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Saving the Sea Otter Population in California: Contemporary Problems and Future Pitfalls

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California sea otters first entered the biopolitical arena in the 1960s when the conflict developed between the red abalone (Haliotis rufescens) fishery and the growing sea otter population. Since that time the central issues of concern for sea otter conservation have been conflicts with shellfisheries and, later, the perception of risk associated with marine oil development and transport. Concern about possible oil spills eventually placed California sea otters on the list of threatened species pursuant to the Endangered Species Act (ESA) of 1973 as amended. The listing provided an early example of the conundrum that has bedeviled conservation efforts since passage of the ESA: Here was a population viewed simultaneously as desperately in need of protection by some, and as a socioeconomic menace by others. Although other issues have since emerged, discussions of the conservation of California sea otters have to date invariably focused primarily on shellfisheries or oil spills. Now we approach a transition, from which the range of issues broadens and their complexity deepens.

I have two purposes here. The first is to provide a synopsis of key issues identified in the other papers of this publication and briefly discuss their significance. The second purpose is to look beyond current controversies and anticipate issues emerging in the conservation politics of sea otters as we enter the new millennium. The central assumption throughout this paper is that sea otters will be taken off the endangered species list and will be declared at an optimum sustainable population (OSP) level, pursuant to the Marine Mammal Protection Act (MMPA) of 1972 as amended, within the next few decades. As a consequence new problems will move to the forefront. In my opinion these problems will be vexing, possibly even intractable. Thus, it is not too soon to begin considering approaches to their resolution.

Problems emerging from other articles

Reducing the risk of oil spills in California waters

Preceding papers include accounts of considerable effort devoted to mitigating the consequences of a drastic reduction in sea otter numbers. Such efforts follow largely from the perception that a major oil spill is possible in California sea otter habitat and could affect a significant portion of the population (VanBlaricom and Jameson 1982; Bonnell et al., this issue), and the recognition that oil spills cause significant mortality in sea otter populations (Garrott et al. 1993; DeGange et al. 1994; Loughlin 1994; Brody et al. 1996).

Three specific types of mitigation effort are discussed: techniques and facilities for rescue, treatment, and rehabilitation of sea otters (see Jessup et al.; Williams and Williams, this issue); strategies for captive breeding (see Brennan and Houck; Duffield et al., this issue); and development of a genome resource bank (see Long et al., this issue). Each approach promises a significant contribution toward enhancement of a population that has been precipitously reduced by an oil spill.

The efficacy and efficiency of post-spill mitigation measures for sea otter conservation have been hotly debated (e.g., VanBlaricom and Gornall 1989; Ames 1990; VanBlaricom 1990; Estes 1991). Even among antagonists there is broad agreement, however, that measures preventing oil spills from occurring likely are much more effective tools than any measures designed to restore sea otter populations from spill-related reductions. There is a clear need for involved agencies, researchers, and non-governmental organizations (NGO) to develop a joint plan for reduction of oil spill risk, and to enter negotiations with the large vessel industry to implement new standards from which sea otter conservation will benefit. The new standards must focus on moving vessel traffic farther offshore (e.g., Bonnell at al., this issue). An obvious advantage of this process is that reduced spill risks are of benefit to everyone involved in coastal zone

management: oil companies and related industries, tourism interests, marine sanctuary programs, commercial and recreational fisheries, local governments, transportation regulatory agencies, conservation-oriented NGOs, university researchers, and resource agencies. There are few negatives other than increases in operational costs for large vessels, and possibly increased enforcement costs. The megaliabilities of damage assessment, restoration, and litigation falling to parties responsible for oil spills (witness the case of the *Exxon Valdez*) argue that increased operational and enforcement costs should be the preferred alternative.

At least one objection to the risk reduction approach can be imagined. The oil industry and the related large-vessel transportation industry are expansive and multi-faceted, thus, "negotiating with the industry" will in fact be a daunting logistical challenge. However, the translocation of sea otters to San Nicolas Island faced comparably intimidating obstacles. Despite substantial administrative and technical challenges, political complexities, and the vocal disapproval by some interest groups, management authority was able to build a plan that led to project approval (see Benz, Attempts to Reintroduce, this issue).

What should the optimum sustainable population level be?

The ESA and MMPA provide key legislative guidelines for conservation of marine mammal populations such as California sea otters. The presence of listed populations can result in far-reaching habitat protection policies and can limit many kinds of economic activity within preferred habitat (e.g., Clark, this issue). Thus it is desirable to "recover" listed populations in order to facilitate conservation and perhaps to reduce impediments to various options for management and economic enterprise.

For the ESA, definition of listing criteria typically has fallen to Recovery Teams appointed on a case-by-case basis. For California sea otters the appointed Recovery Team has proposed that endangered status is appropriate for a population size less than 1,850 animals, and threatened status for a population size between 1,850 and 2,650 animals. The MMPA mandates that populations of marine mammals smaller than the OSP level are to be listed as depleted, subject to a petition process (see below). Again, specific listing criteria are not a part of the legislation, but the customary management practice has been to set a minimum OSP size at 60% of carrying capacity (K; see DeMaster et al., this issue).

Marine mammal populations listed either as endangered or threatened under ESA are by default categorized as depleted under MMPA. Removal from lists defined by ESA also automatically removes the depleted designation as defined by MMPA, even if the population size is less than 60% of K. An approved petition is required for populations delisted under ESA to be listed as depleted under MMPA (see Baur et al., this issue).

For my purposes here I assume that such a petition will follow immediately after the delisting of the sea otter population. This circumstance would make the delisting meaningless in a management context, because depleted status under the MMPA carries many of the same restrictions as the ESA, and could limit management options designed to balance conservation goals and socioeconomic needs. Thus, in my view, the central recovery issue relates to MMPA, not ESA, and specifically is: What is OSP level for California sea otters?

There is a range of views regarding the appropriate criteria for determination of the OSP size. DeMaster et al. (this issue) present a largely ecologically-based argument for a minimum value of 8,100 animals. Wendell (this issue) argues for consideration of socioeconomic as well as ecological issues in setting a minimum OSP level, implying that a value closer to ESA thresholds would be preferred in order to accommodate diverse human concerns along with sea otter conservation goals. Given the gap between these estimates I see an obvious potential for discord.

The MMPA is ambiguous in defining minimum OSP levels, implying substantial flexibility in approaching

the problem. Thus the opportunity is available for setting OSP levels that accommodate diverse interests and concerns. I urge management authority and affected parties to begin, now, the process of negotiating toward a consensus OSP range.

Jurisdictional strife: template for polarization

Since 1972 there has been a consistent pattern of dissension between California Department of Fish and Game (CDFG) and U. S. Fish and Wildlife Service (FWS; note that the research division of FWS, formerly known as the National Biological Service, became part of the U.S. Geological Survey (USGS) in 1996) with regard to the conservation of sea otters. The preemption of state management of sea otters by MMPA in 1972 greatly complicated the efforts of CDFG to find a solution for sea otter-shellfishery conflicts. The listing of California sea otters as threatened in 1977 was, in the view of CDFG, an unjustifiable exaggeration of oil spill risk relative to the population size and distribution of sea otters (see Wendell, this issue). These events fostered an understandable resentment of federal management authority, injecting distrust and bitterness to interactions of state and federal managers and researchers. Efforts by federal agencies to introduce new research hypotheses and management concepts only engendered further skepticism and division, with the result that federal staff also became suspicious and distrustful of state positions on key issues. Because there has been relatively little turnover in staffing of federal and state sea otter management and research since the late 1970s, there have been few stimuli for embittered individuals on either side to seek a more positive approach to resolution of mutually significant issues. Thus, federal-state interactions regarding California sea otter conservation often have shown all the sophistication of a rugby match on the mudflats of Elkhorn Slough.

The real tragedy of the dysfunctional state-federal relationship is that it has created a template for polarization of public interest in sea otter conservation and management. Given the strongly dichotomous, apparently irreconcilable positions of CDFG and FWS/USGS on many sea otter conservation issues, non-governmental interest groups and stakeholders have gravitated to one side or the other. Rather than developing a unified front necessary to influence decision-makers and move forward on the implementation of consensus conservation policy, each side instead has invested substantial energy in attempts to discredit the views and goals of the other side, with the result that decision-makers have done nothing on many significant issues.

It is disturbing to find new evidence of the destructive polarization process. For example, Jessup et al. (this issue) summarize the recent progress in the development of facilities and procedures for care of oiled marine wildlife in California. The Oiled Wildlife Care Network (OWCN), managed by CDFG, is a good model of cooperative effort among potentially disparate agencies, NGOs, and other interests, and reflects the lesson of the Exxon Valdez disaster: rescue and rehabilitation facilities and procedures cannot possibly succeed if they are assembled post-spill. Unfortunately, the 1996 draft revised Southern Sea Otter Recovery Plan (Recovery Plan), prepared at the behest of FWS, makes a strongly negative editorial categorization of the type of approach represented by OWCN. The draft Recovery Plan offers no analytical justification for the stated position. Thus the Recovery Team, and by extension FWS, appear to be arbitrarily categorizing as worthless the most prominent element of the CDFG strategy for dealing with oil spills in California sea otter habitat.

A consensus agreement on OSP level probably is not attainable if the dysfunctional relationship of CDFG and FWS/USGS persists. Public polarization and decision-making stagnation will follow inevitably from continued failure of state and federal authorities to place high value on effective cooperation. Third-party mediation may be a desirable approach in moving CDFG-FWS/USGS interactions to a more constructive realm.

Omissions of note

There are two important problems receiving only minimal discussion in this issue. The first is the method

currently used for assessing the size and dispersion of the California sea otter population (see Bodkin and Ballachey, this issue). This method was developed by FWS and CDFG in the early 1980s, primarily through the initiative of R. J. Jameson, and includes two components. Most of the current sea otter range can be censused by ground observers because of the availability of State Highway 1 and the precipitous nature of the coastline. Less accessible portions of the range, such as those off Santa Cruz County and south of Pismo Beach, are surveyed by aircraft. Detection probabilities for ground counts are known (Estes and Jameson 1988), but to my knowledge detection probabilities for the aerial surveys have not been estimated for California sea otters. Thus, the total number of sea otters counted underestimates the total number present, but the magnitude of error is unknown. The unknown error has not been regarded as a significant problem because the range of the sea otter population has changed relatively little since the early 1980s, and surveys have been consistent with regard to technique, timing, weather and sea conditions, and personnel.

Monitoring of population size and distribution of sea otters in California will continue to be a crucially important activity, forming the basis for decisions regarding attainment of conservation and management goals. As the population continues to grow, it may be necessary to modify survey methods for at least two reasons. First, an expanding range will increase the difficulty in completing a count in a short period, which is important to ensure that survey results are not biased by significant movements of animals during the survey period (R. Jameson, personal communication). Second, increases in range likely will change the proportion of the population that can be surveyed by each of the two component methods. Such changes will alter the correlation between total number counted and actual population size in an unknown manner. In turn, these changes affect the accuracy of calculated trends in population size and alter the error in numbers used to measure attainment of management goals (see Bodkin and Ballachey, this issue). I recommend that research staffs of FWS/USGS and CDFG undertake the tasks necessary to resolve these problems, keeping in mind the need to determine the relationship of new methods with those currently in use, such that a long-term measure of population trend can be maintained without artificial discontinuities.

The second problem not receiving extensive coverage in this issue involves the relationship of sea otters with the biological structure of kelp forest communities in California. Sea otter foraging is known to limit numbers of benthic herbivorous invertebrates, particularly sea urchins, with the result that kelp forests are larger, more productive, more diverse biologically and structurally, and provide more benefits in terms of secondary availability of fixed carbon (e.g., Estes and Duggins 1995). This model has become dogma for much of the coastal Pacific Rim, especially in Alaska, but it remains in dispute in California (McLean 1962; VanBlaricom 1984; Foster and Schiel 1988; Estes and Duggins 1995). The alternative view, articulated by Foster and Schiel (1988), is that sea otters are only one of a number of factors that influence kelp forest structure at any particular location. Foster and Schiel argue that our capability for predicting the otter-urchin-kelp relationship is weak and that the model is overgeneralized, and possibly not applicable, for California coastal habitats.

Resolution of the dispute is important for two reasons. First, both ESA and MMPA mandate an understanding of the ecological connections between sea otters and their ecosystems. Because kelp have profound effects on habitat for other coastal organisms (e.g., Duggins 1988; Duggins et al. 1989), appropriate management of sea otters demands that the dispute be resolved. Second, kelp is harvested and supports a significant economic enterprise in California (e.g., Tarpley and Glantz 1992). Wendell (this issue) argues that human recreational and commercial enterprises in coastal marine waters should be significant factors in the determination of OSP level for California sea otters. For such determinations kelp harvesting interests should be considered (VanBlaricom 1984).

The best opportunity for additional study of the sea otter-kelp relationship in California is at San Nicolas Island (SNI). Coastal habitats at SNI include a diverse array of ecological patch types on shallow rocky substrata, with patches of well-developed kelp forests and areas that have been largely deforested by grazing sea urchins (e.g., Harrold and Reed 1985). The FWS/USGS ecosystem database for SNI dates to 1980 and represents systematic monitoring since that time. The future of the sea otter population at

SNI is uncertain given the small number of animals present (Benz, Attempts to Reintroduce, this issue), but should the population grow and the FWS/USGS monitoring program be continued, many aspects of the current dispute may be resolved. Because of the potential management significance of data from SNI, continued monitoring of the translocation is imperative.

Problems for the new millennium

In this section I offer predictions of three problem areas that may develop over the next few decades as California sea otters emerge from the protection of ESA and reach a consensus OSP level: (1) sustainability of shellfisheries as zonal management of sea otters becomes broadly implemented and accepted; (2) changes in marine oil activity, and the associated consequences for oil spill risk; and (3) the emergence of interest in harvest of sea otters and shellfish by Native Americans. These issues will be direct and logical consequences of the removal of California sea otters from the list of threatened species, and the attainment of OSP levels. They will be as challenging as any issues currently under consideration.

Sustainability of shellfisheries

CDFG and FWS have for some years endorsed the concept of zonal management of California sea otters. Zonal management involves restriction of the range of the sea otter population to certain agreed areas, with the premise that areas without sea otters will be better suited for productive shellfisheries (see Wendell, this issue). Zonal management likely will become firmly implemented at some point after the population is delisted and attains the OSP level.

The concept of zonal management includes three assumptions: (1) sea otter range can be effectively constrained by an economically reasonable and politically palatable management program; (2) shellfisheries cannot be sustained in the presence of an unmanaged sea otter population; and (3) shellfisheries are sustainable and productive in the absence of sea otters. All three assumptions are controversial (Estes and VanBlaricom 1985; Wendell et al. 1986; Wendell 1994; see Benz, Attempts to Reintroduce; Wendell, this issue). Here I limit my comments to the third assumption. I focus primarily on California's abalone fisheries to illustrate my arguments, although with some caution my views can be generalized to other shellfisheries.

The chronology of harvest data for California's commercial abalone fisheries suggests that, for a given species, high-yield areas are fished at a rate that typically exceeds the actual local rate of biomass production. Once a given location is depleted, fishing effort is moved elsewhere. Ultimately the fishery must refocus effort to a less desirable species (because high-yield areas are not able to recover from depletion before all high-yield areas for a given species are depleted). This pattern is apparent in harvest data records that indicate chronologically progressive depletion of abalone stocks (Haliotis spp.) over a period of several decades (Estes and VanBlaricom 1985). The problem has been exacerbated by sea otter predation in central California (Wendell 1994) and disease outbreaks in southern California (Haaker et al. 1992; Davis 1993; Lafferty and Kuris 1993; Richards and Davis 1993; VanBlaricom et al. 1993; Gardner et al. 1995), but the general model of over-utilization seems clear for areas and species that have not been affected by sea otters or disease (Estes and VanBlaricom 1985).

As a consequence of excessive harvest the present status of southern California's abalone stocks is dismal. White abalone are nearly extinct (Davis et al. 1996) and should be a candidate for immediate listing under the ESA. Fisheries for pink, green, and black abalones presently are closed because of depleted stocks or, in the case of blacks, disease (P. Haaker, personal communication).

Among California's harvested abalone species only red abalones have significant populations north of the present sea otter range. Commercial fishing for red abalones has been closed north of San Francisco since 1945, and recreational fishers are not allowed to use scuba gear, as they are in southern California.

Stock sizes of red abalones are much larger in northern California than elsewhere, probably as a direct consequence of reduced total fishing mortality and the prolonged absence of sea otters (e.g., Pollard 1992). However, northern California stocks also face problems. Good recruitments are rare and growth rates of post-metamorphic individuals are low (Tegner 1989; Tegner et al. 1992). Large-scale illegal harvest is a burgeoning problem, and there is interest in opening northern California to commercial harvest.

Shellfishery management will be further complicated should the Native American communities of California successfully reassert access to traditional shellfishing grounds and resources. The coastal Native tribes of California relied heavily on shellfish gathered from ocean shore habitats for subsistence in pre-Columbian times (e.g., Vedder and Norris 1963; Bryan 1970; Douros 1993) and there can be little doubt that any legally binding affirmation of fishing rights for coastal California's Native Americans would extend to shellfish. Two federal court cases, the Boldt Decision and the Rafeedie Decision, both involving issues in Washington State, appear to provide legal precedents that could stimulate entry of Native tribes as significant users in California shellfisheries. These decisions also stated that it is within the right of tribal fishers to use modern techniques such as scuba diving, to seek newly available species such as those introduced from other regions (Katzen 1996), and to pursue commercial as well as subsistence harvests of shellfish.

The imposition of zonal management as the long-term foundation of sea otter management carries an assignment of responsibility to fishery management authority and the shellfishing industry. If sustainable shellfisheries are to be a part of coastal California's future, shellfishery management may need to assert more conservative harvest guidelines, and the appearance of Native fishers as significant participants in California shellfisheries would require a further reduction in the harvest share taken by non-tribal fishers. Ludwig et al. (1993) review the discouraging status of the world's marine fisheries, describe several insidious mechanisms that can lead to unforeseen and damaging overharvest, and argue for "distrust" of claims of sustainability in fisheries management. Such patterns certainly are of concern for species with the life history characteristics typical of abalones and many other shellfish species harvested in California. The failure to sustain shellfisheries will mean a failure of zonal management, destabilizing a crucial element in long-term conservation planning for sea otters.

Changes in marine oil activity

The California sea otter population has been viewed as vulnerable to the effects of spilled oil for at least two decades, on the basis of laboratory studies (e.g., Costa and Kooyman 1982; Williams et al. 1988), examination of surrogates for oil spills (VanBlaricom and Jameson 1982), oil spill risk modelling (e.g., Bonnell et al., this issue), and actual oil spills in sea otter habitats. As a consequence, marine oil development plans routinely have been modified or cancelled since the listing of the sea otter population as threatened in 1977. Since the Exxon Valdez oil spill of 1989, sea otters have been the very symbol of resistance to marine oil activity for purposes of environmental protection (e.g., Batten 1990). Nevertheless, the fundamental socioeconomic, cultural, and demographic factors that drive global consumer demand for petroleum products have not changed appreciably in recent decades and likely will not change in the foreseeable future, necessitating additional development and transportation of new oil reserves.

Removal of California sea otters from the list of threatened species, and subsequent attainment of OSP levels, likely will lead to new plans for increased development of California's marine oil reserves, and new consequent transportation scenarios. Having lost the status of a listed or depleted population, California sea otters also will lose some of their "poster-child" clout as the oppressed victims of Big Oil. Any pre-OSP negotiated changes in oil shipment patterns off California could become obsolete as the demand for inexpensive oil supersedes public concern for a "recovered" sea otter population.

As development plans are implemented, risks of oil spills in sea otter habitat will increase, perhaps precipitously. The magnitude of the change is difficult to predict for several reasons. First, tanker traffic

carrying crude oil southward from the trans-Alaska pipeline system (TAPS) has been declining for several years, and recent changes in TAPS-associated tanker traffic patterns off California will reduce spill risks by an unknown degree (see Jessup et al.; Saunders, this issue). Second, the choice of offshore tracts targeted for development will depend largely on economic and political factors well beyond the scope of this discourse. Third, a significant portion of petroleum transport through or near the California sea otter range is done by tankers moving refined products between San Francisco Bay and Los Angeles County, and these transport rates are affected by a complex of economic and demographic factors. Thus, although rates and associated spill risks likely will increase over the long term, the magnitudes of trends in the rates are difficult to predict.

Most available risk analyses consider current scenarios for transportation and development. The possibility of a significant change of risk levels associated with removal of sea otters from protected status has not been evaluated quantitatively to my knowledge. Changing oil spill risks after the year 2000 certainly represent a potential pitfall in sea otter conservation, and zonal management may have a regressive long-term impact on sea otter conservation if sea otter population size and range are constrained to constant values while oil spill risks increase.

Harvest by Native Americans

The MMPA includes provisions allowing Alaskan Native peoples to harvest marine mammals. The provisions are in recognition that harvest of marine mammals is a matter of enormous cultural significance to Alaskan Native communities, and that many marine mammal populations in Alaska are large enough to sustain Native hunting activity. The original MMPA was ambiguous about methods for regulation of Native harvest. Subsequent amendments and decisions have formalized co-management of marine mammal stocks between federal agencies and tribal governments.

The MMPA provisions for Native harvest laid groundwork for significant take of sea otters by Natives in Alaskan coastal waters. For most of the 1970s and 1980s few sea otters were taken as various legal issues were sorted out. Between 1988 and 1996 Native hunters took about 500 sea otters per year from Alaskan coastal waters (C. Gorbics, personal communication).

The MMPA makes no provision for harvests of marine mammals by Native peoples outside of Alaska. In 1995, after gray whales were taken off the endangered species list, the Makah Native people of coastal Washington State announced an interest in a limited harvest of gray whales off tribal lands of the Olympic Peninsula. The tribe cited rights specified in 19th century treaties with the U.S. government including provisions for continued pursuit of hunting practices in a manner consistent with tribal tradition. The Makah people are also known to have hunted sea otters in previous generations, and may be considering an assertion of treaty-based rights to renew the take of sea otters, whose population has been growing rapidly in the vicinity of tribal lands (R. Jameson, personal communication).

Many Native tribes in the western United States signed treaties with the U.S. government in the 19th century. Often these agreements involved retention of hunting and fishing rights and other traditions in return for land exchanges and other concessions. Such agreements often seem ambiguously worded by contemporary standards. To date, portions of the language of five treaties involving Native tribes in western Washington have been tested in the U.S. Supreme Court on seven different occasions. Two important conclusions emerge from Court rulings, as summarized by Katzen (1996). First, the right of tribes to fish and hunt in usual and accustomed places is an inherent right pre-dating the appearance of European colonists, and this right remained with tribes unless explicitly relinquished. Second, the burden of proof for ambiguity in treaty language lies with challengers of treaty rights and obligations, not with the tribes. The courts interpret treaty language as it is thought to have been understood by tribes at the time the treaties were signed (Katzen 1996).

I suggest the possibility that attainment of OSP levels by the California sea otter population may open the

door to proposals for Native harvest in California. California Native peoples are known to have taken marine mammals, including sea otters, either for food or to generate pelts for trade (e.g., Kroeber 1925; Bennyhoff 1950; Kroeber and Barrett 1962; Bleitz 1993). Coastal tribes without legally binding forfeitures of hunting rights likely will have a case for the legal development of sea otter harvests.

It is both difficult and highly presumptuous to predict the actions of Native tribes with regard to the harvest of sea otters. Given the potential establishment of a precedent by a non-Alaskan tribe such as the Makah, and the stimulus provided by removal of California sea otters from protected status, a move toward Native hunting of sea otters in California is a reasonable expectation. Such a move likely would provide politically contentious pitfalls and technical challenges for those charged with shepherding the conservation of sea otters after the year 2000. Should Native harvest plans materialize in California, I predict a difficult, high-profile public debate with no obvious pathway for resolution.

Conclusion and recommendations

Sea otters are attractive to scientists because they are accessible, easy to observe and count, have easily quantifiable diets with readily recognized prey, and are part of ecological interactions that are interesting, sometimes astonishing, and always relevant to a number of significant management issues. It is no coincidence that we have a better technical understanding of many aspects of sea otter biology than for most other carnivorous marine and terrestrial mammals. It should follow, then, that the available repository of data and models is a powerful resource for resolution of questions bearing on conservation of sea otters in California. In short, if science can't save the California sea otter population, science probably can't save anything.

Science cannot function as a tool for conservation planning without broad public support. Diminishing support for the scientific method as a pathway for answers is a widespread and growing problem in our culture (e.g., Sagan 1995; Ehrlich and Ehrlich 1996). The loss of faith in science results from the consistent failure of society to understand the process of science, and from the progressive replacement of secular logic with traditional values and mythologies as the basis for making decisions. Here emerges a dilemma, wherein public support for science may be tied to lay participation, but lay participation may be at best inappropriate, and at worst a detriment to objective knowledge.

The making of public policy in the 1990s is a pluralistic process in which user groups and interest groups sit at a round table with scientists and managers. For complex issues involving social, economic, and technical components, pluralism and egalitarianism are appropriate. Determination of the OSP level is perhaps a good example. For scientific questions that underlie many management issues, the involvement of interests outside the realm of science may interfere with the search for truth. In evaluating hypotheses, scientists cannot be swayed by association with advocacy, nor can they mix the roles of scientist and advocate, without compromising the process. The involvement of advocacy may lead to settlement of scientific questions by popular consensus rather than rigorous elimination of incorrect explanations and the development of accurate syntheses.

If sea otters are to be saved in California, scientists must do good science and avoid advocacy. Advocates must defend their interests but not meddle in the dialectic of research. Managers must determine whose data are objectively represented, and whose models represent good science. The interested public must demand the highest standards of all. The reward for commitment to the scientific process and assumption of appropriate roles is the survival of the California sea otter population for another millennium.

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