost calculations will implicitly assign them a value of zero, which we know is incorrect and unnecessary since plenty of analyses exist that have estimated the monetary value of similar services.[3] This literature is quite extensive and includes values derived for all manner of ecosystems, including tropical rainforests, wetlands, deserts, and a variety of marine environments. In light of this information and methods, the National Resource Council (2004) made the following recommendations:

- Policymakers should use economic valuation as a means of evaluating the trade-offs involved in environmental policy choices; that is, an assessment of benefits and costs should be part of the information set available to policymakers in choosing among alternatives.
- If the benefits and costs of a policy are evaluated, the benefits and costs associated with changes in ecosystem services should be included along with other impacts to ensure that ecosystem effects are adequately considered in policy evaluation.
- Economic valuation of changes in ecosystem services should be based on the comprehensive definition embodied in the total economic value (TEV) framework; hence, both *use* and *non-use* values should be included (Arrow et al. 1993).[4]

[2] Remarks by State Senator Ducheny at "The Salton Sea Centennial Symposium", San Diego, Ca., April 1, 2005

[3] Wilson and Carpenter (1999), for example, provide a summary of the economic value of freshwater ecosystem services in the U.S., noting 30 refereed published articles in the scientific literature from 1971 to 1997.

[4] *Use* values are those values society places on the tangible uses of goods and services whereas *non-use* values are those values society places on intangible uses. Complete definitions and examples are given in section II.

With these recommendations in mind, the intention of this report is to provide some preliminary estimates that are suggestive of the value associated with preserving the Salton Sea. Our approach involves developing updated estimates of habitat or species preservation values from research that has performed a primary valuation study or meta-analysis. This simple benefits transfer approach is outlined in Freeman (2003) and Rosenberger and Loomis (2003). To develop these estimates, which we assume can be suggestive of potential value associated with characteristics of the eight Salton Sea Restoration alternatives versus the no-action alternatives as outlined under the Salton Sea Ecosystem Restoration Draft PEIR, we undertook a thorough search of the environmental and natural resource economics literature on ecosystem service valuation, focusing on the types of services that tend to benefit geographically dispersed populations, rather than just the local population residing in the immediate vicinity of the resource. From this survey, we identify the aggregate and disaggregate (e.g., per acre of habitat preserved or per household) preservation value estimates that may serve as starting points for valuing preservation of the Salton Sea.[5]

Because time constraints restrict us from performing a primary valuation study or a meta-regression, either of which would provide a more accurate and reliable estimate, we therefore employ a more straightforward value transfer method (Rosenberg and Loomis, 2003) using existing research that provides estimates from other studies to be used as a benchmark for possible preservation values for the Salton Sea and can serve two important roles. First, these estimates can provide policy makers with an idea of the preservation benefits from other studies of similar, albeit not identical, habitat. Second, this exercise highlights the importance of and value in performing a more concrete and extensive study so as to better pinpoint the preservation estimates associated with a particular restoration alternative. Of course, all the caveats of using this simple benefits transfer method, as pointed out in Freeman (2003) and Rosenberger and Loomis (2003), apply.

The report is organized as follows. Section II provides a brief discussion of the Salton Sea, with particular attention to the services that may be lost in lieu of any restoration plan as well as the legal and regulatory underpinnings that seem to motivate some sort of restoration. Elements of eight restoration alternatives as outlined in the Salton Sea Ecosystem Restoration Draft PEIR (Draft PEIR; California State Resources Agency 2006) are discussed briefly. In section III, a brief discussion of environmental and natural resource non-market valuation is provided, with particular attention given to non-use values, in the context of benefit-cost analysis. Section III also includes a brief discussion of legal and regulatory framework supporting non-market valuation. Case studies that have estimated the preservation values of ecosystem goods and services are presented in section IV, along with a short description of our research methodology. Finally, section V provides the conclusions.

[5] While the authors are aware of two studies that have attempted to estimate the economic value of preserving the Salton Sea—CIC Research (1989) and the Inland Empire Economic Database and Forecasting Center (IEEC 1998)—neither of these studies estimated non-market values; rather their main focus was on expenditures, changes in property values, and tax revenues generated from those property value changes.

II. The Salton Sea: Services, Legislation, and Elements of the Restoration Plans

The Salton Sea, a terminal lake located in Southern California 35 miles north of the U.S.-Mexico Border, has a total surface area of nearly 370 square miles making it the largest body of water in California as measured by surface area (Cohen and Hyun 2006). While lakes have existed in the present site in the past, the current configuration was formed in 1905 due to an unanticipated dam breach. The elevation of the Sea is relatively stable currently, at around 238 feet below mean sea level. This elevation is maintained by agricultural drainage inflows primarily from the Imperial and Coachella Valleys. The salinity and nutrient-laden constituency of the inflow, coupled with the fact that the Salton Sea is a terminal lake, leads to increasing levels of salinity and nutrient loadings with each year. Currently, Salton Sea salinity levels are around 46,500 mg/L, approximately 1/3rd saltier than the ocean; the nutrient-rich inflows from agricultural drainage have resulted in the Sea being a very productive ecosystem with high biological activity yet with very low levels of dissolved oxygen concentrations.

II.1 Biological Services

Over the past 100 years, the Salton Sea has become a very unique and productive ecosystem. Currently, the Sea provides habitat to over 400 species of birds and a variety of other wildlife species. In recent years, over one-half a million water birds have been observed in and around the Sea, and nearly 3.5 million eared grebes (Jehl and McKernan 2002). This valuable avian habitat has supported more than 50 species that are officially considered threatened, endangered, or *species of concern*. As outlined in Cohen and Hyun (2006) and elsewhere[6], the Sea provides habitat to the federally endangered brown pelican, nearly 40% of the entire U.S. population of federally endangered Yuma clapper rails, more than 90% of the North American population of eared grebes, approximately 30% of the entire North American population of white pelicans, and nearly 50% of the world's population of mountain plovers (Shuford et al. 2002). As highlighted in Shuford et al. (2002), the Salton Sea provides habitat to 19 species of water birds that are considered species of high conservation concern. As an aquatic habitat, the Sea supports a number of fish species, including the federally endangered desert pupfish. Large populations of Tilapia, Orangemouth Corvina, Sargo, and Gulf Croaker have been present.

As a system, the Sea provides a very unique and important habitat. As emphasized in Shuford et al. (2002; p. 255), it is a "vital migratory stopover and wintering habitat for species that breed elsewhere in Western North America," and the health of many of the populations that reside, roost, feed, or nest are dependent on the health of the Salton Sea. As succinctly put by Cohen and Hyun (2006), "The Salton Sea provides critically important habitat to a diversity and abundance of birds." Furthermore, the California State Resources Agency (2006; Chapter 1) citing Cooper (2004) suggests that the Salton Sea has "become an internationally significant stopover site for hundreds of thousands of transients moving north and south along the 'Pacific Flyway', and east into the Great Basin/Prairie Pothole region as well as the winter home for hundreds of thousands of individuals of numerous species from around North America."

[6] For instance, see the Salton Sea Authority webpage (www.SaltonSea.org).

Yet, with increases in salinity and nutrients, and the loss and degradation of substitute habitat elsewhere (Dahl et al. 1997), the future portends grave concern for many of these species. Indeed, declining water quality from increased salinity and pollutant loadings has all but eliminated the marine fish species. Barring major human intervention, the ability of the Sea to continue to serve as a vibrant ecosystem providing habitat for the avian populations currently using it and the fish species that have relied on it is unlikely. Furthermore, under the Quantification Settlement Agreement (QSA) signed in 2003 that transfers water from agricultural users to urban users, the outlook is even bleaker. The transfer water will come from agricultural users in the Imperial Irrigation District mostly through fallowing and water conservation schemes, thereby resulting in less drainage water flowing into the Salton Sea; consequently, salinity levels will increase even more rapidly than currently observed.

While the exact outcome associated with the no-action alternative is unknown, researchers at the Pacific Institute has made some predictions. On the physical and chemical aspects of the Sea, Cohen and Hyun (2006; page i) suggest:

> The amount of water flowing into the Sea in the next twenty years will decrease by more than 40%, causing its surface elevation to drop by more than 20 feet, rapidly shrinking its volume by more than 60%, tripling its salinity….

Consequently, the biological outcome from these changes include (ibid 2006; p. i):

> Many—if not most—of the hundreds of thousands of birds that currently use the Sea will lose their roosting and breeding habitats and their sources of food. The Sea's fish will be almost entirely gone within a dozen years. Those birds that remain will suffer from disease and the reproductive deformities and failures that plagued the Kesterson National Wildlife Refuge twenty years ago. Some of the endangered and threatened species that use the Sea may be able to find other habitats, but others could suffer significant population losses.

Finally, the report concludes that (ibid 2006; p. iii):

> The future loss of food sources and the loss of habitat as the Sea recedes will eliminate the ecological value of the Salton Sea for most of the birds that currently use it. The loss of this critically important breeding habitat and refueling stopover for migrating birds will be felt throughout western North America.

II.2 Anthropocentric Services

From an anthropocentric perspective, the losses in habitat, fish, and avian species and diversity have implications. This diverse habitat has provided many benefits to society, particularly on the recreational front. Millions of people have visited the Salton Sea for such activities as camping, fishing, birding, photography, boating, and other water-related activities. Given the diversity and magnitude of the bird populations, visitors worldwide visit the Salton Sea to see the birds (personal communication, T. Miller, Southwest Birders, December 2006), often during the

Salton Sea International Bird Festival, which has held an annual event since 1997. Alternatively, the Sea has been considered one of the most productive fisheries in the world (Cohn 2000), especially during the years from 1960 to 2000. For instance, in 1969, the Salton Sea experienced nearly 1.5 million visitors, 2/3rd of which were for sport fishing (Harris et al. 1969). In 1987, there were nearly 2.6 million visits by recreators to the Salton Sea, making it a more visited site than Yosemite National Park (CIC Research 1989).

Recreational opportunities due to the services provided by the Salton Sea occur at a number of locals in the Imperial, Coachella, and Riverside counties (see the Draft PEIR, Chapter 13, for a more complete description of these establishments and the services they provide). Recreational opportunities such as swimming, water skiing, sport fishing, and boating have been available around the Salton Sea shoreline. At the Sonny Bono Salton Sea National Wildlife Refuge, which was established in 1930 as the Salton Sea National Wildlife Refuge, critical habitat exists for the Pacific Flyway; furthermore, this area is considered one of the premier bird watching locations in the nation, if not the world (California State Resources Agency 2006, p. 13-4). Opportunities such as wildlife observation, photography, picnicking, and nature trails also exist at the Sonny Bono Refuge, which has averaged nearly 32,000 visitors annually since 1990.

Another popular destination for recreation that is reliant on the restoration of the Salton Sea is the Salton Sea State Recreational Area (SRA). Located along 15 miles of Salton Sea shoreline, the SRA has provided camping, boating, swimming, waterskiing, and angling opportunities. Season-high recreational visits occurred in the 1960s, with nearly 660,000 visitors. Since the mid-1990s, though, visitation rates have ranged from around 100,000 to nearly 282,000 annually.

Additional locations for recreation and for the preservation of these valuable and unique resources, especially in the aggregate as a biologically rich and diverse ecosystem, exist in and around the Salton Sea (e.g., the Wister and Hazard Wildlife Areas in the Imperial County). All of these activities will be threatened with the continual degradation of the Salton Sea. In the Draft PEIR it is noted that under a no-action policy, hunting and birdwatching opportunities would be reduced compared to existing conditions. As mentioned earlier, fish populations would decline even further than recently observed. As of 2000, there was a substantial decline in all sport fish, and marine fish have not been detected in the Department of Fish and Game gill net samples since mid-May 2003. Tilapia still exist, but their populations are down to 10% of those levels observed in the early 1990s. Fishing and recreational boating activities have practically vanished. In the 1980s, there were eight boat launching facilities around the Salton Sea, whereas today only one remains. Without the diversity and abundance of avian and marine species, and with the ever-decreasing water quality conditions, recreational visits for hunting, photography, boating, camping, picnicking, and birdwatching will decrease.

Another loss associated with the degradation of the Sea, and perhaps the largest loss, does not necessarily come from the loss to current users of the Sea, but rather from people that care about the Sea regardless of whether they tangibly use the Sea currently. People have been observed benefiting from environmental resources, and willing to pay to protect them, just by knowing the resources exists. For example, Sanders et al. (1990) estimates what people are willing to pay (i.e., their value) for preserving free flowing rivers with no intention of ever visiting them. Alternatively, Olsen et al. (1991) estimate peoples willingness to pay (value or benefits) for

maintaining salmon migrations, again, without actively engaging in any recreation activities (e.g., fishing, photography) involving these salmon. As will be expounded on in the next section, this sort of value is called a non-use or passive-use value and captures that value people have for resources for possible future use by themselves, future use by future generations, current use by others, or simply because they think it is the right or moral thing to do.

II.3 Legislation and Additional Responses by Governmental Agencies

Governmental response to these potential threats has occurred as early as 1992, when Congress enacted the Reclamation Projects Authorization and Adjustment Act (Public Law 102-575), which officially recognized that Salton Sea restoration was in the *interest of the nation*. In particular, it required the Secretary of Interior to conduct research to identify a means to reduce and control salinity, provide endangered species habitat, enhance fisheries, and protect human recreational values in the area of the Salton Sea. At the more local level, the Salton Sea Authority (SSA) was formed in 1993 as a joint powers authority by the approval of Imperial and Riverside Counties, along with the Imperial Irrigation District (IID) and Coachella Valley Water District (CVWD). The SSA was charged with managing and operating the Salton Sea so as to improve recreational activities/opportunities, and improve water quality. In 1998, Congress passed the Salton Sea Reclamation Act of 1998, which charged the Secretary of the Interior to perform feasibility studies and cost analyses of options for restoring the Salton Sea. The goal of these investigations included finding solutions to restore recreational uses, maintain a productive fishery, and provide a safe, productive environment for birds and endangered species (Glenn et al. 1999). A final federal act, the Water Supply, Reliability, and Environmental Improvement Act of 2004 (Public Law 108-361), required the Secretary of the Interior to complete a feasibility study on a preferred alternative for the restoration of the Salton Sea in coordination with the State of California and the SSA.

At the state level, a number of bills were enacted, and collectively referred to as the QSA legislation. One outcome of these bills was the Salton Sea Restoration Act (California State Fish and Game Code Section 2930), which charges the State of California to undertake the restoration of the Salton Sea ecosystem and provide permanent protection of the wildlife dependent on that ecosystem. The Salton Sea Restoration Act required that California identify a preferred alternative from a list of possible restoration alternatives. The preferred alternative was to provide for the maximum feasible attainment of the following objectives related to avian and marine species:

- Restoration of long term stable aquatic and shoreline habitat for the historic levels and diversity of fish and wildlife that depend on the Sea;
- Protection of water quality.

II.4 Elements of Salton Sea Restoration Draft PEIR

As outlined in the Draft PEIR (Chapters 2 and 3), eight alternative restoration plans are presented and evaluated versus two no-action alternatives. Associated with each of the restoration alternatives is the provision of a Saline Habitat Complex and/or Partial Sea that is intended to provide similar or improved habitat relative to what currently exists for the marine and avian

species that have historically been present at the Salton Sea. These alternative habitat configurations would provide food, nesting, and roosting habitat, as well as adequate stopover and wintering habitat for those birds migrating along the Pacific Flyway.

Specifically, the Saline Habitat Complex, as outlined in the Draft PEIR (pp. 2-24), is to provide "a mosaic of shallow and deep water habitats with islands and snags that would be similar to the habitat located near the confluences of the New, Alamo, and Whitewater rivers and the Salton Sea and shallow shoreline habitat. This type of habitat has been extremely productive for both fish and wildlife at the Salton Sea..." The salinity levels of the Saline Habitat Complex would range from 20,000 mg/L to 200,000 mg/L, and "could be located in areas that could provide relatively shallow water along the shorelines."

For the Partial or Marine Sea, a number of objectives have been slated to be included, such as:

- Salinity of 30,000 to 40,000 mg/L to maintain marine sea water quality;
- Water surface elevation of -230 feet mean sea level to maintain the shoreline as close as possible to existing conditions;
- Partial Sea water to be located near communities on the western and eastern shorelines, and managed wildlife and agricultural areas along the southern shoreline.

Together, the Marine Sea and the Saline Habitat Complex are to provide services that maintain or build upon the quality of such services in the past, including: fishing, boating, water skiing, bird watching, hiking, hunting, swimming, camping, and other sorts of activities (e.g., biking).

In terms of habitat that could be considered substitute habitat for current habitat, or perhaps even an improvement upon current habitat, the eight alternatives provide the following:

- Alternative 1: 38,000 acres of Saline Habitat Complex.
- Alternative 2: 75,000 acres of Saline Habitat Complex.
- Alternative 3: 61,000 acres of Marine Sea.
- Alternative 4: 88,000 acres of Concentric Lakes that would serve a similar role as the Saline Habitat Complex.
- Alternative 5: 45,500 acres of Saline Habitat Complex; 62,000 acres of Marine Sea.
- Alternative 6: 29,000 acres of Saline Habitat Complex; 74,000 acres of Marine Sea.
- Alternative 7: 12,000 acres of Saline Habitat Complex; 104,000 acres of Marine Sea
- Alternative 8: 18,000 acres of Saline Habitat Complex; 83,000 acres of Marine Sea.

The particular details of each alternative vary quite substantially, even in terms of where and how the Saline Habitat Complex and Marine Sea will be provided. Yet the common denominator across all of these alternatives is that they are to provide habitat that is intended to (i) restore the long-term stable aquatic and shoreline habitat to historic levels and diversity of fish and wildlife that depend on the Sea, and (ii) protect water quality. Hence, in our analysis

below, we do not evaluate and compare neither particular alternatives nor the specific configuration of any alternative. Rather, we compare the intent of these restoration plans—the provision of substitute habitat that at a minimum maintains the services and diversity that have been provided historically—to the outcome under a no-action alternative. We assume that the services at that have been provided at the Sea under the no-action alternative will either cease to exist, or those that still exist will be of substantially lesser quality relative to what has been historically provided (see our discussion in section II.1). Furthermore, we do not consider other elements of the restoration alternative that could be substantial, in particular, issues associated with air quality. Rather, we focus exclusively on the potential benefits of preserving ecosystem services such as those found at the Salton Sea, with particular attention to the values associated with birds, endangered and threatened species, biodiversity, and unique habitats.

Finally, we should note that all of the particular restoration alternatives require substantial construction activities over a number of years, beginning in 2012. The benefits of the services these alternatives are intended to provide may take between 18 and 66 years to come to fruition. Our analysis does not consider adjusting for differing time horizons over which these services will be provided. It should be noted, though, that during the interim period while the construction or these alternatives is occurring, a substitute habitat will be provided to mitigate the adverse impacts of the construction activities as well as any increases in salinity and habitat degradation occurring prior to construction. As noted in the Draft PEIR (2006, pp. 3-6):

> All eight alternatives would include up to 2,000 acres of shallow saline habitat for use by birds after the Salton Sea salinity becomes too high to sustain some species. This habitat would be constructed prior to construction of full-scale habitat components, and is referred to as Early Start Habitat. Early Start Habitat was assumed to be located at elevations between -228 and -232 feet msl. Early Start Habitat would be a temporary feature for two to six years and would be eliminated or assimilated as the alternatives are constructed along the southern shoreline prior to 2020.

Hence, overlooking the time dimension in terms of measuring the benefits these alternatives provide is not critical given the provision of this Early Start Habitat.

III. Non-market Valuation in Benefit-Cost Analysis

Much of the discussion surrounding the restoration of the Salton Sea has centered on the costs of the various alternatives, understandably so given these costs may exceed $4 or $5 billion over the 75 year horizon in which the restoration alternatives are evaluated. The focus on the costs also is likely due, in part, to legislation that mandates such an evaluation. The Secretary of the Resources Agency in California is mandated to establish "suggested criteria for selecting and evaluating alternatives" (Section 2081.7 of the California State Fish and Game Code, part (e)). Two explicitly mentioned criteria include an evaluation of the construction, operation, and maintenance costs of each alternative, and the identification of a cost-effective, technically feasible option. What is surprisingly absent from this discussion is the role the benefits, and in particular the quantification of the benefits, play in the choice of a preferred alternative. While there likely is no disagreement that restoration will cost substantial money, one need only pause briefly to realize that the benefits of restoration can also be substantial and as such, should be considered in concert with any discussion of the costs.

Consideration of the benefits as having equal footing with the costs of such preservation activities is not novel. Ciriacy-Wantrup (1952), Barnett and Morse (1963), and Krutilla (1967) all highlight this point in one way or another in the context of how government might go about considering the trade-offs it requires of its citizenry with respect to natural resource preservation. A major point emphasized by Krutilla, in terms of this trade-off, is to recognize that society benefits from preservation in real terms:

> When the existence of a grand scenic wonder or a unique and fragile ecosystem is involved, its preservation and continued availability are a significant part of the real income of many individuals. (Krutilla 1967; p. 779)

Furthermore, with the loss of similar habitat elsewhere, the value of these assets will likely increase:

> Natural environments will represent irreplaceable assets of appreciating value with the passage of time. (Krutilla 1967; p. 783)

The manner in which one might consider these preservation benefits is in the context of benefit-cost analysis, which we believe provides a more accurate comparison and evaluation of the merits from public spending on Salton Sea restoration than what is currently required of the Resources Agency. While the foundations of benefit-cost analysis can be traced back as far as Benjamin Franklin's discussion of prudential algebra, the formal use of benefit-cost analysis for large water-related projects can be linked to Eckstein (1958) in his evaluation of federal water-resource programs. In particular, Eckstein (1958, p. 2) references the Flood Control Act of 1936, which suggests that only projects where "the benefits, to whomsoever they may accrue, are in excess of the estimated costs" would be considered. Eckstein described benefit-cost analysis as a very promising approach for evaluating the use of scarce natural and financial capital that can provide a much stronger foundation for policy decisions than what might otherwise be available.

Such insight is certainly useful in the current discussion associated with the Salton Sea. The estimated price tag associated with the eight restoration alternatives range from $2.3 to $5.9 billion in construction costs alone. If decisions were based on just these costs, the no-action alternative would be the economically prudent strategy, costing $801 million.[7] Yet a more economically efficient approach, and one that echoes the sentiments of Eckstein, Franklin, and Krutilla, among others, is to consider the returns for the investment and choose the strategy that provides the greatest returns per dollar invested. The policy that maximizes the difference between total benefits and total costs, i.e., *net benefits*, is considered the most economically efficient solution.

Why there has not been greater focus on using benefit-cost analysis in the context of Salton Sea restoration is puzzling, especially when such an approach has been prominent for more than 30 years at federal level in consideration of major environmental, health, and safety regulations (Morgenstern 1997). Under President Reagan's Executive Order 12291, for instance, all major health, safety, and environmental regulations were subject to a regulatory impact assessment and needed subsequent approval by the Office of Management and Budget (OMB). OMB required the "potential benefits outweigh the costs" and that "of all the alternative approaches to the given regulatory objective, the proposed action will maximize net benefits to society." These requirements were amended slightly under Executive Order 12866 during the Clinton administration. EO 12866 replaced the condition "benefits outweigh costs" with "a reasoned determination that the benefits of the intended regulation justify its costs." Agencies were now allowed to "include both quantifiable measures and qualitative measures of costs and benefits" and to "select those approaches that maximize net benefits (including potential economic, environmental, public health and safety, and other advantages; distributive impacts, and equity)." Clinton's order endorsed benefit-cost analysis as a tool to help inform the regulatory process, without forcing it to adhere to any rigid decision-making formula.

Numerous real world examples exist of governments incorporating the benefits of preserving natural and environmental resources into their decision-making, both in the U.S. and abroad. Such evaluations cover a wide array of resources, including the Glen Canyon Dam (Bishop et al. 1989), Hell's Canyon (Krutilla and Fischer 1975), Mono Lake (Loomis 1987), the spotted owl in the Pacific Northwest (Hagen et al. 1992), Kootenai Falls in Montana (Duffield 1982), and the Kakadu Conservation Reserve in Australia (Imber et al. 1991), to name a few. In these and other studies, the preservation benefits associated with the environmental and natural resources were quantified and given standing in benefit-cost analysis. In each case, the quantification of the preservation benefits either supported an action for preservation, or modified an existing development scheme to be more environmentally friendly. A large part of the value of preservation, if not the largest component economically, is that value that is not traded in markets, i.e., its non-market value.

III.1 Non-market Environmental and Natural Resource Values

For most goods and services, the starting point for estimating value is the market price. Yet for many environmental and natural resource goods and services, no such market price exists. For

[7] Construction costs for the no-action alternatives include pre-existing regulations and mandates requiring protection of the desert pupfish, air quality management, and modification of the recreational facilities at the Salton Sea.

such goods as cleaner air, biodiversity, endangered species, and wildlife habitat, rarely are there market transactions revealing the price, and subsequently the value, of these goods and services to society. Consequently, the scarcity value of these goods and services is not readily apparent to policy makers in charge of determining how these scarce and often unique resources are to be allocated. As an example of this problem, consider the decision of how to allocate an acre of land in, say, Sequoia National Forest. There is value associated with the timber that could be obtained from these giant trees. Yet, there also is value in preserving the forest in its present state for recreation activities such as hiking, camping, and photography today and in the future. There is value indirectly in the habitat these forests and trees provide for other wildlife resources we enjoy. There is also value in simply knowing that these resources exist for use by others, and possible future use by current and future generations. As such, we define the value of a resource that is not revealed through market transactions as its non-market value. Without knowledge these non-market values, benefit-cost analysis is limited in its usefulness in aiding policy markers on how to efficiently and equitably allocate these resources.

The objective of non-market valuation is to estimate the economic value of these environmental and natural resources to society. Quantification of the benefits allows these goods and services to have equal footing in benefit-cost analysis. In considering the benefits of preservation, one would want to account for total value of the resource, where total value is defined as:

Total Economic Value = Use Value + Non-use Value.

Use value relates to the tangible use of the resource presently. It can include both consumptive use (e.g., *catch and keep* fishing) and non-consumptive use (e.g., photography, or *catch and release* fishing). Non-use value, as described in Kopp and Smith (1993; p. 340), is that "…component of the value of a natural resource that does not derive from the in situ consumption of the resource." Alternatively, Freeman (2003) notes that environmental values that are independent of peoples' current use have been given a variety of names, including non-use value, existence value, intrinsic value, and passive-use value. There are four general categories for non-use values, including: *option value*—the value that people place on a good or service for future possible use; *altruistic value*—the value someone places on the preservation of a resource for use by others in the current generation; *bequest value*—the value someone places on the preservation of a resource for use by future generations; and *existence value*—the value one places on a resource for its mere existence, possibly for moral or ethical reasons.

Non-market valuation techniques are widely accepted and used by federal and state agencies, including the National Marine Fisheries Service, the U.S. Water Resources Council, and state fish and game agencies in such states as Oregon, Nevada, California, Idaho, and Maine, to name a few (Loomis 1993).[8] And while the popular press has only recently begun extolling the importance of placing a value on non-market environmental goods and services,[9] these values, and the techniques used to estimate them, have been given standing in legislative mandates and by state and federal government agencies for decades, including: the Comprehensive Environmental Response, Liability, and Compensation Act (CERCLA) of 1980; the Oil

[8] For a complete description of these techniques, see Freeman (2003).

[9] For example, The Economist, 2005, April 3rd- 29th, pp. 76-78; Business Week, 2004, December 29th; Infocus Magazine, 2005; 4.3; Outside Magazine, March, 2005, pp. 106-123.

Pollution Act (OPA) of 1990; U.S. Water Resources Council; the U.S. Department of Interior (DOI); and the U.S. Forest Service. Federal and state agencies also consider non-market values when making natural resource allocation decisions. Since 1979, for example, the U.S. Army Corps of Engineers and U.S. Bureau of Reclamation have been required to assess the value of recreation benefits in cases where federal projects impact areas of high visitation (U.S. Water Resources Council 1979; Loomis 2005). The U.S. Environmental Protection Agency is required to conduct benefit-cost analyses of environmental regulations and must include estimates of non-market benefits. CERCLA mandates that lost recreation values and "passive use" values from toxic waste sites and hazardous materials spills must be assessed in order to measure the full value of damaged natural resources. Many states have funded studies measuring non-market values associated with recreation, including the State of California, which sponsored an analysis of the values of protecting Mono Lake as a bird habitat (Loomis 2005). The validity of valuing changes in natural resource quality has been upheld in state and federal courts, and these techniques have been useful in guiding resource allocation decisions at state and federal levels.

In considering the non-market values associated with preservation of the Salton Sea, a variety of stakeholders come to mind. The Sea provides many non-market benefits to the State of California. As mentioned in Section II, thousands of visitors frequent the Sea annually for birdwatching, it has been the only Talapia sports fishing area in the state, and other activities such as camping, boating, and swimming occur throughout the year. Indeed, on average nearly 200,000 visitors annually frequent the Salton Sea State Recreation Area alone. According to IEEC (1998), the total value in 1998 of all Salton Sea properties within ½ mile of the shoreline was $154.8 million, while the total population within five miles of the Salton Sea was estimated to be fewer than 15,000. Maintaining and/or enhancing recreational uses can impact a large population base, including residents from San Diego and Los Angeles, California.

The Sea also provides non-market benefits to the nation as a whole. The Salton Sea is ranked as the second highest birding area in the nation. Indeed, 90% of the North American population of eared grebes, more than 80 percent of the entire western U.S. population of white pelicans, and nearly half of the U.S. population of Yuma clapper rails (an endangered subspecies) utilize this habitat. The Sea is also one of the two nesting areas in the western US for gull-billed terns, a bird proposed for listing as a threatened species. From a fishery perspective, the Sea has supported eight species of fish, including the federally endangered desert pupfish and four important sport fishes (Tilapia, Bairdiella, Sargo, and Orangemouth Corvina).

While citizens throughout the U.S. are likely to have positive use and non-use values for preserving ecosystem services at the Salton Sea, geographic proximity likely plays some role in influencing the magnitude of these values. While there is an obvious connection between use value and proximity, particular types of non-use values (e.g., option value, altruistic value, and bequest value) are likely to be influenced by proximity as well. From a regional or national perspective, then, other states along the Pacific Flyway—Washington, Oregon, and Arizona—are likely to have fairly high non-market values for Salton Sea preservation. Furthermore, given that Nevada is contiguous with California and has a major metropolitan center less than a one-day drive from the Salton Sea, they too likely have large non-market values for Sea preservation.

III.2 The Contingent Valuation Method and Non-use Values

Much, if not most, of the value and benefits of preserving the Salton Sea likely is represented by non-market values, and in particular, the non-use value component of total value. In the studies presented below from which we identify possible values associated with Salton Sea restoration, the Contingent Valuation Method (CVM) is often used. CVM is one of the most popular methods for estimating non-market values, and the most popular method for estimating non-use values as it is one of two methods that estimate these values.[10] As a stated preference method, CVM uses a survey to create a realistic, albeit hypothetical, market where peoples' values for a good or service are expressed. CVM is well-suited for estimating the preservation value associated with the Salton Sea as it allows estimation of total value of any particular good or service, or habitat, rather than components of that value. CVM is a well-accepted technique for valuing non-market goods and services, with there being far greater than 1600 CVM studies estimating non-market values in over 40 countries (Carson et al. 1994). The U.S. DOI has adopted CVM to measure non-market values for damages under CERCLA, while NOAA has endorsed the use of this method for damage assessment under the Oil Pollution Act of 1990; it is also recommended by the U.S. Water Resources Council (1979) for use in benefit-cost analysis.

CVM surveys consist of four main elements. The first element is a description of the program the respondent is asked to value or vote upon. This element often involves a description of the baseline services with no action, and an improved level of services with some type of policy action. Identifying the conditions of the "no-action" alternative and other restoration options will require research by the physical and biological scientists on this team. The second element of the CVM is specifying a mechanism for eliciting value or choice. There are a variety of options for eliciting value, the most well-accepted being a referendum type question that asks the respondent to vote yes or no to a specified price or prices. A "payment vehicle" describing the manner in which the hypothetical payments are collected is the third element. Such vehicles have included higher taxes or utility bills, or a payment into a trust fund (Loomis et al. 2000). The fourth element consists of collecting information on respondent attitudes and characteristics including socioeconomic characteristics and environmental attitudes.

It should be mentioned that the measurement of non-use values, and in particular using CVM to measure non-use values, has generated controversy. In theory most economists seem to agree that non-use values are indeed a legitimate value; in practice, though, there is concern as to the reliability of such estimates since non-use values entail no actual observable use (Hausman 1993). In an effort to assess the reliability of CVM in measuring non-use values, NOAA convened a panel of prominent social scientists co-chaired by two Nobel Laureate economists. The panel concluded that if CVM practitioners follow a certain set of conditions, the results obtained from CVM are likely to be reliable (Arrow et al. 1993) and a useful starting point for administrative and judicial decisions. Subsequent research has discussed issues associated with the conclusions of the NOAA panel, and provided additional procedures that ensure CVM reliability (Hanemann 1994). There is precedent at the federal levels for acknowledging and incorporating non-use values into economic analysis. The U.S. DOI under CERCLA, and NOAA under the Oil Pollution Act of 1990, both endorse including non-use values in their economic analyses associated with measuring the loss in value from chemical and oil spills.

[10] For a complete description of this method, see Freeman (2003).

IV. Case Studies of Non-Market Benefits Estimates for Ecosystem Services

The most accurate and reliable assessment of the non-market benefits provided by the ecosystem services of the Salton Sea would require a primary valuation study. Such a study would involve a detailed survey of a sample of the population of individuals who potentially benefit from the ecosystem services of the Sea. This sample would include both users of the Sea (e.g., birders, anglers, hunters) as well as people who have not used the Sea and who may not even plan to use it, but who nonetheless derive benefits from the flow of ecosystem services in the form of non-use value. The survey data would form the basis for a statistical analysis of individual values, which would then be extrapolated from the survey sample to the relevant population to determine the aggregate benefit provided to the public by the ecosystem services of the Sea.

Currently it is not possible to conduct a primary valuation study for the Salton Sea because both time and funding are insufficient. But it is possible to examine the results of previous studies of similar resources in order to gain a better understanding of the likely magnitudes of non-market benefits derived from the Sea. The use of information from previous primary valuation studies to inform current decisions is known as "benefit transfer" (Rosenberger and Loomis 2003).

Generally the initial steps in any benefit transfer involve: (1) defining the policy context; (2) conducting a thorough literature review; and (3) screening and evaluating the previous research studies. Subsequently, various statistical tools can be brought to bear on the estimates derived in the previous studies in order to "transfer" the information to the case at hand. Relatively simple applications involve calculating an average per-unit value from the previous studies and using that quantity to approximate the per-unit value in the current application. This is often called "value transfer." More complex analyses involve using the previous studies to estimate a "benefit function" that accepts as inputs the characteristics of a resource and provides as output a value estimate. This is often called "function transfer" (for an example involving wetlands, see Brander et al. 2006).

The purpose of this report is to accomplish steps (1) – (3) and then to provide some preliminary estimates using the value transfer method that suggest the likely magnitude of non-market benefits provided by the Salton Sea. These estimates are preliminary because we are unable to undertake a formal statistical analysis of the previous research studies at this time. However, our approach conforms to accepted benefit transfer practices.

IV.1 Research Methodology and Literature Search Strategy

To identify previous valuation studies with potential relevance for the Salton Sea, we undertook a thorough search of the environmental and natural resource economics literature on ecosystem service valuation. We focused on the types of services that tend to benefit geographically dispersed populations, rather than just the local population residing in the immediate vicinity of the resource.[11] Our search included: (1) the EconLit database, which is the American Economic

[11] It is worth emphasizing that the purpose of this report is not to focus on the types of values the Sea provides to its local resident population, but rather the types of values it provides to a much broader set of individuals residing in California, throughout the U.S., and perhaps even in other countries.

Association's electronic bibliography and the main repository for academic research in all economics disciplines, including over 782,000 records; (2) the Environmental Valuation Reference Inventory (EVRI), which is maintained by Environment Canada and includes over 1,700 economic valuation studies; (3) Google Scholar, which provides access to potentially relevant papers published in disciplines other than economics that may not be included in the preceding databases; and (4) our own private collections of literature on natural resource valuation. We searched for studies that addressed combinations of the following topics: existence, option, preservation, bequest, altruistic, passive use, or non-use value; birds, fish, endangered, or threatened species; ecosystem, wetland, flyway, habitat, or biodiversity; waterfowl hunting; Mono Lake, San Joaquin Valley, Owens Lake, Great Salt Lake, Aral Sea, or San Diego National Wildlife Refuge; or contingent valuation.

IV.2 Results and Interpretation

Our initial searching and screening of these sources and topics produced around 70 studies. Our secondary screening narrowed the list to 23 studies of which 20 included at least one value with potential relevance for the Salton Sea. These 23 studies are summarized in table 1. They also are grouped according to topical similarity: San Joaquin Valley (7 studies), Mono Lake (3 studies), endangered species (5 studies), waterfowl hunting (3 studies), and other (5 studies).

Table 1 is organized as follows. The first column provides the bibliographic source. We were able to locate copies of 21 of the 23 studies; for the remaining 2 studies we relied on summaries provided by EVRI. The second column summarizes the most relevant valuation information from each study: typically the resource(s) that was (were) valued, the relevant population, and the reported value estimate(s). In this column we also translate reported values to current values by adjusting each reported estimate to 2006 dollars using the U.S. Bureau of Labor Statistics' Consumer Price Index (U.S. Department of Labor 2006). The third column identifies the relevance of each study for the Salton Sea and the fourth column provides additional comments.

IV.2.a San Joaquin Valley Studies

Before it was intensively developed for agricultural and urban uses, the San Joaquin Valley (SJV) provided habitat for between 5 and 10 million resident and migratory waterfowl and 100,000 spawning Chinook salmon annually (Jones & Stokes Associates (JSA) 1990). By the mid 1980s, the bird population had declined to nearly 500,000, the salmon population had declined to approximately 30,000, and about 90% of all wetlands in the SJV had been lost (JSA 1990). As part of an effort to address the problem of agricultural drainage in the SJV and its impacts on natural resources, a contingent valuation study was conducted by Jones & Stokes Associates, Inc. (JSA 1990) to estimate the economic values associated with alternative fish and wildlife programs. Here we review this study (the JSA-SJV study) and the analyses it spawned.

The JSA-SJV study surveyed selected households in California (both within and outside of the SJV), Oregon, Washington, and Nevada in order to determine estimates of both use and non-use values. By focusing on these states, the study captured values held by residents in the heart of the Pacific Flyway, of which the SJV is an important part. Clearly residents in other states and countries may also benefit from the ecosystem services of the SJV, but this study focused on the

region where individual values arguably could be highest. The values estimated by the study later were used to determine the economic efficiency of transferring water from existing uses, such as agriculture, to wetlands and the San Joaquin River.

The JSA-SJV study focused on five possible environmental programs and asked respondents to state whether they would vote for each program if it would cost their household some additional amount in taxes each year. The programs were (JSA 1990):

- Wetlands habitat and wildlife maintenance program. Prevents a 70% decline in high-quality wetlands habitat (from 85,000 to 27,000 acres); prevents an 85% decline in resident bird populations and a 65% decline in migratory bird populations; maintains other threatened and endangered species in the SJV at their current population levels.
- Wetlands habitat and wildlife improvement program. Increases high-quality wetlands habitat by 45% (from 85,000 to 125,000 acres); increases resident bird populations by 40% and migratory bird populations by 45%; increases populations of other threatened and endangered species in the SJV by about 50%.
- Wildlife contamination control maintenance program. Prevents an increase (from 70% to 95%) in the percentage of the SJV's resident bird population that is regularly exposed to harmful levels of contamination.
- Wildlife contamination control improvement program. Reduces (from 70% to 20%) the percentage of the SJV's resident bird population that is regularly exposed to harmful levels of contamination.
- San Joaquin River and Salmon improvement program. Increases annual number of spawning Chinook salmon from less than 100 to 15,000; increases commercial salmon catch by about 6% and recreational catch by about 5%; improves habitat for resident and migratory bird populations; improves wildlife viewing opportunities and scenic quality; improves opportunities for water-based recreation (rafting, canoeing, kayaking).

The data collected by the JSA-SJV study was used by six of the seven *San Joaquin Valley* studies listed in table 1. The six studies differ in terms of their statistical methods, their relevant populations (some use all respondents, one uses only California residents, one uses only SJV residents, one uses non-SJV California residents), and their main foci (one focuses on distance, another on substitution effects across the five programs). The seventh study in this section uses a different data set—a survey of visitors to SJV wetlands—to estimate use value.

The relevance of these studies for the Salton Sea is clear. Each assesses use and/or non-use values held by western U.S. residents for maintaining or improving ecosystem services in the California section of the Pacific Flyway. Each focuses on wetlands habitat and bird populations. Several demonstrate significant value held by residents who do not reside in the immediate vicinity of the resource. All of these characteristics are applicable to the case of the Salton Sea.

San Joaquin Valley Studies: Values

Using the information summarized in table 1, we can generate a range of estimates for the current annual value of 1,000 acres of SJV wetlands to an average household (in 2006 dollars):[12]

For the average household in CA:

- Annual value of 1,000 acres of SJV wetlands saved: $4.31
- Annual value of 1,000 acres of SJV wetlands created: $6.15-$10.33

For the average household in OR, WA, and NV:

- Annual value of 1,000 acres of SJV wetlands saved: $2.59
- Annual value of 1,000 acres of SJV wetlands created: $4.18-$6.55

For the average household in CA, OR, WA, and NV:

- Annual value of 1,000 acres of SJV wetlands saved: $4.26
- Annual value of 1,000 acres of SJV wetlands created: $10.20

Extrapolating the per-household values to the number of households reported in the 2000 census (U.S. Department of Commerce 2001), which is a conservative estimate of the current number of households, gives (in 2006 dollars):

For all households in CA:

- Annual value of 1,000 acres of SJV wetlands saved: $49.6 million
- Annual value of 1,000 acres of SJV wetlands created: $70.7-$118.9 million

For all households in OR, WA, and NV:

- Annual value of 1,000 acres of SJV wetlands saved: $11.3 million
- Annual value of 1,000 acres of SJV wetlands created: $18.2-$28.5 million

For all households in CA, OR, WA, and NV:

- Annual value of 1,000 acres of SJV wetlands saved: $67.6 million
- Annual value of 1,000 acres of SJV wetlands created: $161.8 million

Using the lowest estimates, the current annual value of 1,000 acres of SJV wetlands is:

- $49.6 million to all households in CA
- $11.3 million to all households in OR, WA, and NV
- $67.6 million to all households in CA, OR, WA, and NV

San Joaquin Valley Studies: Summary

To the extent wetlands at the Salton Sea provide ecosystem services similar to those provided by wetlands in the SJV, and to the extent people value these services similarly, a conservative

[12] This analysis assumes a constant per-acre value and does not consider statistical confidence intervals that may have been reported in the original studies.

estimate of the current state-wide annual value of 1,000 acres of wetland habitat at the Salton Sea is approximately $50 million. Applying this estimate to each of the eight restoration alternatives implies the following state-wide annual values:

- Alternative 1: $1.9 billion for 38,000 acres of Saline Habitat Complex.
- Alternative 2: $3.75 billion for 75,000 acres of Saline Habitat Complex.
- Alternative 3: Unknown value for 61,000 acres of Marine Sea.
- Alternative 4: $4.4 billion for 88,000 acres of Concentric Lakes that would serve a similar role as the Saline Habitat Complex.
- Alternative 5: $2.275 billion for 45,500 acres of Saline Habitat Complex; unknown value for 62,000 acres of Marine Sea.
- Alternative 6: $1.45 billion for 29,000 acres of Saline Habitat Complex; unknown value for 74,000 acres of Marine Sea.
- Alternative 7: $0.6 billion for 12,000 acres of Saline Habitat Complex; unknown value for 104,000 acres of Marine Sea
- Alternative 8: $0.9 billion for 18,000 acres of Saline Habitat Complex; unknown value for 83,000 acres of Marine Sea.

Assuming any of these alternatives would adequately restore the ecosystem services provided by the Sea and prevent future degradation, Alternative 7 suggests that the state-wide value of preserving the Sea is at least $0.6 billion annually and probably significantly higher due to the unknown value associated with the large Marine Sea. Alternatives 1, 2, and 4 suggest the state-wide value is between $1.9 and $4.4 billion annually. We believe the latter range is more indicative of the actual value.

However, caution should be used in transferring any of the estimated SJV values directly to the Salton Sea. Despite their many similarities, the Salton Sea and the SJV are different places marked by different characteristics. People's perceptions of them may differ and therefore their values may differ. The JSA-SJV study also was conducted 17 years ago when the population of the western U.S. was different than it is today. Although none of these arguments should be interpreted as justification for necessarily discounting the values reported in table 1 (indeed, as wetland habitat along the Pacific Flyway becomes more scarce (Dahl et al. 1997; Friend 2002), its value is likely to rise; furthermore, as people become wealthier, their willingness to pay for preservation efforts tends to increase), they should be interpreted as rationale for treating the value transfer as a *suggestive* estimate. A significantly more accurate estimate could be obtained from a primary valuation study of the Salton Sea.

IV.2.b Mono Lake Studies

Mono Lake is a 760,000 year-old saline lake which historically contained about 4.3 million acre-feet of water with an average depth of around 78 feet and an approximate surface area of 54,700 acres (Mono Lake Committee 2006; JSA 1993). Since 1941, the City of Los Angeles has been using the lake's natural inflow as a water source when it extended the first Los Angeles aqueduct north into the Mono Basin. When the second Los Angeles aqueduct was completed in 1970, the city began diverting its full allocation of 100,000 acre-feet of water each year (Loomis 1987). Due to both water diversions and drought, the lake level fell significantly and the ecosystem—

which provides nesting habitat for substantial portions of the California population of California gulls and the world population of Eared Grebes—became increasingly stressed (Loomis 1987). The scenic quality of the lake and its suitability as a recreational resource also were damaged. A series of court cases eventually established that the State of California must balance its enforcement of the right to divert water against its duty to steward natural resources, and that this balancing may involve modifications to existing water rights when diversion causes unavoidable damages (Loomis 1987).

To help inform the debate regarding the definition of "balance," a contingent valuation study was conducted to determine the public benefits derived from the Mono Lake ecosystem (Loomis 1987). After reviewing this study, the California State Water Resources Control Board (the State Water Board) required an even more thorough non-market valuation study as part of the Environmental Impact Report (EIR) for the Mono Basin Water Rights Review. This study was conducted by Jones & Stokes Associates, Inc. (JSA 1993) and also included a contingent valuation survey. The two contingent valuation studies were similar but the values reported in the EIR (the JSA-Mono Lake study) generally were more conservative.

Both studies surveyed selected households in California in order to estimate both use and non-use values associated with Mono Lake.[13] As in the case of the SJV wetlands, residents in other states and countries may also benefit from the ecosystem services provided by Mono Lake; but these studies again focused on the region where individual values are probably highest. In the Mono Lake case, this region coincided with the political entity charged with balancing the costs and benefits of competing uses. The values estimated by these studies, particularly the JSA-Mono Lake study, were used to assess how much the public should invest in water conservation practices and/or reallocate existing diversions from lower to higher valued uses.

The key issue in the Mono Lake case is the lake elevation, which is directly linked to the scenic quality of the lake, recreation opportunities, water quality, air quality, habitat suitability and food availability for birds, and water supply for Los Angeles. Therefore each of these studies developed alternative lake elevation scenarios to be evaluated by respondents. Each lake elevation corresponded to a set of conditions that were described to respondents who were then asked questions about their preferences for the different scenarios. Loomis also conducted a follow-up study (Loomis 1989) to determine if values had changed through time.

Mono Lake Studies: Values

In 1994 the State Water Board established a target lake elevation of 6,392 feet. Although this level is about 25 feet below pre-1941 levels, the Board determined that this level would adequately restore the ecosystem services and prevent future degradation. Using the information summarized in table 1, we can generate a range of estimates for the current annual value of maintaining an "ecologically adequate" lake level, as defined by the State (in 2006 dollars):[14]

For the average household in CA:

[13] The JSA-Mono Lake study also conducted a separate regional assessment of recreation benefits, but the recreation benefits that are specific to Mono Lake also are included in the contingent valuation estimates.

[14] Again we do not consider statistical confidence intervals that may have been reported in the original studies.

- Annual value of maintaining a 6,387-foot elevation (Loomis 1987): $288-$656
- Annual value of maintaining a 6,387-foot elevation (Loomis 1989): $199-$252
- Annual value of maintaining a 6,390-foot elevation (JSA 1993): $131

It is important to note that these values are relative to a "no-action" scenario that was specified in each study. That is, these values represent average household willingness to pay to achieve the specified lake level *rather* than allow the lake level to decline to the no-action level. As table 1 shows, the no-action level specified by Loomis (6,342 feet) was much lower than the no-action level specified in the EIR (6,372 feet). We suspect the relatively higher values derived by Loomis were largely due to this difference: with more at stake, people were willing to pay more.

Extrapolating these per-household values to the number of households reported in the 2000 census (U.S. Department of Commerce 2001), which is a conservative estimate of the current number of households, gives (in 2006 dollars):

For all households in CA:

- Annual value of maintaining a 6,387-foot elevation (Loomis 1987): $3.3-$7.5 billion
- Annual value of maintaining a 6,387-foot elevation (Loomis 1989): $2.3-$2.9 billion
- Annual value of maintaining a 6,390-foot elevation (JSA 1993): $1.5 billion

Mono Lake Studies: Summary

To the extent the ecosystem services provided by a restored Mono Lake and a restored Salton Sea to the residents of California are similar, and to the extent people value these services similarly, a conservative estimate of the current state-wide value of adequate restoration and preservation of the Salton Sea is approximately $1.5 billion annually.

However, as before, caution should be used in transferring any of these values directly to the Salton Sea. Although Mono Lake and the Salton Sea exhibit many of the same important characteristics, they also exhibit important differences that have not been quantified here. People's perceptions of these resources also may differ and therefore their values may differ. Both the Loomis study and the JSA-Mono Lake study were conducted 15-20 years ago when the population of California was different than it is today. Again, these arguments should not be interpreted as justification for discounting or inflating the values in table 1, but they should be interpreted as strong motivation for treating the value transfers as *suggestive* estimates. A significantly more reliable estimate could be obtained from a primary valuation study of the Salton Sea.

IV.2.c Endangered Species Studies

Table 1 presents five studies of endangered species preservation. Four of these studies are primary valuation studies and one is a meta-analysis of previous work. The species examined by the four primary valuation studies include: the Riverside fairy shrimp, the whooping crane, the Mexican spotted owl, and the striped shiner. Although the relevance of each study for the Salton Sea is provided in the table, both individually and as a whole the values estimated by these studies are not as informative or as transferable as those for the SJV and Mono Lake. Generally

this is because the SJV and Mono Lake studies focus on whole ecological systems that provide a myriad of benefits to the public, whereas these studies focus on the value of preserving individual species.[15] The SJV and Mono Lake studies therefore provide more reliable assessments of the total non-market value associated with a resource like the Salton Sea. Our discussion of the endangered species studies, therefore, is more limited.

As a group, these studies generally demonstrate significant non-use value held by U.S. residents (or subsets thereof) for preserving endangered bird and fish species. Two of these species—the Riverside fairy shrimp, which is native to Southern California, and the striped shiner—could be characterized as obscure or uncharismatic but potentially important components of the food web. This is particularly true for the fairy shrimp which is an important food source for migratory birds (Stanley 2005). Similarities with the Salton Sea are evident.

It is important to note that it would not be appropriate to simply add the value of species preservation to an estimate of ecosystem value similar to those presented above because doing so likely would involve double-counting certain benefits. However, it is reasonable to expect that people place higher values on ecosystem preservation efforts when an endangered species is involved *ceteris paribus*.[16] The presence of multiple threatened and endangered species at the Salton Sea, including the Yuma clapper rail and the brown pelican, thus would tend to increase preservation values.

Lastly, it is also worth noting that Stanley (2005) argues for national support of species preservation efforts because the benefits of such efforts tend to be geographically wide-spread. A primary valuation study of the Salton Sea that includes residents from throughout the western U.S. likely would capture a significant portion of this dispersed value.

IV.2.d Waterfowl Hunting Studies

Upon first consideration, the benefits provided by the Salton Sea to waterfowl hunters might seem to comprise a relatively small portion of its total non-market value. This would seem to be especially true if one considers only hunting trips taken to the Sea itself. But the Sea is an important component of the Pacific Flyway. The characteristics of the Sea help to determine the types and numbers of birds using the Flyway and thus affect the quantity and quality of hunting trips taken throughout the Flyway. In other words, just as preservation efforts at the Sea provide non-use value for residents who live far away and may never visit the Sea, such efforts also provide use value for hunters who also never visit the Sea but who hunt elsewhere in the Flyway.

According to the U.S. Fish and Wildlife Service, nearly 2.5 million hunting trips were taken for migratory birds in the Pacific Flyway states of CA, OR, WA, and NV during 2001 (U.S. Department of the Interior 2001). Using the most conservative estimate of the net benefit of a

[15] Preservation of a species typically involves preservation of its habitat which likely generates other benefits. However, the contingent market that must be created to assess the value of preserving a species tends to be different from the market created to assess the value of preserving habitat that contains a species; therefore the estimated values tend to be different.

[16] We are unable to find statistical evidence that supports this reasoning.

trip from table 1 ($47), the current annual net value of hunting migratory birds in these states is approximately $115 million.[17]

The portion of this net value that can be attributed to the ecosystem services provided by the Salton Sea is unclear. It has been shown that hunters value more bird sightings (Duffield and Neher 1991), so to the extent the Salton Sea ecosystem supports the migratory bird population of the Flyway, it adds to the value of each trip currently taken (and thus to the total value of hunting). Higher bird numbers may also encourage more trips to be taken, which also would increase the total value of hunting in the Flyway.[18] Furthermore, as the total amount of habitat in the Pacific Flyway decreases, each remaining refuge plays an increasingly important role in sustaining the bird population. Less habitat generally means less food, fewer nesting sites, and increased risk of disease due to the effects of concentrating the population in relatively few areas.

As before, it is important to note that it would not be appropriate to add the value of hunting in the Flyway to an estimate of ecosystem value because doing so likely would involve double-counting certain benefits. Rather, we highlight this use value to emphasize that both use and non-use values provided by the Sea are probably both large in magnitude and geographically widespread. A contingent valuation study that includes residents throughout the Pacific Flyway could capture this aspect of preservation value.

IV.2.e Other Studies

The remaining five studies in table 1 cover a range of subjects, each related to the Salton Sea. Three are primary valuation studies of Pacific coast seabirds, migratory birds in the Central Flyway, and wetlands in the northeastern U.S. One is a meta-analysis of wetland valuation studies. Notably, the study by Loomis (2000) emphasizes the diffuse nature of benefits derived from resource preservation programs. For six different programs, the study estimates the fraction of total national value that is held by residents within the state(s) where the resource is located. The study finds that, on average, state residents hold only 13% of the total value, with the remaining benefits accruing to out-of-state residents. For California, the fraction is slightly higher at 18%, and it is not possible to rule-out percentages as high as 100% for two of the three California programs considered. Nonetheless, these results reinforce the argument by Stanley (2005) that national support for preservation efforts typically can be justified on the basis of geographically wide-spread benefits. This is likely to be true especially for large-scale efforts.

IV.3 Summary of Results

Our review of the relevant literature produced 23 studies of which 20 contain at least one value which is potentially relevant for the Salton Sea. Of these studies, those which address wetlands and wildlife in the San Joaquin Valley and those which address the Mono Lake ecosystem are

[17] Net benefit (or net value) is the difference between the gross benefit derived and the cost incurred. All other values reported in this report are gross benefits, which can be measured as willingness to pay (WTP). Using the estimated (gross) benefit of a hunting trip in the Montana section of the Pacific Flyway from table 1 ($140) yields a current annual value of $342 million for hunting in these four Flyway states.

[18] Duffield and Neher (1991) examined this possibility but did not find a statistically significant effect. We are unable to find statistical evidence that supports this reasoning.

most relevant and provide the most useful benefits estimates. Keeping in mind the uniqueness of the Salton Sea—which we believe tends to increase its value while also making it difficult to transfer benefits estimates from previous research—and the caveats we have provided throughout this report, we believe that a conservative order-of-magnitude estimate of the non-market benefits provided to the residents of California by a restored and preserved Salton Sea would be in the range of $1-$5 billion annually. This is an annual value expressed in 2006 dollars. It is largely based on the $1.9-$4.4 billion benefit estimate calculated from the SJV studies and on the $1.5 billion benefit estimate calculated from the Mono Lake studies. This estimated range includes both use and non-use value, but probably mostly non-use value.

When considering whether to invest in a project that will generate returns for many years into the future, economists regularly convert all future payments into present values to determine whether the investment is expected to produce a positive net return. By specifying a discount rate and a time horizon, and making the conservative assumption that the nominal annual benefit derived from the Sea remains constant through time, we can convert our estimated range of annual benefits into a present value so that it may be more readily compared with anticipated costs. Table 2 provides the present value of $1 billion annually for different discount rates and time horizons. Multiplying each table entry by 5 gives the present value of $5 billion annually for the same combinations of discount rates and time horizons.

Some additional considerations are worth mentioning when interpreting this estimated range of preservation benefits. First, assuming the transferability of the SJV and Mono Lake estimates is high (something we cannot determine with certainty without conducting a similar primary valuation study of the Salton Sea), we are inclined to believe that they probably underestimate the total non-market value of the Sea. We believe the SJV estimates are low primarily because they value only wetland habitat. The other attributes of the Sea clearly have positive values that are not included in this estimate. We believe the Mono Lake estimate is low primarily because the Sea is significantly larger than Mono Lake and seems to provide a wider variety of services to society. Furthermore, we believe the higher Mono Lake estimates by Loomis (1987, 1989) may provide better comparison values for the Sea because they are based on a relatively worse no-action scenario. Compared to the no-action scenario considered in the Mono Lake EIR (JSA 1993), we think the no-action scenario considered by Loomis is more similar to that for the Salton Sea.[19]

However, people's perceptions of the Sea could differ significantly from their perceptions of the SJV wetlands and Mono Lake, and this could lead to lower values being associated with the Sea. Mono Lake, in particular, is a very unique resource with a relatively high degree of scenic quality. We would not be surprised if western U.S. residents generally are more aware of Mono Lake than they are of the Sea, and this, too, could affect aggregate values. There also may be a perception that the SJV wetlands and Mono Lake are more "natural" resources deserving of preservation whereas the current Sea was formed (and continues to be sustained) by human manipulation of the environment. We are not passing judgment on such perceptions; rather we simply are highlighting their role in value determination.

[19] It is also worth noting that the time horizon considered in Loomis' no-action scenario—30 years—is very similar to the expected amount of time it would take the Sea to transition in the absence of a restoration effort.

On the other hand, the Sea is linked to a much larger local economy than is Mono Lake, and it is arguably a much more important part of this economy than are wetlands to the SJV economy. Furthermore, this economy exhibits a high degree of poverty and health problems (Cohen and Hyun 2006) relative to the state-wide averages in California. To the extent people are willing to pay to achieve a more equitable distribution of wealth and well-being in society, this would tend to increase the values derived from preserving the Salton Sea.

Lastly, it is worth noting that the Draft Environmental Assessment and Land Protection Plan for the South San Diego Bay Unit of the San Diego National Wildlife Refuge states, "… values on the order of $10 to $100 per household per year [are] representative of the value California households place on the protection of resources such as South San Diego Bay." (U.S. Department of the Interior 1998, p.75) This range refers to non-use values and was used in the socioeconomic analysis for the Refuge, which also provides habitat in the Pacific Flyway and is in relatively close proximity to the Salton Sea. However, the total amount of protected area being considered at the time was, at most, only 5,000 acres. Converting this range of household values to 2006 dollars, aggregating across all California households (again using the 2000 census figures), and rescaling to 1,000 acres gives a total value in the range of $28 million to $280 million annually. Although we place relatively less faith in the accuracy of this estimate, it nonetheless appears to be consistent with our preceding estimate of $50 million for 1,000 acres.

V. Conclusions

The Salton Sea is a unique, biological diversity habitat that supports an abundance of wildlife. From an avian perspective, and quoting Shuford et al. (2002):

> Various studies indicate the Salton Sea is of regional or national importance to various species groups—pelicans and cormorants, wading birds, waterfowl, shorebirds, gulls and terns—and to particular species—the Eared Grebe, American White Pelican, Double-crested Cormorant, Cattle Egret, White-faced Ibis, Yuma Clapper Rail, Snowy Plover, Mountain Plover, Gull-billed Tern, Caspian Tern, Black Tern, and Black Skimmer.

As Cohen and Hyun (2006) note, in addition over 402 bird species having been recorded in and around the Salton Sea, the Sea provides habitat to two species listed on the Federal Endangered Species List—the Yuma Clapper Rail and the Brown Pelican—and is possibly the most critical wintering habitat for eared Grebes worldwide. Through its role in providing food (e.g., fish), as a roosting or nesting site, or as a stopover or wintering habitat for migratory birds along the Pacific Flyway, Salton Sea provides services to society at the local, state, regional, national, and international levels.

Unfortunately, without substantial human intervention, the Salton Sea will cease to provide such an impressive array of critical, unique, and abundant services. Rising salinity levels, continual inflows of pollution from agricultural drainage and wastewater flows, and a water transfer scheme that threatens to exacerbate salinity rise and inflow reductions will damage and degrade this habitat for roosting and breeding, and eliminate the food source (fish) for many of the bird species. The outcome of this trend in habitat degradation and loss could be significant, for both

the Salton Sea in its ability to serve its historic function as a habitat for both birds and fish, and for the existence and health of particular bird and fish populations themselves.

The objective of this report is to provide an approximate value for what society might gain from restoring and preserving the Salton Sea using a simple benefits transfer approach. While time constraints restricted our ability to perform a specific and complete valuation study of the restoration alternatives for the Salton Sea relative to a baseline with no-action, or to analyze statistically the results from previous studies in a meta-analysis, we were able to obtain valuation estimates from previous studies that did perform such analyses of unique habitats, ecosystems, or endangered and threatened species. Based on the estimated values from a variety of ecosystem or species valuation studies, and assuming the Salton Sea provides similar services or provides habitat to similarly valued individual and threatened species as investigated in these other studies, restoration and preservation of the Salton Sea may be worth between $1 and $5 billion annually to California residents.

Caution is warranted regarding the interpretation of these estimates because they are based on previous studies involving different natural characteristics, different populations, and at different time periods. Yet, *ceteris paribus*, economic theory suggests that loss of substitute habitat, increasing populations in California, the western U.S., and the U.S. as a whole, and increasing real income levels would all put upward pressure on these preservation values. To echo Krutilla (1967) again, these unique natural resources are assets of appreciating value that provide a significant part of the real income of many individuals. Furthermore, most of the studies we analyze are specific to a state or region rather than national in scope. Based on the results of Loomis (2000) who evaluates six different resource preservation programs, residents within the states where each resource is located hold only a fraction of the total national value. Furthermore, as estimated in Loomis and White (1996) through their meta-analysis of valuation studies for rare, threatened, and endangered species, the authors find that even for the most costly endangered species preservation efforts, the benefits are likely to exceed the costs. With these factors in mind, there are many reasons to believe that the estimates developed here are conservative estimates of the national values associated with Salton Sea restoration/preservation.

In conclusion, while the costs of restoring the Salton Sea has been touted as exorbitant, with estimates exceeding $4 or $5 billion, when one considers the possible benefits of these restoration alternatives based on previous studies valuing other threatened ecosystems and species, the benefit-cost ratio, and indeed the net benefits, could very well likely be large. Clearly, for a more accurate representation of the benefits associated with restoration, a more specific and detailed valuation study of the restoration alternatives associated with the Salton Sea would need to be performed. Yet with limited time before the legislature makes a decision based on the alternatives presented to it, information on the possible returns from restoring the Salton Sea may be gleaned from previous studies that have confronted similar situations. Time and time again, it seems to be the case that when the non-market benefits of these unique natural resources are placed on equal footing with the costs of restoration, preservation seems to come out as the economically efficient strategy. And from our perspective, we see no reason why such benefits should not be given standing in light of such precedence by other agencies, mandates, and legislation at both the state and federal level.

VI. References Cited in the Main Text

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Table 1. Previous Environmental Benefits Estimates with Potential Relevance for the Salton Sea Restoration Project.

Source	Summary	Relevance	Comments
	San Joaquin Valley		
Jones & Stokes Associates, Inc. 1990. Final Report: Environmental Benefits Study of San Joaquin Valley's Fish and Wildlife Resources. (JSA 87-150). Sacramento, CA. Prepared by J.B. Loomis, W.M. Hanemann, and T.C. Wegge.	Estimates that the average household in CA would be willing to pay $154 annually to avoid losing 58,000 acres of **wetlands in the SJV,** or $254 annually to obtain 40,000 additional acres. Estimates that the average household in OR, WA, and NV would be willing to pay $92 annually to avoid the same loss, or $161 annually to obtain the same increase. *Current values in CA: $250 or $413 annually per household* *Current values outside CA: $150 or $262 annually per household*	Evidence of significant value held by western U.S. residents for wetlands maintenance and improvement in the California section of the Pacific Flyway. Demonstrates significant value beyond the vicinity of the resource.	Baseline wetland acreage was 85,000 (about 10% of original wetland acreage in the SJV). Total value probably consists mostly of non-use values. Approximately 78% of the aggregate value is held by CA residents living outside the SJV. Suggest caution applying these results to the Salton Sea due to different population & site characteristics.
Ibid.	Estimates that the average household in CA would be willing to pay $188 annually to avoid increasing the **population of resident SJV wildlife exposed to agricultural drainage contaminants** to 95%; or $313 annually to reduce the exposed population to 20%. Estimates that the average household in OR, WA, and NV would be willing to pay $93 annually to avoid the same increase, or $131 annually to obtain the same decrease. *Current values in CA: $306 or $509 annually per household* *Current values outside CA: $151 or $213 annually per household*	Evidence of significant value held by western U.S. residents for limiting or mitigating the effects of agricultural drainage on resident wildlife populations in California. Demonstrates significant value beyond the vicinity of the resource.	Baseline exposure level was 70%. Total value probably consists mostly of non-use values. Approximately 80% of the aggregate value is held by CA residents living outside the SJV. Suggest caution applying these results to the Salton Sea due to different population & site characteristics.
Loomis, J. et al. 1991. Willingness to Pay to Protect Wetlands and Reduce Wildlife Contamination from Agricultural Drainage. In A. Dinar and D. Zilberman, eds., *The Economics and Management of Water and Drainage in Agriculture*. Boston: Kluwer.	Estimates that California residents would be willing to pay $1.52 billion annually to avoid losing 58,000 acres of **wetlands in the SJV**; or $2.50 billion annually to obtain 40,000 additional acres. *Current values: $2.5 or $4.1 billion annually to California residents alone*	Evidence of significant aggregate value held by California residents for wetlands maintenance and improvement in the California section of the Pacific Flyway.	Baseline wetland acreage was 85,000. Total value probably consists mostly of non-use values. Suggest caution applying these results to the Salton Sea due to different population & site characteristics. Same results provided in Jones & Stokes (1990).

Source	Summary	Relevance	Comments
Ibid.	Estimates California residents would be willing to pay $1.85 billion annually to avoid increasing the **population of resident SJV wildlife that is exposed to agricultural drainage contaminants** to 95%; or $3.08 billion annually to reduce the exposed population to 20%. *Current values: $3 or $5 billion annually to California residents alone*	Evidence of significant aggregate value held by California residents for limiting or mitigating the effects of agricultural drainage on resident wildlife populations in California.	Baseline exposure level was 70%. Total value probably consists mostly of non-use values. Suggest caution applying these results to the Salton Sea due to different population & site characteristics. Same results provided in Jones & Stokes (1990).
Hanemann, M. et al. 1991. Statistical Efficiency of Double-Bounded Dichotomous Choice Contingent Valuation. *American Journal of Agricultural Economics* 73:1255-63.	Estimates the average household in CA, OR, WA, and NV would be willing to pay $152 annually to avoid losing 58,000 acres of **wetlands in the SJV**; or $251 annually to obtain 40,000 additional acres. *Current values: $247 or $408 annually per household in western U.S.*	Evidence of significant value held by western U.S. residents for wetlands maintenance and improvement in the California section of the Pacific Flyway.	Baseline wetland acreage was 85,000. Total value probably consists mostly of non-use values. Implements a more efficient statistical method. Suggest caution applying these results to the Salton Sea due to different population & site characteristics.
Ibid.	Estimates the average household in CA, OR, WA, and NV would be willing to pay $187 annually to avoid increasing the **population of resident SJV wildlife that is exposed to agricultural drainage contaminants** to 95%; or $308 annually to reduce the exposed population to 20%. *Current values: $304 or $501 annually per household in western U.S.*	Evidence of significant value held by western U.S. residents for limiting or mitigating the effects of agricultural drainage on resident wildlife populations in California.	Baseline exposure level was 70%. Total value probably consists mostly of non-use values. Implements a more efficient statistical method. Suggest caution applying these results to the Salton Sea due to different population & site characteristics.
Creel, M. and J. Loomis. 1992. Recreation Value of Water to Wetlands in the San Joaquin Valley: Linked Multinomial Logit and Count Data Trip Frequency Models. *Water Resources Research* 28(10):2597-2606.	Estimates that the annual benefits derived by the average visitor to **wetlands in the SJV** by recreation type: Wildlife viewers….$128-$152 annually Anglers…….$126-$137 annually Hunters…….. $149-$159 annually *Current values per visitor:* *Wildlife viewer……$209-$248 annually* *Angler……..$205-$223 annually* *Hunter……. $243-$259 annually* Also, estimates aggregate value for all 14 sampled destinations (current annual value ≈ $130 million).	Evidence of significant use value associated with wetlands in the California section of the Pacific Flyway.	Range of values due to different assumptions of statistical model. Suggest caution applying these results to the Sea due to different population & site characteristics. Estimates that increasing wetland water allocations to optimal levels would increase benefits by around 17%. Finds that values for multi-purpose users are greater than the sum of the values for single-purpose users. These values should not be added to the preceding estimates.

Source	Summary	Relevance	Comments
Hoehn, J.P. and J.B. Loomis. 1993. Substitution Effects in the Valuation of Multiple Environmental Programs. *Journal of Environmental Economics and Management* 25(1): 56-75.	Estimates that the average household in the SJV would be willing to pay $120 annually to avoid losing 58,000 acres of **wetlands in the SJV**; or $166 annually to obtain 40,000 additional acres. *Current values: $195 or $270 annually per household in SJV*	Evidence of significant value held by SJV residents for wetlands maintenance and improvement in the California section of the Pacific Flyway.	Baseline wetland acreage was 85,000. Total value probably consists mostly of non-use values. Considers cross-policy substitution effects not addressed by preceding studies, and derives lower values. Suggest caution applying these results to the Sea due to different population & site characteristics.
Ibid.	Estimates that the average household in the SJV would be willing to pay $113 annually to avoid increasing the **population of resident SJV wildlife that is exposed to agricultural drainage contaminants** to 95%; or $184 annually to reduce the exposed population to 20%. *Current values: $184 or $299 annually per household in SJV*	Evidence of significant value held by SJV residents for limiting or mitigating the effects of agricultural drainage on resident wildlife populations in California.	Baseline exposure level was 70%. Total value probably consists mostly of non-use values. Considers cross-policy substitution effects not addressed by preceding studies, and derives lower values. Suggest caution applying these results to the Sea due to different population & site characteristics.
Pate, J. and J.B. Loomis. 1997. The Effect of Distance on Willingness to Pay Values: a Case Study of Wetlands and Salmon in California. *Ecological Economics* 20(3):199-207.	Estimates that the average household in CA would be willing to pay $211 annually to obtain 40,000 additional acres of **wetlands in the SJV**. Estimates that the average household in OR, WA, and NV would be willing to pay $103 annually to obtain the same increase. *Current values in CA: $343 annually per household* *Current values outside CA: $167 annually per household*	Evidence of significant value held by western U.S. residents for wetlands improvement in the California section of the Pacific Flyway. Demonstrates significant value beyond the vicinity of the resource.	Baseline wetland acreage was 85,000. Total value probably consists mostly of non-use values. Estimates how distance from the resource affects value, and calculates values for each state. Suggest caution applying these results to the Salton Sea due to different population & site characteristics.
Ibid.	Estimates that the average household in CA would be willing to pay $223 annually to avoid increasing the **population of resident SJV wildlife that is exposed to agricultural drainage contaminants** to 95%. Estimates that the average household in OR, WA, and NV would be willing to pay $91 annually to avoid the same increase. *Current value in CA: $363 annually/hh* *Current value outside CA: $148 annually/hh*	Evidence of significant value held by western U.S. residents for limiting the effects of agricultural drainage on resident wildlife populations in California. Demonstrates significant value beyond the vicinity of the resource.	Baseline exposure level was 70%. Total value probably consists mostly of non-use values. Calculates values for each state. Suggest caution applying these results to the Salton Sea due to different population & site characteristics.

Source	Summary	Relevance	Comments
An, M.Y. 2000. A Semi-Parametric Distribution for Willingness to Pay and Statistical Inference with Dichotomous Choice Contingent Valuation Data. *American Journal of Agricultural Economics* 82:487-500.	Estimates that the average household in CA but outside the SJV would be willing to pay between $155 and $190 annually to obtain 40,000 additional acres of **wetlands in the SJV**. *Current value: $252-$309 annually per household in CA not in SJV*	Evidence of significant value held by California residents for wetlands improvement in the California section of the Pacific Flyway.	Baseline wetland acreage was 85,000. Total value probably consists mostly of non-use values. Range of values due to different assumptions in statistical model. Suggest caution applying these results to the Sea due to different population & site characteristics.
Mono Lake			
Loomis, J. 1987. Balancing Public Trust Resources of Mono Lake and Los Angeles' Water Right: An Economic Approach. *Water Resources Research* 23(8):1449-1456.	Estimates that the average household in CA would be willing to pay between $3.27 and $7.43 monthly to avoid lowering the **water level in Mono Lake** from 6,372 feet above MSL to 6,342 feet; and between $9.58 and $21.78 monthly to raise it from 6,372 feet to 6,387 feet above MSL. *Current values: $6.12-$13.91 and $17.94-$40.79 monthly per household in CA depending on increase in elevation.*	Evidence of significant value held by California residents for preservation of saline lake habitat that supports migratory waterfowl, including Eared Grebes, in the California section of the Pacific Flyway.	Range of values is due to different assumptions about how to extrapolate individual values to the California population. Total value probably consists mostly of non-use values. The lower numbers are considered conservative estimates. Suggest caution applying these results to the Sea due to different population & site characteristics.
Loomis, J. 1989. Test-Retest Reliability of the Contingent Valuation Method: A Comparison of General Population and Visitor Responses. *American Journal of Agricultural Economics* 71(1):76-84.	Estimates that the average household in CA would be willing to pay between $4.72 and $5.51 monthly to avoid lowering the **water level in Mono Lake** from 6,372 feet above MSL to 6,342 feet; and between $4.12 and $5.89 monthly to raise it from 6,372 feet to 6,387 feet above MSL. *Current values: $8.87-$10.14 and $7.75-$10.84 monthly per household in CA.*	Evidence of significant value held by California residents for preservation of saline lake habitat that supports migratory waterfowl, including Eared Grebes, in the California section of the Pacific Flyway.	Range of values is due to multiple surveys of the same population. Total value probably consists mostly of non-use values. Also surveyed Mono lake visitors and found their values to be about twice as high as non-visitors (reported here). Suggest caution applying these results to Sea due to different population & site characteristics.
Jones & Stokes Associates, Inc. 1993. Environmental Impact Report for the Review of Mono Basin Water Rights of the City of Los Angeles. Draft. May. (JSA 90-171) Sacramento, CA. Prepared for the California State Water Resources Control Board, Division of Water Rights, Sacramento, CA.	Estimates that California residents would be willing to pay $81.90 annually to increase the **Mono Lake water level** from 6,372 feet above MSL to 6,377 feet; and $9.26 annually to increase the water level from 6,377 feet to 6,390 feet above MSL. *Current values: $117.63 and $13.30 annually per resident.*	Evidence of significant value held by California residents for preservation of saline lake habitat that supports migratory waterfowl, including Eared Grebes, in the California section of the Pacific Flyway.	Survey asked respondents to consider slightly different water elevations; authors then adjusted the values to reflect the elevations considered in the EIR (shown here). Total value probably consists mostly of non-use values. Suggest caution applying these results to the Salton Sea due to different population & site characteristics.

Source	Summary	Relevance	Comments
	Endangered Species		
Boyle, K.J. and R.C. Bishop. 1987. Valuing Wildlife in Benefit-Cost Analysis: a Case Study Involving Endangered Species. *Water Resources Research* 23:943-950.	Estimates that the average resident of WI would be willing to pay between $4.16 and $5.66 per person annually to prevent the extinction of the **striped shiner**. *Current value: $7.80-$10.62 annually/person*	Evidence of significant value held by U.S. residents for preservation of an unfamiliar and uncharismatic endangered fish species.	Total value probably consists mostly of non-use values. Caution applying these results to the Salton Sea due to different population & site characteristics.
Bowker, J.M. and J.R. Stoll. 1988. Use of Dichotomous Choice Nonmarket Methods to Value the Whooping Crane Resource. *American Journal of Agricultural Economics* 70(2):372-81.	Estimates that respondents in Texas and four major U.S. cities (Los Angeles, Chicago, Atlanta and New York) would be willing to pay between $21 and $70 per person annually to help preserve the **whooping crane**. *Current value: $43-$142 annually/respondent*	Evidence of significant value held by U.S. residents for preservation of endangered bird species.	The relatively wide range of values is due to different assumptions made about the statistical model. Suggest caution applying these results to the Salton Sea due to different population & site characteristics. Respondents may have reported household WTP.
Loomis, J.B. and D.S. White. 1996. Economic Benefits of Rare and Endangered Species: Summary and Meta-analysis. *Ecological Economics* 18(3):197-206.	Authors present a meta-analysis of valuation studies for **rare, threatened, and endangered species**.	Evidence of value associated with rare, threatened, and endangered fish and bird species.	Authors argue that even for the most costly endangered species preservation efforts, the benefits are likely to exceed the costs.
Loomis, J. and E. Ekstrand. 1997. Economic Benefits of Critical Habitat for the Mexican Spotted Owl: A Scope Test Using a Multiple-Bounded Contingent Valuation Survey. *Journal of Agricultural and Resource Economics* 22(2): 356-66.	Estimates that U.S. residents would be willing to pay $1.8-$3.7 billion annually to preserve habitat in AZ, CO, NM, and UT for the **Mexican Spotted Owl**. *Current values: $2.3-$4.8 billion annually*	Evidence of significant value held by U.S. residents for preservation of an endangered bird species.	Range of values is due to different assumptions made about the statistical model. The lower number is a conservative estimate. Suggest caution applying these results to the Salton Sea due to different population & site characteristics.
Stanley, D.L. 2005. Local Perception of Public Goods: Recent Assessments of Willingness-to-Pay for Endangered Species. *Contemporary Economic Policy* 23(2):165-79.	Estimates that the average household in Orange County, CA would be willing to pay $25 annually ($7.5-8 million for the entire county) to preserve the **Riverside fairy shrimp**, which otherwise would likely become extinct within the next 100 years. *Current values: $28 per household, or $8.5-9.0 million county-wide, annually*	The fairy shrimp is a non-charismatic endangered species that is not well-known by the public but is an important food source for migratory birds. Evidence of significant value held by southern California residents for habitat that supports migratory bird populations.	The author also argues for national support of species preservation efforts due to geographically wide-spread benefits. Suggest caution applying these results to the Salton Sea due to different population & site characteristics and/or distance.

Source	Summary	Relevance	Comments
	Waterfowl Hunting		
Brown, G.M. and J. Hammack. 1972. A Preliminary Investigation of the Economics of Migratory Waterfowl. In J.V. Krutilla, ed., *Natural Environments*. Baltimore: Johns Hopkins University Press.	Estimates the net economic value of **waterfowl hunting in the Pacific Flyway** is $25 per trip or $247 per season. *Current values: $145 per trip or $1,432 per season*	Evidence of significant use value associated with serviced provided by bird habitat in the Pacific Flyway.	Relatively old study. "Net economic value" refers to the difference between the benefit of a trip and its cost.
Hay, M. 1988. Net Economic Recreation Values for Deer, Elk, and Waterfowl Hunting and Bass Fishing. *U.S. Dept. of the Interior Fish and Wildlife Service*.	Estimates the net economic value of a **waterfowl hunting trip in the Pacific Flyway** is $25, and that of a **bass fishing trip in California** is $22. *Current values: $47 per trip for hunting and $41 per trip for fishing*	Evidence of significant use value associated with services provided by bird habitat in the Pacific Flyway and fish habitat in California.	Unable to locate publication (summary provided by EVRI). Total number of trips not provided. "Net economic value" refers to the difference between the benefit of a trip and its cost.
Duffield, J. and C. Neher 1991. Montana Waterfowl Hunting, A Contingent Valuation Assessment of Economic Benefits to Hunters. *Montana Department of Fish, Wildlife and Parks*.	Estimates the value of a **waterfowl hunting trip in the Montana section of the Pacific Flyway** is around $140. *Current value: $228 per trip*	Evidence of significant use value held by non-California residents for services provided by Pacific Flyway habitat.	Unable to locate publication (summary provided by EVRI). Total number of trips not provided. Also determines the effects of more/fewer birds on the value of a trip, but not specifically for Pacific Flyway trips.
	Other Studies		
Green, D., et al. 1998. Referendum Contingent Valuation, Anchoring, and Willingness to Pay for Public Goods. *Resource and Energy Economics* 20:85-116.	Estimates respondents in San Francisco, CA would be willing to pay around $64 per person annually to protect 50,000 **Pacific Coast seabirds** from off-shore oil spills. *Current value: $85 per person*	Demonstrates significant value held by California residents for protecting part of an aquatic-based west coast bird population.	The study was conducted primarily to test the contingent valuation method and it showed that WTP can be influenced by question structure. Caution applying these results to a large population or to the Salton Sea due to the survey design characteristics.
Boyle, K.J., et al. 1994. An Investigation of Part-Whole Biases in Contingent-Valuation Studies. *Journal of Environmental Economics and Management* 27(1): 64-83.	Estimates respondents in Atlanta, GA would be willing to pay at least $88 per person to protect 2% of the **migratory bird population in the Central Flyway** (200,000 birds) from presumably certain human-induced mortality. *Current value: $127 per person*	Evidence of significant value held by residents of a geographically separate region for protecting a small portion of a migratory bird population within a single flyway.	The study was conducted primarily to test the contingent valuation method and it showed that WTP did not increase with the number of avoided deaths. Caution applying these results to a large population or to the Salton Sea due to the survey design characteristics.

Source	Summary	Relevance	Comments
Loomis, J. B. 2000. Vertically Summing Public Good Demand Curves: An Empirical Comparison of Economic Versus Political Jurisdictions. *Land Economics* 76(2):312-21.	For six different resource preservation programs, estimates **the fraction of national value held by residents within the state(s)** where the resource is located. Finds, on average, that only 13% of total value is held by state residents.	Evidence of significant value held by out-of-state residents. Resources valued include: three California programs (wetlands, wildlife exposure to agricultural contamination, spotted owl) and three other programs focused on birds, fish, and rare/threatened/endangered species.	Confidence intervals are relatively wide and include 100% of national value for three of the programs, including two in California. Average percent of national value held by California residents is around 18%.
Johnston, R.J., et al. 2002. Valuing Estuarine Resource Services Using Economic and Ecological Models: The Peconic Estuary Study System. *Coastal Management* 30: 47-65.	Estimates that the average household in eastern Long Island, NY would be willing to pay around $0.066 annually to preserve an additional **acre of wetlands in eastern Long Island**. *Current value: $0.087 annually/household*	Evidence of value associated with incremental protection of wetlands.	Suggest caution applying these results to the Salton Sea due to different population & site characteristics. Also, WTP likely includes both use and non-use value.
Brander et al. 2006. The Empirics of Wetland Valuation: A Comprehensive Summary and a Meta-Analysis of the Literature. *Environmental & Resource Economics* 33:223-50.	Authors present a meta-analysis of valuation studies for **wetland services** and estimate a meta-regression that can facilitate benefit transfer.	Evidence of value associated with ecological services provided by wetlands.	Benefit transfer errors average around 74%.

Notes: Current values for individual respondents and/or households are adjusted to 2006 dollars using the U.S. Department of Labor, Bureau of Labor Statistics Consumer Price Index. Aggregate values reported in the table are not adjusted for temporal changes in factors such as population (this does not apply to the main text). SJV = San Joaquin Valley. WTP = Willingness-to-pay. MSL = mean sea level. EIR = Environmental Impact Report. hh = household. NA = not applicable/available.

Table 2. Present Value of $1 Billion Annually for Various Discount Rates and Time Horizons.

Time (years)	Annual Discount Rate (%)									
	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%
5	4.85	4.71	4.58	4.45	4.33	4.21	4.10	3.99	3.89	3.79
10	9.47	8.98	8.53	8.11	7.72	7.36	7.02	6.71	6.42	6.14
15	13.87	12.85	11.94	11.12	10.38	9.71	9.11	8.56	8.06	7.61
20	18.05	16.35	14.88	13.59	12.46	11.47	10.59	9.82	9.13	8.51
25	22.02	19.52	17.41	15.62	14.09	12.78	11.65	10.67	9.82	9.08
30	25.81	22.40	19.60	17.29	15.37	13.76	12.41	11.26	10.27	9.43
35	29.41	25.00	21.49	18.66	16.37	14.50	12.95	11.65	10.57	9.64
40	32.83	27.36	23.11	19.79	17.16	15.05	13.33	11.92	10.76	9.78
45	36.09	29.49	24.52	20.72	17.77	15.46	13.61	12.11	10.88	9.86
50	39.20	31.42	25.73	21.48	18.26	15.76	13.80	12.23	10.96	9.91
75	52.59	38.68	29.70	23.68	19.48	16.46	14.20	12.46	11.09	9.99
100	63.03	43.10	31.60	24.50	19.85	16.62	14.27	12.49	11.11	10.00

Notes: Table entries are expressed in billions of dollars. Multiply entries by 5 to calculate the present value of $5 billion annually. Multiply by X to calculate the present value of $X billion annually.