

Economic Benefits of Expanding California's Southern Sea Otter Population

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EXECUTIVE SUMMARY

If in fact, the final Supplemental Environmental Impact Statement on the Southern Sea Otter Translocation Program allows for unlimited population growth, eventual expansion of southern sea otter populations and range would provide more than \$100 million in annual economic benefits to California households. These benefits derive from recreation, tourism, ecosystem services, option value and existence value. The majority of these benefits are associated with existence value -- the value people place on just knowing that sea otters are being saved from extinction and their populations increasing to levels where the species could be removed from the federal list of threatened species.

To estimate existence value benefits, we used a willingness to pay study sponsored by and published by the National Marine Fisheries Service (Hageman 1985), and a meta-analysis of rare and endangered species valuations reported in the literature. The Hageman study is the only published research that has been done to assess California households' willingness to pay for three different levels of sea otter population recovery, and was adjusted to reflect changes in survey response rate and inflation. We consider that the adjusted results are likely to be an underestimate of the current willingness to pay, in part due to increased sea otter education efforts in the state, increased opportunities to view sea otters, and rising real incomes in California.

Sea Otter Tourism--Expansion of southern sea otter populations and habitat will likely result in increases in tourism in Santa Barbara in the next decade, and eventually in Ventura County. Using a statistical model of tourism in California along with survey data on sea otter visits, we estimate an increase in Santa Barbara county of at least 62 direct jobs to as much as 326 direct jobs. This increase in jobs is associated with estimates from the U.S. Fish and Wildlife Service (USFWS) Draft Supplemental Environmental Impact Statement on the Translocation of Southern Sea Otters (DSEIS) of 117 additional otters along the coast in Santa Barbara county in the next decade. These job estimates do not include multiplier effects, which could easily double the eventual number of jobs provided once sea otter populations expand and additional tourism infrastructure is put in place in Santa Barbara and Ventura counties. This expansion of southern sea otter populations along the Santa Barbara coast would result in at least \$1.5 million in direct tourism income related to sea otters to a best estimate of \$8.2 million annually in Santa Barbara and Ventura counties from the initial expansion of sea otter populations reported by USFWS. These direct income effects do not reflect any multiplier effects, consideration of which may double these direct income estimates.

Non-Market Economic Benefits--The USFWS predicts an expansion of 117 sea otters that will reside year-round between Point Conception and Santa Barbara Harbor (USFWS 2005: 75) and another 79 sea otters at San Nicolas Island near Santa Barbara. There would also be at least \$3.4 million dollars, with a median estimate of \$21.4 million in annual non-market economic benefits to California households from the sea otter expansion. These non-market benefits include recreation, existence values, and option values. The majority of these benefits arise from existence values from just knowing that sea otter populations would increase by a total of 196 otters over the next decade (117 along the Santa Barbara coast and 79 at San Nicolas Island). These results are based on an existing willingness to pay survey by San Diego State University for National Marine Fisheries Service and by applying a meta-analysis of previous valuation literature on rare and endangered species.

Ecosystem Services--Sea otters are also a keystone species in sustaining healthy kelp forests off the California coast. These kelp forests provide many valuable services, directly and indirectly, to humans. These services include reduced shoreline erosion, improved habitat for numerous invertebrates such as mussels and clams, several fish species, as well as carbon storage that can moderate climate change. The expansion of sea otter populations will aid in the restoration and maintenance of kelp forests off the coast of Santa Barbara. The ecosystem services provided by kelp forests have been valued by other scientists at \$7,600 an acre per year.

Costs to Commercial Fishing--Over the ten-year expansion of sea otters off the coast of Santa Barbara, the USFWS predicts that commercial harvest of sea urchins, crabs and spiny lobster would be reduced to zero in this area due to consumption of these species by sea otters. Based on the USFWS data in the DSEIS the gross revenue or ex-vessel revenue foregone is estimated to be \$610,242 annually. This reduction overstates the losses to these commercial anglers and society since reduction in these commercial fishing activities would result in savings of boat fuel and labor that can be re-employed elsewhere. Converting the gross revenue to total jobs (including multiplier effects), the commercial fishing losses would involve about 24-26 jobs.

Comparison of Economic Effects--Table E-1 presents a comparison of the gains in direct sea otter tourism income, total employment, and non-market value as compared to costs to commercial fishing. As can be seen, even the lower bound of the direct gain in sea otter related tourism in Santa Barbara county is more than double that of the reduction in commercial fishing. The total jobs realized from sea otter tourism is at least five times that estimated to be lost in commercial fishing. Of course the gain in recreation use and passive use (primarily existence values) to California households from the additional 196 sea otters is substantial at a median value of \$21 million.

Table E-1.
Annual Economic Effects by 2014 of Sea Otter Population Expansion Along the Santa Barbara Coast.

	Commercial Fishing	Sea Otter Tourism	Sea Otter Non-Market Value
Dollars (millions)	-\$61 revenues	\$1.5 to \$8.2 direct income	\$21 median Use/Passive Use
Total Jobs	-24 to -26.5	+143 to +750	N/A

Sensitivity Analysis--While there may be some uncertainty around these estimates of non-market value, an alternative perspective can be gained on the overall economic benefits of the sea otter expansion by dividing the annual revenues lost by the number of sea otters gained. While the annual revenues lost of \$610,242 overstates the net loss in commercial fishing income because it does not deduct costs, it may provide an upper bound on what a sea otter would need to be worth to make the expansion program economically efficient. Dividing the \$610,242 by the 117 additional sea otters along the Santa Barbara coast that USFWS indicates would be directly affecting commercial fishing yields an annual cost of \$5,216 per sea otter. This annual benefit is far below the rehabilitation costs per sea otter cited below of \$20,000 to \$50,000. In fact, each household in California would only need to pay about a nickel per household to cover the entire \$610,242 in foregone fishing revenue involved in maintaining the additional 117 sea otters.

While decisions regarding endangered species are and should be based on more than economic factors, this range of estimates on the economic values of sea otters helps bring some balance to the debate over southern sea otter range expansion: it is clearly not sea otters versus jobs. Sea otter tourism has the potential to support a substantial number of jobs and income in the Santa Barbara area, as well as providing non-market economic values to millions of California households.

Sea otters have several types of economic values to people that have not been quantified by USFWS in the DSEIS. These economic benefits should be included by USFWS when evaluating sea otter management alternatives in the Final SEIS. If the USFWS is quantifying the costs in dollar terms, a balanced and complete economic analysis should quantify the benefits in dollar terms as well. The remainder of this analysis provides the details on the data sources, methods and calculations used to arrive at these estimates.

1. PURPOSES OF RE-ANALYSIS OF THE U. S. FISH AND WILDLIFE SERVICE DRAFT SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT ON THE TRANSLOCATION OF SOUTHERN SEA OTTERS

Purposes of Analysis

This analysis estimates the economic benefits associated with allowing the expansion of the geographic range of the southern sea otter (*Enhydra lutris nereis*) population along the southern California coast from Point Conception to Santa Barbara Harbor as projected in the U.S. Fish and Wildlife Service (USFWS) Draft Supplemental Environmental Impact Statement on the Translocation of Southern Sea Otters (DSEIS) (2005: 75). In particular, we estimate the tourism-market benefits and the non-market benefits of the USFWS ceasing its current policy of attempting to keep sea otters out of the no-otter management zone south of Point Conception in Santa Barbara County. These non-market benefits take the form of resident's recreation benefits, option value to view sea otters in Santa Barbara in the future, and existence value from knowing increasing numbers of sea otters exist along the southern California coast. This economic benefit information is compared to the USFWS estimates of the costs to commercial fisheries associated with the southward expansion of the sea otter population. This analysis provides estimates of these economic benefits to provide a more complete economic assessment of the USFWS DSEIS alternatives. The remainder of this report discusses the types of economic values that would be realized from increases in the sea otter population south of Point Conception. Section 2 provides a discussion of the conceptual framework and methods used in estimating the tourism-market and non-market economic benefits. Section 3 discusses recreational tourism from increases in sea otters. Section 4 focuses on the non-market values of increasing the sea otter population south of Point Conception such as recreation benefits and existence values. Section 5 explores the ecosystem benefits that sea otters provide as a critical element in the near-shore marine environment.

Southern Sea Otter Status and Protections

The southern sea otter is listed as a threatened species under the Endangered Species Act (ESA). To maintain and increase sea otter populations and to expand their range to safeguard the species from an oil spill or other localized catastrophic event, and to minimize the conflicts caused by sea otters in areas with commercial and recreational shellfish fisheries, USFWS initiated a Translocation program in August 1987, after publication of the final EIS in May 1987.

Public Law 99-625 (Fish and Wildlife Programs: Improvement; Section 1, Translocation of California Sea Otters) passed by Congress on November 7, 1986, authorized USFWS to translocate southern sea otters. The subsequent translocation plan called for USFWS to establish a "no-otter", or management zone south of Point Conception in Santa Barbara County. Under this law, USFWS is required to " use all feasible non-lethal means and measures to capture any sea otter found within the management zone and return it to either the translocation zone or the range of the parent population." (Public Law 99-625). Between 1987 and 1990, USFWS moved 140 otters to a translocation zone off San Nicolas Island near Ventura to create an experimental colony further south in California and to maintain the no-otter management zone.

Despite this legal requirement, USFWS has not attempted to remove any sea otters found in the management zone since 1993, because "capture and relocation of a large number of sea otters could result in the deaths of animals, disrupt the existing social structure of resident groups,.

...and possibly exacerbate population decline” (FWS, 2003:14). The conservation and research communities also believe the translocation program and the no-otter management zone have not been a success and have, in fact, run counter to the goal of southern sea otter recovery. Only half of the original animals relocated to San Nicolas Island are accounted for, and sea otters have been moving from the Central Coast into and out of the management zone seasonally since 1998. In addition, the southern sea otter population has exhibited periods of growth and decline since 1995. USFWS has used this information to bolster its case for not removing sea otters found in the no-otter zone. The agency is continuing its policy of non-removal while evaluating the translocation program and following the adoption of its final Southern Sea Otter Recovery Plan (U.S. Fish and Wildlife Service 2003). The release of the DSEIS was published in the Federal Register (66 FR 6649).

According to the final Southern Sea Otter Recovery Plan, the sea otter population must exceed an average of 3,090 animals for three consecutive years before the species can be considered for delisting as a threatened species from the Endangered Species list. In addition to meeting population targets, the ESA requires that long-term threats to the species be reduced or eliminated. The DSEIS presents alternatives for reaching these recovery goals.

Sea otters are also protected under the Marine Mammal Protection Act (MMPA). As an ESA-listed species, they are automatically treated as a depleted population under the MMPA. This protection will continue if and when ESA delisting occurs, because the sea otter population still will not meet the optimal sustainable population level, the lower limit of which USFWS has determined to be 8,400 based on analysis of southern sea otter carrying capacity. Once delisted, the USFWS would need to initiate or be petitioned to designate the southern sea otter stock a depleted population under the MMPA.

Economic Analysis Required by Law

The National Environmental Policy Act (NEPA) requires federal agencies to consider the socioeconomic impacts of its proposed actions on the "human environment," which NEPA regulations define as "the natural and physical environment and the relationship of people with that environment" (40 C.F.R. §1508.14). Specifically, NEPA regulations state that the environmental impacts that must be addressed include direct and indirect effects "caused by the action." These include "cultural, economic, social, or health" effects (Id. §1508.8). Although "economic or social effects are not intended by themselves to require preparation of the impact statement," when an EIS is otherwise required, it must address these effects to the extent that they are "interrelated" with "natural or physical environmental effects" (Id. §1508.14).

The courts have confirmed that an EIS must consider these economic consequences. In State of Louisiana v. Lee, 758 F.2d 1081, 1084 (5th Cir. 1985), cert. den. 475 U.S. 1044, (1986), the U.S. Supreme Court ruled that "[a]n environmental impact statement is intended to detail the environmental and economic effects of any proposed Federal action so that those not directly involved can understand and give meaningful consideration to and make appropriate comment on the factors involved (emphasis added)." An EIS will be invalid if its economic analysis is inaccurate and "impair[s] fair consideration of the Project's adverse environmental effects." Hughes River Watershed Conservancy v. Glickman, 81 F.3d 437, 448 (4th Cir. 1996).

As these legal authorities dictate, the SEIS on the southern sea otter zonal management program

must consider economic impacts. Toward that end, this report presents an analysis of the economic benefits associated with the termination of zonal sea otter management. These benefits are substantial and, when coupled with the clear environmental advantages that would result from declaring the translocation a failure and allowing for natural range expansion, provide a compelling justification for ending the zonal management program. This can then be compared to USFWS estimates of economic impacts such as the costs to commercial fisheries associated with the expansion of sea otter populations.

We begin with a discussion of the conceptual framework and methods used in estimating commercial fishing values and the tourism-market and non-market economic benefits. We then look at the human-centered values of increasing sea otter populations such as recreation benefits and existence values, the impact of increases in sea otter numbers on recreational tourism, and the ecosystem benefits that sea otters provide as a keystone species in the nearshore marine environment.

2. FRAMEWORK FOR ESTIMATING COMMERCIAL FISHING VALUES, SEA OTTER TOURISM EFFECTS, AND NON-MARKET ECONOMIC VALUES OF SEA OTTERS

Concepts of Economic Value

Economic values reflect the scarcity of a resource, and the southern sea otter is currently quite scarce by historical standards. The California population is thought to have numbered about 16,000 animals prior to the 18th century (USFWS DSEIS 2005: 46). Over the last five years, the estimated population has ranged between 2,160 and 2,800 otters. As another indicator of scarcity, the species was listed as a threatened species under the Endangered Species Act in 1977. Thus, there are relatively high values to recovering sea otter populations. Even increasing the population to its historic level of 16,000 would still have positive economic benefits.

To allow valid comparison of the benefits of sea otters to costs to commercial anglers, it is important that both be quantified in commensurate terms. This is particularly important when comparing marketed commodities such as commercial shellfish, tourism, and non-marketed natural resources such as sea otters. The fact that sea otters are not sold through conventional markets does not mean they do not have an economic value. Sea otters meet the two conditions for a resource to have economic value: they are scarce and viewing sea otters provides enjoyment. Since the USFWS reports the costs to commercial anglers in dollars, a balanced and complete economic analysis requires that the benefits from sea otter expansion also be quantified in dollars, so they are in comparable units.

Commercial Fisheries

Sea otters can consume significant quantities of some of the same species that have a commercial value. For example, sea otters consume shellfish (Estes, 1996) and sea urchins. In some cases, commercial or recreational fishing may be limited to not interfere with or harm sea otters. Thus, reductions in commercial fisheries are one of the costs of expanding the southern sea otter population. The USFWS DSEIS analyzes this in detail, so we will not focus on it at great length, other than to contrast it with the economic values of sea otters.

For market goods like commercial shellfish, there is little difference between financial or cash flow value and its economic value. That is, the price-received dockside by commercial anglers is a fairly accurate measure of the gross value or revenue. This is commonly called the Ex-Vessel price or Ex-Vessel Revenue in the DSEIS. Using the average annual sea urchin landings in the SEIS (page 94) and the ex-vessel price per pound of sea urchins calculated from the DSEIS (page 54) indicates that the sea urchin fishery in the sea otter expansion area generate an annual average of \$190,574 over the 1994 to 2003 time period. This represents about only about 2 percent of the sea urchin harvest in southern California (DSEIS, page 94). The affected shellfish include lobster and crab. Currently the crab fishery in the sea otter expansion area has a gross revenue or average annual Ex-Vessel revenue of \$185,790 (DSEIS estimate of landings from page 102 and price calculated from page 54 of DSEIS). This represents about 18 percent of the crab harvest in southern California according to the DSEIS (page 102). The ex-vessel revenues for spiny lobster harvest in the area of sea otter expansion have an annual value of \$233,878 (calculated using pounds from the SEIS on page 99, and the ex-vessel price from page 96). This represents about 5 percent of the annual lobster landings in southern California (DSEIS, page 98).

Across the three affected fisheries the total gross revenues currently produced by these three fisheries averages \$610,242 per year. However, if as projected by the USFWS in the DSEIS these fisheries will be reduced to zero over a ten-year period of sea otter expansion, the loss to society is *not* the entire \$610,242 each year. To arrive at the *net* losses to society and commercial anglers, i.e., what they would pay for the opportunity to continue to harvest the current quantities of shellfish, it is important to deduct the costs of harvest to arrive at a net income figure. That is, if expanding sea otter populations reduces the harvest of shellfish and sea urchins, commercial anglers and society only lose the difference between the revenues and the costs of fishing. Specifically, the actual loss is only the value of the shellfish minus the harvesting cost saved or no longer incurred (i.e., the net income). For example, while revenues to commercial anglers is estimated to fall by \$610,242, the loss to the commercial anglers in Santa Barbara is likely a fraction of this because the anglers actually do not keep \$610,242 as net income because they have to pay for fuel and any hired labor. If commercial fishing for these species no longer takes place in Santa Barbara, that frees up the boat fuel and labor to be employed elsewhere in the economy. The variable costs of commercial fishing avoided would include saved boat fuel, hired labor and the opportunity cost of the angler's own labor. The opportunity cost of the angler's own labor include wages that could be realized in the next best occupation, rather than commercial fishing for the three affected species. Thus only a fraction of the \$610,242 in revenues is actually net income to anglers. This concept of net economic value is used by federal agencies in their benefit-cost analysis (U.S. Water Resources Council 1983; U.S. Environmental Protection Agency 2000) and the USFWS should use it here as a measure of losses rather than the ex-vessel revenues.

As noted in the DSEIS itself (page 52) these ex-vessel revenues overstate the loss to commercial anglers. Thus, conversely, reliance on ex-vessel revenues would overstate the losses to commercial anglers and society from reductions in commercial fishing associated with expansion of the sea otter population. While the DSEIS indicates it is difficult to calculate operating costs to allow calculation of net revenues or net value foregone, this type of analyses has been conducted in the past for other fisheries. **This deduction of operating costs should be undertaken by USFWS with assistance from the National Marine Fisheries Service in order to correctly calculate the true net opportunity cost of sea otter expansion.**

If nothing else, the USFWS should acknowledge the tendency in many commercial fisheries is toward dissipation of profits (Hanley, Shogren and White 1997; Tietenberg 1996: 278-287; Fisher 1981: 87). According to a study of the California sea urchin fishery by Smith and Wilen (2004: 94), "first, in spite of existing regulations, some degree of open access forces persists in the urchin fishery." As such, the costs of fishing may nearly equal the gross revenues, indicating net value or net opportunity costs to society from sea otter expansion, which could very well be close to zero.

The \$610,242 of fishing ex-vessel value can be converted to total employment (direct and indirect) via the U.S. Department of Commerce's Bureau of Economic Analysis Regional Input-Output Modeling System (RIMS II). For California (the state is the smallest unit they print) as a whole the direct and indirect (i.e., total) effects of reducing commercial fishery production by \$610,242 is between 24.1 and 26.5 annual equivalent jobs (U.S. Dept of Commerce 1986: 76). Since this estimate includes all the multiplier effects throughout California, the actual number of jobs in Santa Barbara county would of course be less than this.

Sea Otters

Recreation Use Value: This same concept of net value applies to the economic benefits realized from sea otter viewing. Visitors spend money traveling to coastal areas to view sea otters. The net benefits or net value of viewing is the gain in enjoyment over and above the travel costs. Thus recreation benefits from viewing sea otters are measured by the visitors' willingness to pay (WTP) in excess of their current travel costs. This concept of net economic value is also used by federal agencies in their benefit-cost analysis of recreation and other natural resources (U. S. Water Resources Council 1983; U. S. Environmental Protection Agency 2000).

Passive Use or Existence Value: Some people that currently do not view sea otters still may derive satisfaction and enjoyment from knowing sea otters exist and their populations have increased beyond the threat of extinction. This type of value is known as **passive use values** or **existence value** (Freeman 1993). Existence value is the benefit or WTP to have a particular level of population of sea otters even if you never plan to see them in the wild. Some economists include in this existence value the bequest benefits that the current generation receives from knowing that future generations will have non-threatened sea otter populations (Randall and Stoll, 1983). This existence value is thought to be a pure non-use value, as it does not require current or future on-site use of the resource by the individual. Preservation of threatened sea otter populations also provides an **option value** for future use. This is the WTP of individuals to maintain sufficient sea otter populations that would allow sea otter viewing in the future (Randall and Stoll 1983). Passive use value has been legally recognized by the courts (U.S. Court of Appeals 1989) and legislation (Natural Resource Damage Assessment under CERCLA-U.S. Department of Interior 1994; Oil Pollution Act of 1990--U.S. Department of Commerce 1994) as a legitimate component of economic value of natural resources. Given that the federal government recognizes passive use values when calculating natural resource damages from oil spills it would seem that consistency would require that it be included when calculating the benefits of increasing the number of sea otters. To quantify passive use values economists measure what a person would pay for a particular level of marine mammal population.

Existence and option values are also types of public goods. Public goods are goods once provided to one individual that involve no additional cost to simultaneously providing them to other individuals. For example, a lighthouse is a public good, as once it is provided to guide one boat, other passing boats can realize the safety benefits of the lighthouse at no additional cost. Hence, the benefits of the lighthouse are the sum of benefits to all individuals (Samuleson 1954). The existence values of increasing sea otter populations is a public good, because everyone that enjoys knowing sea otters exist, can realize this benefit simultaneously without using up these benefits. Thus, if the existence benefit is \$2 per household, and there are 10 million households in California, the aggregate existence value in California is \$20 million.

Total Non-Market Economic Value to California Households: Early analyses of non-market values defined the total non-market economic value as the sum of the recreation use value, option value and existence value (Randall and Stoll 1983). Today, one might add ecosystem service values in as an additional component of total economic value. In our empirical analysis we provide estimates from the literature for the traditionally defined components of total economic value. This total economic value includes additional sea otters along the California coast along with a per acre estimate of ecosystem services related to the maintenance of kelp forests by sea otters.

Regional Economic Effects

While travel costs are costs to the visitor, a fraction of that cost becomes income to tourist businesses. For example, much of the \$100 per night a visitor to Santa Barbara pays for a hotel becomes wages to employees, profits to local storeowners, and rents to area landlords. This is called “local value added”, and becomes the first round or direct effect on the local economy. It is considered a positive economic impact. As the recipients spend the wages and profits in the local economy, additional income to other local businesses is generated. For example, spending by the employee and storeowner in Santa Barbara will generate additional income to other local businesses. Of course this process repeats itself over and over again, giving rise to what is called a multiplier effect (Loomis and Walsh 1997). When we discuss ecotourism, it is these local economic impacts and multiplier effects that are being measured.

Tourism Associated With Marine Mammals And Sea Otters

From whales to coral reefs, marine resources attract recreation visitors (Bhat 2003), and tourism should be considered in plans to conserve these resources. Along the California coast, sea otters are a prime attraction. The sea otter is practically the official mascot of Monterey, California, its likeness featured on everything from banners to water bottles to Web pages. In exit surveys, visitors to the Monterey Bay Aquarium rank the sea otter exhibit as the most enjoyed exhibit, and sea otter merchandise produces more than 20 percent of gift and bookstore sales at the aquarium (Aldrich et al. 2001).

In Monterey, the presence of sea otters has a positive influence on tourism related activities. According to Anjanette Adams of Monterey Bay Kayaks, one of several rental companies in the area, people who inquire about renting kayaks often ask if they can view sea otters by kayak, and where the best places are to see them (personal communication, June 12, 2003). While much of the wildlife viewing from boats in Monterey Bay is related to whales, several whale-watching charter boat operators report people on their trips frequently ask if they will observe sea otters and where else they can go in Monterey to view them. Many operators now also offer separate bay cruises that stay close to shore for sea otter viewing.

The USFWS DSEIS recognizes the importance of coastal tourism to California tourism industry, the third largest employer in the economy of California. The southern sea otter population is expanding south into Santa Barbara and Ventura counties. Tourism is an important industry in these two counties. According to Aldrich et al., overall tourism in Santa Barbara county supported 11,000 jobs (6.5 percent of the entire workforce) and resulted in \$26 million in local taxes. Further south, tourism in Ventura county supported 9,000 jobs and resulted in \$15 million in local taxes. Santa Barbara already has sea kayaking and charter boat businesses, and it is reasonable to expect that these businesses would be enhanced by the presence of sea otters. However, with less public access to rocky shore areas that would likely be populated by sea otters and more constrained harbor space for recreational tour operator boats, the expansion of Santa Barbara’s recreational industry in response to sea otters may be less than observed in Monterey (where these are not limiting factors).

Boncoerur et al. (2002) in his simulation modeling of marine reserves found that the optimal size of a marine sanctuary is larger when ecotourism is taken into account. In their particular analysis of seals, the author concluded that implementation of a reserve or sanctuary for the seals,

generates additional income through ecotourism. This extra income can partly or totally offset the negative impact of the seals on the commercial fishery.

Measuring Local Economic Effects from Tourism

To compare the tourism-employment-related effects of sea otters to those of commercial fishing jobs, it is important to use the same conventions. The initial effect of visitor or angler spending is called the direct effect. Direct effects include visitor spending on hotels, restaurants, gasoline, etc. Not all this money is income to the local economy, as much of the money flows out of the local economy to import the goods sold. For example, out of \$10 spent on a disposable camera in Santa Barbara, about \$4 of that would become wages to employees, profits to the business store owner and rent to the landlord. This \$4 is another example of “local value-added. The \$6 paid to camera manufacturer located outside the local economy is considered a leakage.

However, the initial increase in local value-added stimulates additional spending in the local economy. For the businesses to meet the increased consumer demand, they increase their purchase of wholesale goods and other inputs used in their store. This is known as the indirect effect. Finally, there is the induced effect, the additional income generated when the recipients of the additional wages and profits spend them in the local economy.

Secondary Data Approach to Economic Impact Analysis

Ideally, a visitor survey would be conducted and analyzed through an input-output model to calculate the change in local income and employment related to sea otters. However, the USFWS did not conduct an original visitor study for sea otter recreation as part of its economic analysis in the DSEIS. It is not usual for the USFWS to collect primary data in refuge planning (Caughlan and Loomis 2003). Although USFWS does collect such primary data for refuge planning (Caughlan and Loomis), like the U.S. Forest Service and other federal agencies, it generally uses existing or secondary sources of data for economic impact analysis (Caughlan and Hoag 2003). To perform an economic impact analysis, two pieces of information are needed: (a) number of visitors and (b) spending per visitor. Unfortunately, no data is kept on the number of visitors making trips specifically to view sea otters along the California coast, and very little data exists on visitor expenditures specific to sea otter viewing. However, there are some previous analyses (Aldrich et al.; Hageman 1985), which we have used to make the estimates of the economic impacts of increased sea otter tourism that are presented in Section 3.

Ecosystem Services Provided by Sea Otters

Ecosystem services are processes performed by natural systems that provide humans with clean water, fish, wildlife, food, recreational opportunities and other benefits that improve well being (Dailey 1997). These natural processes include nutrient cycling, detoxification of pollutants and carbon storage. Wetlands, for example, furnish such ecosystem services as detoxifying polluted waters, serving as wildlife habitat and nurseries for fish, recharging groundwater supplies, storing floodwater and providing recreational opportunities. The loss of these ecosystem services reduces our quality of life and results in large expenditures on engineering solutions, such as flood-control dams, water-treatment plants and fish hatcheries, to attempt to replace them. Ecosystem services thus have an economic value to society (Dailey; Costanza et al. 1997). In Section 5, we also examine the ecosystem service benefits that sea otters provide to kelp forests and that kelp forests provide to humans and other species.

3. ECONOMIC EFFECTS OF MARINE MAMMALS AND EXPANDED SEA OTTER POPULATIONS ON TOURISM

With no site-specific surveys of sea-otter-related tourism available, we based our analysis on the work of Aldrich et al. This study and its results are recognized by the USFWS in the DSEIS (page 110, footnote #1), but the agency did not utilize it to calculate the gains in tourism related to sea otters, despite this being the focus of the Aldrich et al. study.

Aldrich et al. statistically estimated the amount of tourism spending related to sea otters using existing data on county-level tourism spending in California. The dependent variable in their statistical regressions varied from regression to regression, but it was either a measure of spending (total visitors spending or spending by sector), tourism-related employment, or taxes. Their explanatory variables included the sea otter population in that county in that year and other control variables that affect tourism such as weather, size of county, coastal access, presence of an international airport, number of large tourist attractions, trend variables, etc. These other variables control for the effects on tourism not related to sea otters, thus holding the other factors constant. The slope coefficient on sea otters should reflect the independent effect of sea otters on tourism spending.

Aldrich et al. were not able to obtain data on other marine wildlife populations at the county level for each year to include in the model. While this potentially could generate omitted variable bias and overstate the effect of sea otters on visitor spending, the researchers state that “changes in otter populations are unlikely correlated with changes in other wildlife viewing opportunities, this [omission] most likely did not influence our results” (Aldrich et al., page 21). In addition, the explanatory power of their models is more than 90 percent, which suggests that it is unlikely other important variables have been omitted from the model. Only five to ten percent of the variation in spending is left unexplained by additional wildlife viewing opportunities and other factors, in general.

However, to calculate a lower bound on the sea otter-tourism-related estimates of Aldrich et al., we applied a sea otter-spending adjustment based on a survey of California residents (Hageman). Hageman conducted a mail survey of California households regarding their WTP for three population levels of sea otters and for trips to the California coast to view sea otters. The sample size was 180 completed surveys. Households were asked to provide the percentage of their trip expenditures that were related to sea otters. The mean percentage was 19 percent. Thus, to account for the possibility that our estimate of regional effects includes spending for other marine mammals, we took only 19 percent of the spending estimate by Aldrich et al. to calculate a lower bound.

Aldrich, et al.'s regressions used tourism spending for all 58 California counties for a time period of 1992 to 1998. Regressions for visitor spending on accommodations, eating-drinking, recreation spending and related retail spending found a statistically significant coefficient on sea otter populations. To remove the leakage of spending outside the county and reflect just the local or county value added, Aldrich et al. (page 24) used the value added percentage for each of the industries. As shown in Table 3, the value added or direct tourism related income per sea otter is \$69,700. Even using the adjusted lower bound from the Hageman study described above, there is an estimated \$13,200 of direct income per sea otter. This \$13,200 is even lower than the lower bound of the 95 percent confidence interval estimated by Aldrich et al. (page 24), thus it is a very

conservative estimate. In addition, Table 1 also provides Aldrich et al.'s employment coefficient per sea otter (2.783 jobs). This is also adjusted by Hageman's estimate that only 19 percent of spending on coastal trips is directly related to sea otters, yielding about a half a full time job per sea otter.

Table 1.
Direct Income and Employment Coefficients per Sea Otter

	<u>Aldrich et al.</u>	<u>Aldrich et al. (with Hageman adjustment)</u>
Direct Income	\$69,700	\$13,220
Employment	2.783	0.5287

Estimating Direct and Total Income Effects from Sea Otter Population Expansion

As did Aldrich et al., we used the value-added coefficient per sea otter for Santa Barbara and Ventura counties calculated by Hageman et al. to estimate the direct aggregate sea otter tourism income for these counties. The USFWS DSEIS (page 74) estimates that there will be about 117 sea otters between Point Conception and the city of Santa Barbara over the next 10 years without the "no otter zone" (they also estimate an additional 79 otters at San Nicholas Island, however, because of the difficulty of sea otter viewing there, these otters are excluded from the tourism analysis, but will be included in the total economic value estimate).

The paper by Tinker et al. (2004), relied upon by the USFWS in the DSEIS to calculate the additional 117 sea otters expected south of Point Conception over the next ten years, also estimates 131 sea otters in the next fifteen years. Without the “no-otter zone”, sea otters will likely re-colonize other southern California habitats as well as south to San Diego (Laidre, et al. 2001).

As can be seen in Table 2, the sea otter-related tourism associated with the additional 117 sea otters, estimated by USFWS, represents a direct income of \$8.2 million in annual income during the next decade. Using Tinker et al.'s estimate of the fifteen-year expansion of the sea otter population to the rest of Santa Barbara would contribute \$9.1 million annual direct income to Santa Barbara and Ventura counties. Table 2 also presents a minimum lower bound estimate of direct income by using the 19 percent adjustment from Hageman to account for the possibility that much of this coastal tourism is related to other species. The additional 117 sea otters represents a minimum direct income of \$1.5 million in annual income during the next decade based on adjusting by Hageman's survey data to a lower bound. Using Tinker et al.'s estimate of the eventual expansion of 131 sea otters to the rest of Santa Barbara county, this would contribute a minimum \$1.7 million annual direct income to Santa Barbara and Ventura counties based on adjusting by Hageman's survey data.

Table 2.
Estimates of Sea Otter Tourism Effects on Direct County Income with Expansion of Sea Otter Populations

	Sea Otter Population	County Income (Millions \$)	County Income (Millions \$) *Hageman Adjusted Lower Bound
DSEIS 10 Years	117	\$8.2	\$1.5
DSEIS 15 Years	131	\$9.1	\$1.7

DSEIS 10 years and 15 years based only on coastal sea otter populations and do not include San Nicolas Island population.

Income Multiplier Effects

These income estimates are quite conservative in that they only represent the direct effects of sea otter tourism. The indirect inter-industry linkages to non-tourism related industries (e.g., gasoline refining, agricultural) is not included, nor are the induced effects of household spending of the additional income. Thus, Aldrich et al’s methodology does not include the multiplier effects. According to Loomis and Walsh, multipliers for recreation range between 1.5 and 2.5, with a majority around 2. Thus, once sea otter populations have increased, and visitation increases, the long-term changes in sea otter related tourism is likely to be double the estimates shown in Table 2.

To calculate these multiplier effects, the U.S. Department of Commerce (1986) provides state level multipliers that reflect the indirect effects of direct changes in spending. The multiplier for tourist related sectors such as hotels/lodging is 2.33, while for eating/drinking places and transportation, the multipliers are both 2.27. Using the average (2.3), even the Hageman survey adjusted lower bound for the lowest near term population estimate (USFWS estimate of 117 sea otters) in Table 2 would yield \$3.9 million annual income in Santa Barbara county. Using the full income effect yields a total income estimate of \$18.86 million in annual income in Santa Barbara county associated with the USFWS estimate of 117 additional sea otters.

Estimating Direct Employment Effects from Sea Otter Population Expansion

Aldrich, et al. also estimated changes in employment associated with sea otter populations. Using regression equations similar to those for tourist spending, they estimated tourism employment in coefficients per sea otter. Table 3 presents these results for Santa Barbara/Ventura counties. Note we also use Hageman's survey reported estimates of 19 percent of wildlife viewing expenditures is related to sea otters to adjust employment estimates to yield a lower bound in Table 3.

In the next decade, between 62 and 326 jobs would be associated with the USFWS estimate of 117 additional sea otters. It may take most of the decade before jobs reach this level. Transition time will be needed to reconfigure marina space to handle additional tour boats, and for signed sea otter viewing areas to be put in place (as was done for elephant seal viewing in the area). Further expansion of sea otter populations in 15 years, as estimated by Tinker et al., will increase sea otter-related jobs to between 69 and 365 jobs. Using the 19 percent downward adjustment derived from the Hageman survey, Table 3 provides a minimum or lower bound estimate of the

direct effect of 62 jobs within the next decade and 69 jobs within the next 15 years.

Table 3.
Estimates of Sea Otter Tourism Effects on Direct County Employment With Expansion of Sea Otter Populations

	Sea Otter Population	County Employment	County Employment *Hageman Adjusted Lower Bound
DSEIS 10 Years	117	326 Jobs	62 Jobs
DSEIS 15 Years	131	365 Jobs	69 Jobs

DSEIS 10 years and 15 years based only on coastal sea otter populations and do not include San Nicolas Island population.

Employment Multiplier Effects

These employment estimates are quite conservative in that they only represent the direct effects of sea otter tourism. The indirect inter-industry linkages to non-tourism related industries (e.g., gasoline refining, agricultural) are not included. Thus, Aldrich et al’s methodology does not include the multiplier effects. According to Loomis and Walsh, multipliers for recreation range between 1.5 and 2.5, with a majority around 2. The Department of Commerce does not provide specific multipliers for the direct employment effects. However employment multipliers appear to be roughly the same size as the output multipliers (Minnesota Implan Group, 1997). Thus we can use Department of Commerce (1986) output multipliers for tourist related sectors such as hotels/lodging (2.33), eating/drinking places (2.27) and transportation (2.27 also). Using the average of these multipliers (2.3), even the Hageman survey adjusted lower bound estimate of employment in Table 3 would yield 142.6 jobs. The best estimate derived from Aldrich et al. for direct jobs would translate into 750 total jobs after ten years following the increase in the sea otter population.

Comparing Gain in Income and Employment from Sea Otters to Lost Commercial Fishing

As shown in Table 2, the gain in direct income (value added) to Santa Barbara by the end of the decade is calculated above to be at least \$1.5 million annually to \$8.2 million annually. The annual loss in gross fishing revenues by the end of the decade is calculated above from the DSEIS as \$610,242. As can be seen, the gain in income from tourism is at least two to more than ten times larger. We can view this comparison from the employment side as well. Table 3 indicates there would be a direct increase in at least 62 jobs to as many as 326 jobs by the end of the decade related to the additional sea otters along the Santa Barbara coast. As discussed above, we converted the \$610,242 of fishing ex-vessel value into total employment (direct and indirect) via the U.S. Department of Commerce’s Regional Input-Output Modeling System (RIIMS). For California as a whole, the direct and indirect (i.e., total) effects of reducing commercial fishery production by \$610,242 are between 24.1 and 26.5 annual equivalent jobs (U.S. Dept of Commerce, 1986: 76). Since this estimate includes all the multiplier effects throughout California, the actual number of jobs in Santa Barbara county would of course be less than this. Further, since the 24-26 jobs reflect the total jobs including the multiplier effect, an appropriate comparison would be to apply an equivalent multiplier from the same RIIMS system. As shown above, by the end of the decade the lower bound estimate of the equivalent total jobs (reflecting multiplier effects) would be 142.6 jobs for sea otter tourism.

4. NON-MARKET ECONOMIC VALUES FOR SEA OTTERS

Contingent Valuation Method for Measuring Non-market Economic Values

We can use market prices to estimate the net economic value or consumers' net WTP for market commodities such as shellfish, but the net economic value from sea otter viewing or existence values cannot be observed in a market. The absence of a market, however, does not mean absence of WTP. The challenge is to measure these human values without the price signals of a market, i.e., to infer what people would pay if there were a market to express these values. Californians have revealed their values for natural resources without explicit markets. For example, California voters placed a minimum value for protecting water quality in Lake Tahoe by voting for approximately \$100 million in bonds over the last several decades. In 1987, California citizens voted with a 65-percent margin in favor of a \$700-million bond for parks, open space and wildlife habitat. More recently, Californians approved \$4 billion in environmental bonds.

Over the last 40 years economists have developed and refined the Contingent Valuation Method (CVM) as a simulated market (Davis, 1963; Randall et al. 1974) or simulated referenda (Randall and Kriesel, 1990) to infer the recreation use value and existence values people hold for non-marketed natural resources. CVM involves conducting a survey that describes the resource to be valued, its current status, the amount of gain to be achieved or loss to be avoided and a means by which the respondent can pay to protect and enhance the resource or to avoid the loss. The means of payment can be higher taxes or contribution to a trust fund via an optional income tax check-off such as the one for non-game in California. (For a detailed discussion of CVM see Mitchell and Carson, 1989).

CVM is not a public opinion poll. Eliciting an economic value is not a popularity contest and resource protection is not free. CVM elicits the monetary sacrifice a household would make each year to achieve a gain in resource quantity or quality. While CVM is not a foolproof method, if done carefully it can yield reasonable estimates of WTP (Loomis 1989, 1990; Reiling et al. 1990). For example, CVM estimates of recreation benefits (Carson et al. 1986) and air quality (Brookshire et al. 1982) are consistent with WTP estimates based on actual behavior. In fact, the U.S. Water Resources Council (1983) guidelines for conducting economic analysis recommends that the Corps of Engineers and U.S. Bureau of Reclamation use CVM for valuation of recreation when performing an economic analysis.

Contrary to the statement in the DSEIS on page 51, that quantifying non-use values is difficult and speculative, there is much evidence and support for quantifying non-use values. As noted above, test-retest studies have shown CVM of non-use values to be reliable (Loomis 1989, 1990). The NOAA blue ribbon panel chaired by two Nobel prize winning economists (Kenneth Arrow and Robert Solow) concluded that a carefully conducted CVM was reliable enough to serve as a starting point for judicial and administrative decisions (see Arrow et al. 1993). Further, the USFWS has included CVM estimates of WTP in past EIS's on the wolf recovery program (USFWS 1994). Other federal agencies such as the U.S. Bureau of Reclamation have conducted non-use value CVM studies for Glen and Grand Canyon, and the National Park Service included non-use values from a CVM study in the EIS on removal of the Elwha Dam (National Park Service 1995).

Thus there appears to be no scientific rationale for the USFWS not having conducted an original

CVM study of the benefits of increasing sea otters along the California coast as part of its DSEIS.

Benefit Transfer Approach to Valuation

However, the fact of the matter is that the USFWS did not conduct an original CVM study for sea otter population increases as part of its economic analysis in the DSEIS. In these situations it is customary for agencies such as U. S. Environmental Protection Agency and U. S. Forest Service to perform their economic analysis using an approach called benefit transfer (U. S. EPA, Rosenberger and Loomis 2001). In benefit transfer, the value per household or per visitor day for the policy analysis is estimated based on prior valuation studies. One approach to benefit transfer is transferring the value per day or per household from the original study to the new policy situation. Thus, if prior studies found what households would pay per year for an increment in sea otter populations in California, then this value would be updated for inflation and applied to the current situation. As described below, we were able to locate such a study for sea otters in California, and have taken this approach.

Another approach to benefit transfer is to estimate a multiple regression equation from all the relevant studies in the literature and to use that equation to interpolate what the value per day or per household would be if an original study (similar to the studies on which the equation was based) were performed (Rosenberger and Loomis 2000). This approach is called meta-analysis benefit transfer. Meta-analysis involves quantitative analysis of past studies and is commonly used to synthesize medical studies and recreation valuation studies (Walsh et al. 1992). Loomis and White (1996) have published a meta-analysis for threatened, endangered and rare species, including several marine mammals. Setting the values of the independent variables in the equation to fit the policy situation in which values are needed, an estimate of annual household WTP for a particular change in population of these species can be calculated. Since this is the second valuation approach used in this report, we present the Loomis and White meta-analysis equation to illustrate the approach. The U.S. Environmental Protection Agency has used this meta-analysis and other meta-analyses in its benefit cost analysis of regulatory decisions regarding water intakes (U.S. Environmental Protection Agency 2003).

Loomis and White reviewed 25 different CVM studies on the total economic value of endangered, threatened or rare species. From these, they obtained 38 estimates of per household WTP to protect these species. About two-thirds of these studies elicited annual WTP, while the other third elicited one-time or lump sum WTP. To explain the variation in the dollar amount that households in different studies would pay to protect a different species, we related this amount to a series of explanatory or independent variables in a multiple-regression equation. The basic form of the multiple regression equation is:

$$\text{WTP per household (\$)} = \text{Constant} + \text{B1 (\% PopulationChangeSize)} + \text{B2 (OneTime Payment)} + \text{B3 (Visitors)} + \text{B4 (MarineMammals)} + \text{B5 (Birds)}$$

The first explanatory or independent variable to control for to make the studies comparable is OneTimePayment (B2). The different studies also elicited WTP for different types of species, so a shifter variable for MarineMammals (B4), and Birds (B5) was included to account for this distinction. Of course, the percentage change in size of the wildlife population being protected would influence WTP as well, so a variable for %PopulationChangeSize (B1) is included. Lastly,

most studies surveyed a random sample of all households, while a few studies surveyed visitors. Since visitors would be expected to have a greater interest in, and hence greater WTP, a shift variable for Visitors (B3) was included to capture this effect.

Variables B1 through B5 are the slope coefficients that show how much of a change there is in WTP per household with a one-unit change in the independent variable. In the case of B3, if the person were a visitor, WTP would rise by the magnitude of the estimated slope coefficient on B3. In the case of B4, if the species were a marine mammal, WTP would rise by the magnitude of the estimate slope coefficient on B4. Using data from the 25 different CVM studies providing 38 individual WTP estimates, a multiple regression was performed to provide a quantitative estimate of the constant term and the slope coefficients. The estimate linear regression equation is presented below (the log equation is presented in the appendix):

$$\text{WTP}(\$) = -\$49.43 + \$0.61(\% \text{PopulationChangeSize}) + \$42(\text{OneTimePayment}) \\ + \$23.55(\text{Visitors}) + \$35.76(\text{MarineMammals}) + \$21.72 (\text{Birds})$$

This equation assumes that for every one-percent increase in population, WTP per household increases by \$0.61 (B1=\$0.61). If the person surveyed is a visitor or viewer of the species, WTP is \$23.55 higher than if the person surveyed was not a visitor or viewer of the species. Finally, all else equal, marine mammals have a value \$35.76 higher per household than fish or terrestrial mammals, suggesting a relatively high value for these species. The equation does a reasonably good job explaining the variation in values across studies and species, because the five variables explain nearly 60 percent of the variation in WTP. This study was published in a peer reviewed, scientific journal, *Ecological Economics*. Below we use the equation to calculate per household WTP for additional sea otters envisioned by the USFWS in the DSEIS.

Economic Values for Marine Mammals and the Southern Sea Otter

There have been several studies that have valued marine mammals. The most studied marine mammal by economists has been whales (Hageman; Samples and Hollyer 1990; Loomis and Larson 1994). Hageman also valued sea otters and seals, and Samples and Hollyer valued seals. Giraud et al. (2002) measured the value of Steller sea lions in Alaska and determined that residents would pay \$40 per year to expand the state's Steller sea lion protection program.

The Hageman Sea Otter Contingent Valuation Method Study

Hageman provides the only estimates for the southern sea otter. As such, we will review this study in detail. Hageman conducted a mail survey of California households to assess WTP for three population levels of sea otters. The sample size was 180 completed surveys. The study meets many of the criteria suggested for a benefit transfer. In particular, the study was of the same species (sea otters), the same geographic area (California), and involved surveying the same human population of interest (California residents).

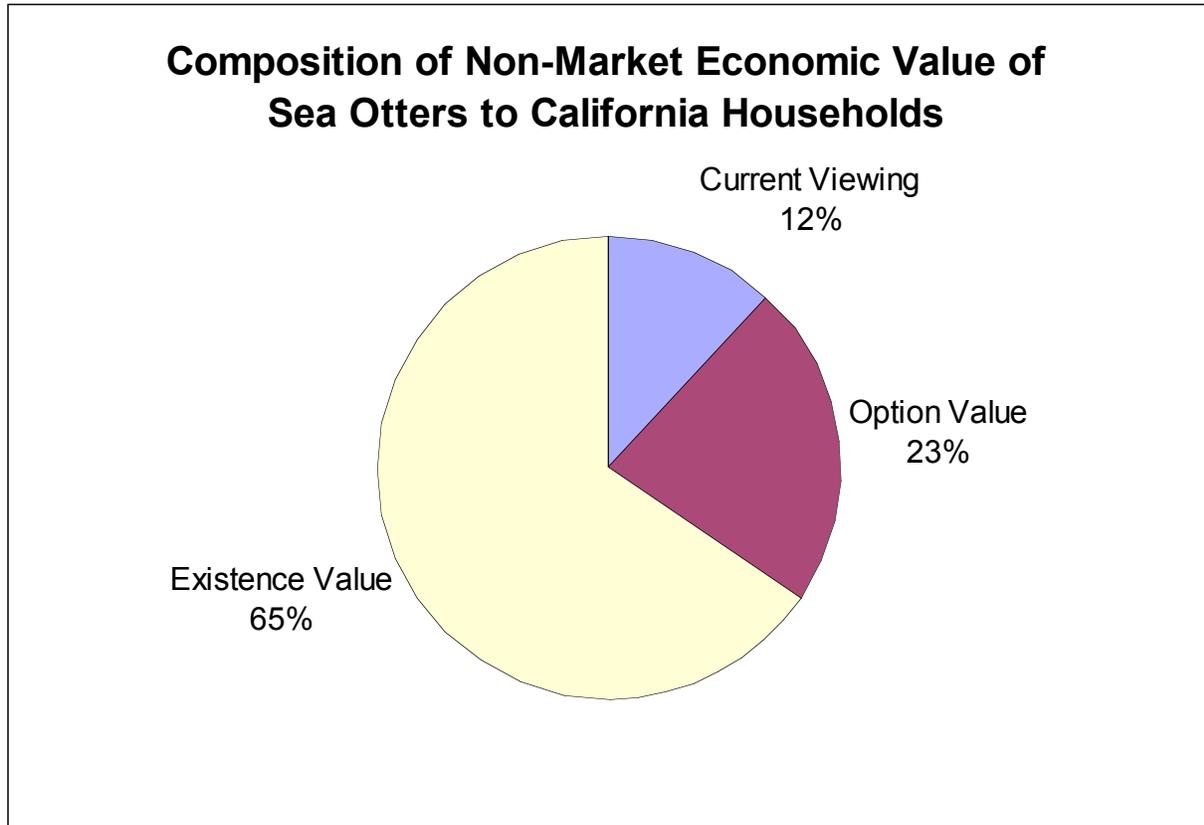
The first valuation question was WTP to prevent a fall from the current southern sea otter population of 1,500 (at the time of the study in 1984) to 100. The second valuation question was WTP to increase the California sea otter population from the 1500 to 3000 (close to the current population estimate of 2,500 sea otters). This additional value is \$10.71 per household per year in 2002 dollars. If we take this \$10.71 per household and divide it by the incremental gain of 1500

otters from 1500 to 3000, this yields an average value per sea otter per household in California. Multiplying this value by the first decade gain of 196 otters (117 along the coast and 79 at San Nicolas Island), we arrive at a value of \$1.40 per household per year. Finally, the additional WTP to increase the sea otter population from 3,000 animals to nearer its historic numbers of 16,000 sea otters yielded annual WTP per household of \$6.21. Note that the standard error on this estimate is \$1.50, which yields a lower-bound estimate of WTP for the additional 13,000 sea otters (16,000 minus 3,000) of \$3.75 per household per year. Thus, even for large increases in sea otter populations up to the various carrying capacity estimates of between 8,400 and 16,000 sea otters, the incremental or marginal WTP is statistically greater than zero. Below we discuss the expansion of this value per household to a range of total California values.

Components of Total Non-market Economic Value

Hageman (1985) also asked households to indicate the proportion of their annual WTP they would allocate to each of the traditional components of total value. In particular, she asked for the proportion due to actually seeing sea otters in the wild off the California coast (non-consumptive recreation-use value), option value of knowing they could view sea otters in the wild if they wanted to, and the existence value of just knowing that populations of sea otters live off the California coast even if they were never to see one. Hageman found the non-consumptive viewing value to be about 12 percent of the total economic value. The option value to someday view sea otters reflects 23 percent of the total economic value. The vast majority of the value (65 percent) was existence value from just knowing that sea otters exist along the California coast. These proportions of total economic value are illustrated in Figure 1. This diagram does not include ecosystem service benefits, however, because at the time of Hageman's study, economists did not recognize them as components of total economic value.

Figure 1.
Composition of Annual Per Household Non Market Economic Value of Sea Otters



(Adapted from Hageman, 1985).

Benefit Transfer Values of Sea Otters Using Meta-analysis

Loomis and White's meta-analysis equation can also be used as a benefit-transfer function to calculate annual household WTP for sea otters. This is done by setting the values of the independent variables to the appropriate levels for sea otters and the DSEIS. First, sea otters are a marine mammal, so that variable is set to one and the other species variable (Bird) is set to zero. We also set the PayFrequency at zero to reflect annual WTP, and Visitors at zero so that we are measuring non-user household WTP. Loomis and White also have a ChangeSize variable that reflects the percentage change in animal populations. In order to estimate the incremental or marginal annual household WTP associated with the DSEIS increase of 196 sea otters, the two calculations are made. First we set the current average population of sea otters at 2,390, calculated from the DSEIS (page 48) as 100 percent, and calculate a baseline or future without annual household WTP (\$59.44). Then we calculate the percentage increase in the sea otter population associated with the 196 sea otters (7.58 percent). Then the WTP estimate is recalculated using ChangeSize of 107.58%. This yields an annual household WTP of \$65.25. The increase in WTP of \$5.81 per household per year represents the annual household marginal or incremental WTP for the additional 196 sea otters. This is the calculation using the linear meta WTP function. We repeat this same procedure for the double natural log meta WTP function where the dependent variable is the log of WTP and the continuous variables such as ChangeSize are now expressed as

the natural log of ChangeSize (still in percent).¹ Both are used to illustrate the robustness of the results. Table 4 presents the results of the two meta-analyses adapted to predict the annual household WTP for sea otters.

Table 4.
Benefit Transfer Estimate of Annual Total Economic Value Per Household Using Meta- analysis Equation

	Meta-analysis	Meta-analysis (\$/household/year)
Sea Otter Populations	Linear Equation	Log Equation
Current Level 2390	\$59.44	\$38.31
DSEIS Level 2586	\$65.25	\$40.63
DSEIS Gain	\$5.81	\$2.31

Expansion of Household Values to California Population Values

Increases in sea otter populations provide benefits simultaneously to all households, because the components of total economic value are non-rival public goods. With 11.5 million households in California, the magnitude of state benefits is potentially quite large. Given that the estimates derived from Hageman and the meta-analysis are all based on random samples of the population, one estimate of California benefits can be calculated by multiplying the WTP value per household by the 11.5 million households in California. Table 5 presents this estimate as \$16.1 million annual benefits of the 196 additional sea otters using the Hageman study values of \$1.40 per household.

It is important to note that the Hageman study had a response rate of 21 percent despite a reminder postcard and a follow-up mailing of a replacement survey to all non-respondents. Given the length of the survey, such a response rate is not terribly low, but it is lower than desirable for generalizing the results to the population. However, Hageman (page 59) did indicate there was no statistical difference in answers between the respondents to the first mailing and the second mailing. Further, the Loomis and White meta-analysis found that survey-response rate had no statistically significant effect on household WTP. Thus there are two pieces of evidence (Hageman’s finding of no significant difference in first and second mailing responses, and Loomis-White meta-analysis) to suggest our generalization in Table 5, applying the sample mean to all 11.5 million households in California, is reasonable. Nonetheless to provide a sensitivity of the results to the representativeness of the sample, we adopt a conservative approach sometimes used by economists. This approach is to assume that the proportion of the population that did not return the survey had zero values for marine mammals such as sea otters. This is overly conservative because many people are simply too busy to fill out long surveys, and that does not mean they have no value whatsoever for marine mammals such as sea otters. But for purposes of calculating something approaching a lower bound on total economic value, we present such a calculation in Table 5, using only 21 percent of California households (2.415 million households),

¹ Linear models involve a constant rate of change of WTP for a one unit change in a given independent variable (equal to its slope coefficient B). A non linear model using a natural logarithmic transformation allows the rate of change in WTP to vary with the level of the independent variable. Typically, there is a diminishing marginal effect, whereby the amount of increase in WTP gets smaller, as the value of the independent variable increases.

rather than the total number of households in California. This conservative, lower bound estimate is \$3.4 million.

Table 5a.
Estimates from Hageman Study of California Households Willingness to Pay for Sea Otter Populations

Number of Sea Otters	Hageman Study Sample Estimate			Hageman Study Lower Bound		
	Value Per Household	Millions of California Households	Total California Value	Value Per Household	Millions of California Households	Total California Value (in millions)
Gain of 1500	\$10.71					
Per Sea Otter	\$0.007					
DSEIS 196 sea otters	\$1.40	11.5	\$16.1	\$1.40	2.415	\$3.4

Table 5b presents estimates of California households' WTP for the additional 196 sea otters based on the meta-analysis from Table 4. Since Loomis and White did not find any effect of response rate on values per household, the WTP values per household from linear and log models are applied to all 11.5 million households in California.

Table 5b.
Estimates from Meta-analysis of California Households Willingness to Pay for Sea Otter Populations

Number of Sea Otters	<u>Meta-analysis Linear Estimate</u>			<u>Meta-analysis Log Estimate</u>		
	Value Per Household	Millions of California Households	Total California Value	Value Per Household	Millions of California Households	Total California Value
Current Level 2390	\$59.44			\$38.31		
DSEIS Level 2586	\$65.25			\$40.63		
DSEIS Gain 196	\$ 5.81	11.5	\$66.8	\$ 2.32		

These benefit estimates are compared to the costs to commercial anglers from expansion of the southern sea otter range.

The conservative nature of all the total value estimates in Table 5a and Table 5b should also be noted, however. Just expanding the value per household by only the number of California households, ignores values to the rest of U.S. households. In one sense, restricting the values to just California households is inconsistent with the fact that the sea otter is a *Federally* listed species under the *Federal* Endangered Species Act. This is recognition of the importance of this

species. Further, Loomis (2000) showed that even though value per household for protection of wildlife species decreases with distance the household lives from the protected resource, there is still a WTP greater than zero. In particular, California household's WTP reflects only 18 percent of U.S. total value (Loomis 2000: 319) for preserving wetland species and spotted owls.

Comparisons to Other Valuation Estimates

While the millions of dollars in non-market benefits for an additional 200 more sea otters may seem to some to be a very large value, the State of California Department of Fish and Game "...conservatively estimates a natural resource value of \$20,000 per otter." (CDFG 2002: 6). They considered this a conservative estimate because the costs incurred for rehabilitating oil-soaked sea otters in the aftermath of several oils spills was in the range of \$40,000 to \$50,000 per animal. Further, they cite a study by Dr. Gardner Brown at the University of Washington that suggested a replacement value per sea otter of \$20,000 based on market prices of captive sea otters in the range of \$40,000 to \$50,000 per sea otter. Monterey Bay Aquarium's rehabilitation costs are from \$40,000 to \$60,000 per sea otter. Thus the total economic value of an additional 196 sea otters to humans, as revealed from efforts taken to prevent mortality to sea otters is in the range of ten million dollars (based on rehabilitation costs) to \$21.4 million dollars based on surveys and the log meta-analysis equation, respectively.

Conclusion on Non-market Economic Value of Sea Otters to California Households

The preceding section quantifies the Total Economic Value (recreation use, option and existence values) that sea otters provide California residents. CVM estimates based on the Hageman survey of California households indicate the value of allowing sea otters to expand their habitat and increase their current numbers. These estimates of Total Economic Value omit any benefits to residents in the rest of the U.S. Even accounting for the greater distance the rest of U.S. residents are from California, the national benefits of expanding sea otter populations are likely to be five times the California resident values.

5. ECOSYSTEM SERVICES PROVIDED BY KELP FORESTS AND SEA OTTERS

Kelp forests off the coast of California are an important marine ecosystem. Much like the multi-layered canopy of old growth terrestrial forests, kelp forests off the coast of California are biologically diverse and support numerous plants and marine animals (Levington 2001).

Part of the reason for the biological richness of kelp forests is they form an extensive three-dimensional habitat composed of multiple vertical layers (Nybakken 2001). Kelp forests are highly productive components of coldwater rocky marine coastlines (Steneck et al. 2003). More specifically, Steneck et al. (page 437) state “kelp forest ecosystems include structure-producing kelps and their myriad associated biota such as marine mammals, fishes, crabs, sea urchins, mollusks, other algae and epibiota that collectively make this one of the most diverse and productive ecosystems in the world”. Species using kelp forests include foraging birds, sea otters, and sea lions (Estes et al., 2003). As discussed in more detail below, sea otters are a critical species in sustaining healthy kelp forests, and hence insuring that ecosystem services from kelp forests are maintained.

Kelp forests provide many ecosystem services. Specific functions include the role of kelp forest particles in providing important food for filter feeders such as mussels and clams (Steneck, et al., 2002). Kelp beds provide habitat for species of fish, including juveniles, which are harvested in recreational and commercial fisheries (Estes 1996). The structure of kelp forests dampen wave surge (Steneck et al. 2003: 453) and thereby reduce coastal erosion (Estes et al. 2003). Coastal erosion in California is a major cost to landowners and recreational beaches, and sometimes necessitates expensive restoration or beach rebuilding efforts. Kelp forests are also quite productive at carbon storage or sequestration (Estes et al. 2003), thereby helping to moderate climate change.

The biodiversity of kelp forests also appear to prevent invasions of non-native species (Steneck et al. 2003). Often times, invasions by non-native species prove costly. For example, the invasion of the zebra mussels in the Great Lakes has clogged many municipal and industrial water intakes.

Sea Otters as Kelp Forest Keystone Species

Estes and Palmisano (1974), in their article in *Science*, indicated that sea otters provide a critical role in maintaining healthy kelp forests along the Pacific Coast. Sea otters do this by consuming sea urchins (Estes et al. 2003). Since sea urchins graze on the kelp forest, in areas where sea otters have been extirpated, the urchins have reduced the kelp forests substantially (Estes et al. 2003). As noted by Estes and Palmisano (1974: 1058), “sea urchins ...are known to be voracious algal grazers which can consume and destroy large quantities of kelp”. In some areas, sea urchin grazing has prevented the re-establishment of kelp forests after major storms (Levinton). Thus, the presence of sea otters plays an important role in restoring and maintaining kelp forests.

Sea otter consumption of sea urchins helps to maintain a balance between sea urchins and kelp forests, sustaining the forests and providing habitat for other species. In this sense, sea otters are considered a keystone species in the nearshore coastal environment (Estes and Pamisano: 1060). As a keystone species, the sea otter has a greater influence on the nearshore coastal ecosystem than might be expected from its size or current population numbers.

Implications of Sea Otters and Kelp Forest Ecosystem Services for the USFWS DSEIS

As discussed above, sea otters play a critical role in maintaining healthy kelp forest ecosystems, and thus insuring that ecosystem services of kelp forests are provided to humans along the California coast. Allowing the expansion of the sea otter population, will aid in the restoration and maintenance of kelp forests along the southern California coast. Thus, kelp forest ecosystem services such as erosion control, carbon sequestration, juvenile fish nurseries, increases in mussels, clams and other invertebrates, as well as protection of the California coast from invasive species will all be increased by the southern expansion of the sea otter and associated enhancement of kelp forests. This is an important ecological and economic benefit provided by allowing the expansion of sea otter habitat along the southern California coast.

Economic Values of Ecosystem Services Provided by Kelp Forests

The economic values of ecosystem services provided by kelp forests are expressed in numerous ways. The nursery benefits of fisheries habitat provided by kelp forests are partially reflected in commercial fishery market values and recreational fishing benefits. The coastal erosion protection benefits can be calculated by evaluating what it would cost to put engineered structures in place to prevent an equivalent amount of erosion. Of course, these engineered solutions come at an aesthetic cost to beach visitors as well.

In a much-cited paper in *Nature* (that was also reprinted in *Ecological Economics*), Costanza et al. estimated the economic values of ecosystem services for different types of biomes around the world. One of these was coastal seagrass/algal beds. Kelp is biologically classified as a brown algae (Nybakken) and is an important part of this coastal biome valued by Costanza et al. Using the existing literature and a team of ecologists and economists, they estimated an annual value of \$19,000 per hectare for these biomes. This translates into annual value of \$7,600 per acre of this type of ecosystem, a sizeable value. As the keystone species critical to sustaining healthy kelp forest ecosystems, sea otters are partly responsible for maintaining this ecosystem service value. If biologists could provide an indication of the additional acres of kelp forests that are maintained per sea otter, then the kelp forest related-value of additional sea otters could be calculated. Such estimates have not been made by biologists to date.

Based on the available biological literature, it is difficult to provide a more specific dollar value of the ecosystem services provided by sea otters and the kelp forest ecosystem. To do so would require biologists to quantify how the ecosystem services of kelp forests change with different levels of sea otter populations. While there is strong evidence of the desirable effect that sea otters have on the maintenance of kelp forest ecosystems and ecosystem services, biologists have not yet quantified these effects. Such a calculation would require an estimate of the amount of reduction in shoreline erosion (acres, tons) an acre of healthy kelp forests provides, or how many tons of carbon are sequestered in a healthy kelp forest maintained by sea otters versus a kelp forest without sea otters. Until such quantifications are available, it is difficult to provide specific estimates of the increase in economic value of the ecosystem services provided by kelp forests maintained by sea otters.

6. CONCLUSIONS

Economic Values of Additional Sea Otters Compared to Commercial Fishing

As demonstrated in the above analysis, sea otters provide a wide range of economic values to California residents and visitors to California's coastline. Increased tourism related to sea otter habitat expansion is likely to make a contribution to Santa Barbara and Ventura counties. As shown in Table 6, the increased income in Santa Barbara and Ventura counties from the USFWS estimate of near term increases in sea otter populations is between \$1.5 million and \$8.2 million annually with between 62 and 326 direct tourism related jobs. Including multiplier effects would likely double these direct tourism income and job estimates. These employment gains associated with sea otter tourism more than offset losses in commercial fishing due to sea otter range expansion.

Table 6a.

Summary of Tourism Benefits from the expansion of Sea Otter Populations into Santa Barbara and Ventura Counties

Sea Otter Population in Santa Barbara and Ventura Counties	Direct Tourism Income (Millions \$)	Tourism Jobs
117 otters in 10 years ¹	\$1.5 to \$8.2	62 to 326

1. U.S. Fish and Wildlife Service, DSEIS page 74 (does not include San Nicolas Island)

Section 4 quantifies the Total Economic Value (recreation use, option and existence values) that sea otters provide California residents. CVM estimates, based on the Hageman survey of California households, indicate a value to allow sea otters to expand by 196 is worth at least \$3.4 million to as much as \$16.1 million. Using a statistical meta valuation analysis of USFWS estimates of increases in sea otter populations in Santa Barbara over the next decade, 196 additional sea otters provide between \$26.7 million and \$66.8 million annually. The median of these four estimates is \$21.4 million, while the mean is \$28.25 million.

Table 6b.

Summary of Non-Market Sea Otter Benefits from the expansion of Sea Otter Populations

Expansion of Sea Otter Population in rest of Southern California	Median Estimate of Non-Market Value to CA Households ² (Millions)	Lower Bound Estimate of Non Market Value to CA Households ³ (Millions)
196 otters in 10 years ¹	\$21.4	\$3.4

1. U.S. Fish and Wildlife Service, SEIS page 74 (includes San Nicolas Island)

2. Calculated median value from the four estimates in Table 5a and 5b.

3. Calculated from Hageman study with downward adjustment for survey response rate.

All of these estimates of non-market economic value to California households omit any benefits to residents in the rest of the U.S. Even accounting for the greater distance the rest of U.S.

residents are from California, the national benefits of expanding sea otter populations are likely to be five times the California resident values.

Sea otters also help to maintain healthy kelp forests off the California coast. These kelp forests provide many ecosystem services of value to humans, such as reducing shoreline erosion, providing nurseries for juvenile fish and habitat for mussels, clams and other invertebrates, and moderating climate change by storing carbon. Sea otters maintain healthy kelp forests by keeping the kelp grazing sea urchin population in check. While California-coastal-specific estimates of dollar magnitude of these ecosystem service benefits are not available, estimates by Costanza et al. of this biome type suggest a value of \$7,600 per acre.

Comparison of Economic Effects—Table 7 presents a comparison of the gains in direct sea otter tourism income, total employment, and non-market value as compared to costs to commercial fishing. As can be seen, even the lower bound of the direct gain in sea otter related tourism in Santa Barbara county is more than double that of commercial fishing. The total jobs realized from sea otter tourism is at least five times that estimated to be lost in commercial fishing. Of course, the gain in recreation use and passive use (primarily existence values) to California households from the additional 196 sea otters is substantial at a median value of \$21 million.

Table 7.
Annual Economic Effects by 2014 of Sea Otter Population Expansion Along the Santa Barbara Coast

	Commercial Fishing	Sea Otter Tourism	Sea Otter Non Market Value
Dollars (millions)	-\$0.61 revenues	\$1.5 to \$8.2 direct income	\$21 median Use/Passive Use
Total Jobs	-24 to -26.5	+143 to +750	N/A

Sensitivity Analysis

While there may be some uncertainty around these estimates of non-market value, an alternative perspective can be gained on the overall economic benefits of the sea otter population expansion by dividing the annual revenues lost by the number of sea otters gained. While the annual revenues lost of \$610,242 overstates the net loss in commercial fishing income because it does not deduct costs, it may provide an upper bound on what a sea otter would need to be worth to make the expansion program economically efficient. Dividing the \$610,242 by the 117 additional sea otters along the Santa Barbara coast, that USFWS indicates would be directly affecting commercial fishing, yields an annual cost of \$5,216 per otter. This annual benefit is far below the rehabilitation costs per otter cited above of \$20,000 to \$50,000. In fact, each household in California would only need to pay about a nickel per household to cover the entire \$610,242 in foregone fishing revenue involved in maintaining the additional 117 sea otters.

While decisions regarding endangered species are and should be based on more than economic factors, this range of estimates on the economic values of sea otters helps bring some balance to the debate over southern sea otter range expansion: it is clearly not otters versus jobs. Sea otter tourism has the potential to support a substantial number of jobs and income in the Santa Barbara area, as well as providing non-market economic values to millions of California households.

In sum, sea otters have several types of economic values to people that have not been quantified in the Draft SEIS. These economic benefits should be included by USFWS when evaluating sea otter management alternatives in the Final SEIS. If the USFWS is quantifying the costs in dollar terms, a balanced and complete economic analysis should quantify the benefits in dollar terms as well.

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Appendix A

Calculation of Incremental Existence Value from the Log T&E Meta Equation of Loomis & White, Ecological Economics, 1996

Meta Eq Benefit Transfer		Sea Otter	Product	Exist otter	10 year
				2390	+196
Constant	-1.13	1	-1.13		
Ln ChangeSize	0.803	4.60517	3.697952	2390=100%	
PayFrequency	0.771	0	0		
Visitor	0.773	0	0		
Marine	0.85	1	0.85		
Bird	0.648	0	0		
		Sum log	3.417952		
		1993\$	\$30.51		
		2002\$	\$38.31		
Meta Eq Benefit Transfer		Sea Otter	Product		
Constant	-1.13	1	-1.13		
Ln ChangeSize	0.803	4.678228	3.756617	% gain	+7.579%
PayFrequency	0.771	0	0		
Visitor	0.773	0	0		
Marine	0.85	1	0.85		
Bird	0.648	0	0		
		Sum log	3.476617		
		1993\$	\$32.35		
		2002\$	\$40.63		
DIFFERENCE IN WTP per HH			\$2.31		
CA HH Total WTP			\$26.62	millions	