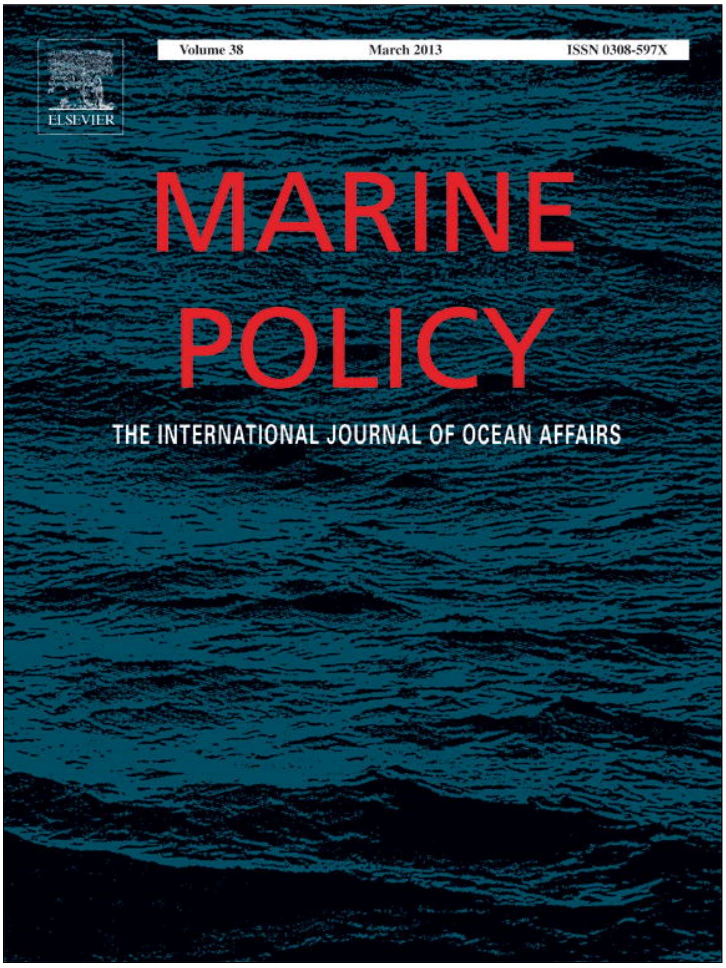
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Conservation values in marine ecosystem-based management

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ABSTRACT

Proactive ecosystem-based management represents a turning point in ocean management, because it formally recognizes the need to balance the potentially competing uses of the ocean, including aquaculture, energy production, conservation, fishing, and recreation. A significant challenge in implementing this balancing act arises from explicitly incorporating conservation in a decision-making framework that embraces assessments of trade-offs between benefits from conservation and conventional commercial uses of marine resources. An economic efficiency-based framework for evaluating trade-offs is utilized, and, for illustration, applied to assess the relative benefits and costs of conservation actions for the endangered western stock of the Steller Sea Lion (wSSL) in Alaska, USA. The example highlights many scientific and political challenges of using empirical estimates of the benefits and costs to evaluate conservation actions in the decision process, particularly given the public's large conservation values for the wSSL. The example also highlights the need to engage in stakeholder discussions on how to incorporate conservation into ecosystem-based management, and more specifically, coastal and marine spatial planning (CMSP). Without explicit consideration of these issues, it is unclear whether CMSP will better conserve and utilize ocean resources than the status quo.

1. Introduction

The US National Ocean Policy [1] represents a turning point in ocean governance in that the central tenet of the policy is the *proactive* application of ecosystem-based management (EBM) [2]. Advocates for EBM call for a realignment of the scale and scope of governance that is motivated by the current mismatch between jurisdictions and ecosystem processes [3], for the application of formal decision-theoretic tools to assess trade-offs both today and in the future across multiple uses and stakeholders (e.g., benefit-cost analysis, cost-effectiveness analysis, etc.) [4–6], and for the development of a unifying ecosystem objective from which to assess trade-offs [7]. Although EBM has broad and growing support, it is not immediately evident how altering jurisdictional boundaries, considering cumulative impacts, and evaluating trade-offs between energy, fishing, coastal protection, tourism, shipping, conservation, and other uses will affect the management of fisheries—one of the largest stressors on the marine system [8].

The importance of incorporating conservation as an ecosystem service into policy analysis and planning has long been recognized as a critical component of natural resource management (e.g., [9]). This recognition has resulted in decades of research to refine and apply methods to measure conservation values [10]. However, the explicit incorporation of conservation in a proactive decision-making environment is a particularly novel and potentially controversial feature of the new national policy for a number of reasons. First, since the historical record has for the most part been dominated by reactionary responses to thwart an ecological crisis (e.g., endangered species listings, seasonal or spatial closures), there is little precedent for using conservation values in an *ex ante* decision-making context that embraces assessments of trade-offs between potential benefits from conservation versus the conventional commercial uses of natural resources. This difficulty was highlighted in the US Ocean Commission Report ([11], pg. 48):

"One, ongoing challenge for policy makers has been to find the right balance between the exploitation of marine resources, whether living or nonliving, and the conservation of those resources and protection of the marine environment. Petroleum exploration, commercial fishing, and marine mammal protection are just three of the arenas where this drama has played out."

Second, the bioeconomics literature has shown that broadening the objective of fishery management to include non-market benefits (either quantified in economic terms or as constraints on potential harvest strategies) can significantly alter policy prescriptions

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from those that do not consider such benefits (see, e.g., [12] and references therein).

Third, while information on the economic returns from commercial activities is more readily available, there is a paucity of data on the benefits of conserving a wide range of US marine species, including many marine mammals (for some exceptions, see [13] and [14]). Without suitable conservation benefit information, it is difficult or impossible to determine the socially optimal level of protection to provide marine species [15].

In this paper, the endangered western stock of the Steller sea lion (wSSL) (*Eumetopias jubatus*) in Alaska is utilized as an illustrative case study to provide insights into the relative magnitude of potential marine mammal conservation benefits to the economic returns of commercial fisheries and to foreshadow some of the implementation challenges with respect to the US National Ocean Policy. Specifically, the paper illustrates a back-of-the-envelope comparison of the relative magnitude of the economic benefits of conserving the wSSL to the economic costs of restrictions on the fisheries. The specific conservation scenario evaluated is a hypothetical improvement in the wSSL population from its current size of approximately 50,000 (in 2010) to 70,000 in 60 years resulting from restrictions on commercial fishing. Given that the wSSL is protected under the US Endangered Species Act (ESA), this case does not represent a "typical" EBM decision-context since the protective actions required by the ESA remove some trade-offs from consideration by fisheries managers. The concreteness of the stylized example, however, is a useful device for highlighting the potential socio-economic research gaps and the political-economy difficulties in implementing the US National Ocean Policy (and policies similar in other countries).[1]

The appropriate choice of logical analytic framework to use for *ex ante* analysis of EBM-related actions is not immediately evident and is context dependent (see [17] for a discussion of the different economic tools and [18] for a recent example of one approach). Examples of contenders are cost-effectiveness analysis, benefit-cost analysis, and management strategy evaluation. In cost-effectiveness analysis, the decisions on the level of conservation and protection of resources are exogenous to the decision-making apparatus and the goal is to find the lowest cost way of meeting the target level. Another framework is benefit-cost analysis (BCA). BCA is a well-established and widely-used decision theoretic approach grounded in welfare economic theory for analyzing trade-offs and assessing the relative merits of alternative policies or programs (e.g., [19]). Finally, management strategy evaluation (MSE), which is a cousin of BCA that does not attempt to put all the trade-offs in the same units (e.g., dollars), is increasingly being used in the fishery context (see, e.g., [20] and [21]). An important difference between BCA and MSE, however, is that the latter framework is neither grounded in welfare economics nor does it provide a transparent method for choosing one scenario over another.

While the choice of the framework often depends on data availability and the decision-making context, our back-of-the-envelope illustrative example is framed within a BCA analysis. BCA does have an explicit goal to evaluate the economic efficiency, in terms of the net benefits (i.e., benefits minus costs), of alternative policies or actions, and can be used to select the most economically efficient policy or action. An economically efficient policy is one that facilitates the greatest level of human well-being given the available resources, and is thus the one that maximizes net benefits [21]. As applied to EBM, BCA requires accounting for all benefits and costs of management objectives, including conservation benefits. The lessons from the case study for implementation of the National Ocean Policy, however, are not unique to BCA. While interesting and important for implementation, a discussion of the pros and cons of different decision-making tools is beyond the scope of this paper (see, e.g., [22]).

2. The case of the Steller Sea Lion

After a precipitous decline in the population of Steller sea lions (SSL) (*Eumetopias jubatus*) from the 1970s, the SSL was listed in 1990 as a threatened stock under the US Endangered Species Act (ESA). In 1997, the SSL population in Alaska was separated into two stocks based on genetic information according to where they fell relative to the 144° W longitude. The stock to the west was designated the western stock (wSSL) and listed as endangered while the stock to the east (eastern stock) remained listed as threatened. The range of the SSL is illustrated in Fig. 1.

In 2000, disagreements between the late Sen. Stevens (R-AK) and President Clinton regarding the SSL and the Alaskan walleye pollock (*Theragra chalcogramma*) fishery almost shut down the US government [23].[2] Sen. Stevens eventually prevailed with the "Stevens rider" to the Omnibus bill for 2001 where the fishermen received $30 million in compensation to offset the expected losses from the fishery closures. Also part of the Stevens–Clinton agreement was the creation of a National Research Council committee to study the collapse of the SSL and an initial allocation of $43 million for Steller sea lion research [24,25]. From 2000 to 2004, the total research expenditures (including State and Federal activities) on the SSL were $122.76 million [24].

Table 1 summarizes the state of the science regarding the changes over time in the understanding of the major factors that contributed to the decline in the SSL populations and that remain a threat to the recovery of the SSL populations. For example, the indirect fisheries effects, including fishing withdrawals of prey populations, such as walleye pollock, Atka mackerel (*Pleurogrammus monopterygius*), Pacific cod (*Gadus macrocephalus*), and yellowfin sole (*Limanda aspera*) are currently listed as a potentially high factor that can thwart the recovery of the SSL.

Some of the current policies developed for wSSL conservation include the complete or partial closure to fishing activities in critical habitat areas (e.g., haulouts and rookeries); the harvest control rule where the pollock, mackerel, or cod fisheries are closed once biomass falls to 20% of its unfished level (see [26]); and the temporal and spatial redistribution of fishing effort in these fisheries. In light of a recent biological opinion on the wSSL [16] that led the US National Marine Fisheries Service to place additional restrictions (including closures) on fishing in the Western Aleutian Islands to protect them, and the consequent federal lawsuits brought by the State of Alaska and industry groups, it is clear that debates surrounding proposed closures in fisheries are ongoing.

2.1. Benefits of conservation

Economic benefits (in the form of willingness to pay (WTP)) from conservation of wSSL through fishing restrictions have been measured for particular conservation programs [27,28]. In our case study, economic benefit estimates of conservation outcomes from Lew et al. [28] are adapted for use in the assessment of the

[1] The case study is also relevant for the management of the wSSL [16], but due to uncertainty on the effectiveness of additional protection measures in achieving recovery, policy implications remain open to debate.

[2] Senator Stevens was the head of the Senate Appropriation Committee at the time and stalled passage of the US domestic budget until an agreement on this issue was resolved [20].

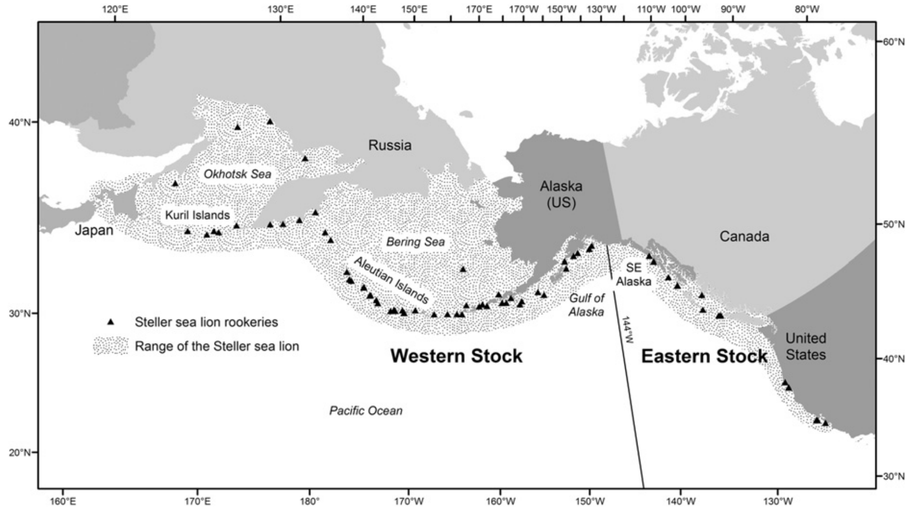

Fig. 1. Range of the Steller sea lion (SSL), *Eumetopias jubatus*.

Table 1
Ranking of different hypotheses that caused the decline and those inhibiting recovery of the Steller Sea Lion.

Hypotheses	***Understanding in 2000***		***Understanding in 2007***		***Understanding in 2010***	
	Decline	***Recovery***	***Decline***	***Recovery***	***Decline***	***Recovery***
Environmental change	Possible	Possible	Possible	Potentially high	Likely	Likely
Indirect fisheries effects	Possible	Possible	Possible	Potentially high	Likely	Likely
Direct human-related	Likely	Possible	Likely	Unlikely	Yes	Unlikely
Predation						
Sharks	Possible	Possible	Unlikely	Unlikely	No	No
Killer Whales	Possible	Possible	Unlikely	Possible	Possible	Possible
Disease	Possible	Possible	Unlikely	Unlikely	Unlikely	Unlikely
Contaminants	Possible	Possible	Unlikely	Possible	Possible	Possible

Source: Adapted from Tables 2.3–4 and 2.3–5 [47] and Table 4.8 [16].

benefits and costs for enhancing the wSSL population. The Lew et al. [28] estimates were derived from a stated preference choice experiment (SPCE), an increasingly popular survey-based non-market valuation approach that asks individuals to choose between different options, such as policies or programs, that differ in attributes (like policy outcomes) and in the prices of the policies [29]. Responses to these questions are analyzed within a random utility maximization (RUM) framework [30], and WTP estimates are estimated from the resulting utility estimates.

In Lew et al. [28], the SPCE questions ask respondents to choose between policy options that differ in the cost to the respondent's household and in the amount of improvement to the ESA status of wSSL (e.g., improvement to a threatened or recovered status) and to the wSSL population size (i.e., increase in population size). Costs are framed as a combination of tax increases and elevated seafood prices over a 20-year period. The survey was administered to a national random sample of US households, and household WTP estimates were calculated for a range of improvements in the ESA status and population size of wSSLs.

The analysis presented in this paper focuses on one particular improvement—a population increase in the wSSL to 70,000 over the next 60 years with no ESA status change resulting from the protection measures undertaken. Lew et al. [28] estimate the mean annual household WTP for this improvement to be $34.94 (with a 95% confidence interval of $29.03–$41.16) under the assumption that the wSSL population is on a slightly increasing trend prior to additional protection measures being put in place, which is roughly consistent with recent stock assessments that indicate either a leveling off or slightly increasing population.[3] Since the WTP measure is based on an optimistic outlook for the species prior to any change in management, it is a conservative value. Other, larger, WTP values were obtained for scenarios that assumed less rosy projections for the wSSL under current conditions (e.g., assuming wSSL will decline or remain stable without additional protection).

Based on the sampling procedures in Lew et al. [28], household WTP estimates can be scaled up to the national level so that the total benefits from conservation can be compared with a measure of the costs. According to the 2000 Census, there are 105,480,101 households in the US. An *upper bound* of total benefits for the US population (WTP^{agg}) can be obtained by multiplying the total US households (N^{us}) by the mean household WTP estimate (WTP^{mean}): $WTP^{agg} = N^{us} \times WTP^{mean}$. This calculation assumes the mean WTP estimate is representative of the population and applicable to all US households.[4]

However, one may ask whether including all US households is the appropriate extent of the market (i.e., who should be counted) to use in the aggregation calculation. In addition to the upper bound estimate that uses all US households, Loomis [31] discusses

[3] The survey indicates that the household would pay annually for 20 years [28].

[4] While statistically significant demographic differences between the sample of heads of households and general US population were found, Lew et al. [28] provide evidence that demographics do not play a major role in influencing the magnitude of the mean WTP estimates. Consequently, the mean *WTP* estimates are appropriate for applying to the general population of US households.

the measurement of a lower bound. In particular, one could apply the mean WTP to a portion of the population, while assuming everyone else has a zero WTP. Typically, this approach involves using the survey response rate as the portion of the population to use. For the entire sample, a 60% response rate implies assuming 60% of US households should be used in the calculation of the aggregate WTP amount (i.e., 63 million households).

When considering the appropriate extent of the market, another question arises as to whether the survey response rate is the most appropriate measure of the proportion of the population to use since there are often further adjustments to the sample done prior to estimation. Lew et al. [28] also exclude from the analysis respondents who indicate a lack of confidence in their stated preference choice experiment question responses, did not provide any responses to the choice questions, or provided responses that indicated a lack of understanding about how to answer the questions. Excluding these additional respondents, the proportion drops to 47.26%. Using these adjustments, our results are an even more conservative *lower bound* for the WTP estimates than proposed in other studies (e.g., [31]).

2.2. *Costs of conservation*

Walleye pollock, Pacific cod, and Atka mackerel make up a significant share of the wSSL diet, and their commercial fisheries are considered to be potential factors contributing to the decline in wSSL populations and a threat to their recovery [16]. As such, the focus is on hypothetical policies to rebuild wSSL that consider various degrees of curtailing fishing in these commercial fisheries. The costs of the policies, therefore, are the economic losses due to reducing the total allowable catches of these species in the waters off of Alaska.

The pollock, Atka mackerel, and Pacific cod fisheries are large and significant fisheries in the North Pacific. The pollock fishery is the largest fishery in the United States (by volume) and consists of separate trawl fisheries in the Eastern Bering Sea, the Gulf of Alaska, and historically and perhaps in the future the Aleutian Islands. The majority of pollock caught in Alaska is caught in the Bering Sea fishery by catcher vessels that deliver to inshore processors and by catcher-processors that fish and process fish at sea. Processed pollock products are sold widely in Japanese, North American, and European markets. The Atka mackerel fishery is a catcher-processor fishery (with 7 large vessels in recent years) that supplies fish products primarily to Asian markets. The Pacific cod fishery is executed by trawl, longline, and pot gear in the Eastern Bering Sea, Aleutian Islands, and Gulf of Alaska. While the Pacific cod fishery is smaller than pollock, it is fished by a larger number of vessels and gear types and delivered to a large number of processors.

With respect to the opportunity costs to the fishing sector that should be included in a BCA of harvest restrictions, the theoretically correct measure is an estimate of the perpetual stream of forgone economic rent earned in the fishery. If the lost economic returns from fish processing are taken into account, the measure would include the forgone perpetual stream of value-added in the processing chain. Both measures are net of costs and vary over time due to changing economic conditions (e.g., fish prices, fuel and labor costs, etc.), fish population trends, and environmental factors. Unfortunately, in the absence of cost information for the fishing sector, measures of economic rent must be proxied by other information.

To this end, first wholesale values, which are readily available statistics, are used as a proxy for these costs. There are several reasons first wholesale values are likely reasonable proxies for the costs of restrictions on harvest for these fisheries. First, the magnitude of wholesale values for pollock is similar to estimates of economic impacts that capture the potential ripple effects of fishery closures through the Alaska economy [32]. As a result, these estimates are implicitly capturing broader community wide effects.[5] Second, for the particular fisheries at hand, first wholesale values seem to better represent the economic characteristics of fish harvesting and processing than ex-vessel fishing revenues.[6] And, finally, first wholesale values provide an upper bound on the lost forgone economic values in the fish harvesting sector, as first wholesale does not net out the costs of fishing and processing nor does it account for the mitigating behavior of fishermen.

Table 2
Descriptive statistics on first wholesale values between 1990 and 2009.

	First wholesale (2007 dollars, millions)		
	Min.	***Mean***	***Max.***
Atka mackerel	22.8	45.10	88.0
Pacific cod	197.0	329.0	456.0
Walleye pollock	754.0	1100.0	1410.0

Alaska Department of Fish and Game (ADF&G) landings and fish ticket data and Commercial Operator Annual Reports (COAR), provide the first wholesale value, which includes fishing revenues and the value added in the processing of the fish, across the period 1990–2009. Table 2 displays the minimum, mean, and maximum first wholesale from 1990 to 2009 for Atka mackerel, Pacific cod, and walleye pollock for all fisheries off the coast of Alaska.

Rather than choose one cost level to compare to WTP, a range of estimates are provided to account for the uncertainty about how much a fishery might be curtailed and for the uncertainty about the broader direct and indirect community benefits from commercial fishing activities. Not focusing on individual cost numbers effectively divorces the BCA from an evaluation of any particular harvest policy, and allows us to assess the economic efficiency for a continuous range of policies that lead to differing costs to the industry. To this end, the percentage (0–200%) of the maximum observed first wholesale values (herein maximum) for pollock, cod, and Atka mackerel over the period 1990–2009 is varied and assumed lost in perpetuity. For example, using 20% of the maximum to calculate the costs approximates a policy that reduces first wholesale values by an equivalent amount forever, such as a permanent reduction in the total allowable catch or partial closure of the fishing grounds.

Because our measures are *not* net of fishing costs and ways the fishermen might mitigate the regulation (e.g., fishing in other fisheries) are not considered, the upper end of this range represents an upper bound estimate of the costs to the fishing sector.

2.3. *Comparing benefits to costs of conservation*

The net benefits of a conservation action to support the wSSL is equal to the benefits, as expressed by the sum of US households'

[5] A closure of the entire fishery or a significant share of it will have broader impacts on the fishing communities. First wholesale values do not capture the economic impacts that include the forward and backward linkages that result from the resources the fishing activity consumes. Research on the economic impact of Alaska fisheries that considered a hypothetical 10 percent reduction in pollock total allowable catch (TAC) [32] estimated for 2004 the total economic impact to be $110.7 million. Scaling up these results to consider a 100 percent fishery closure (multiplying the 10 percent impacts by 10), results in an economic impact of $1.107 billion for a complete fishery closure, which is surprisingly close to the 1st wholesale value of pollock produced in 2004, which was $1.101 billion.

[6] Inclusion of the opportunity costs to the processing sector are appropriate when few other sources of employment are available, such as in small, remote areas of Alaska, and when the capital used in processing has few, if any, alternative uses.

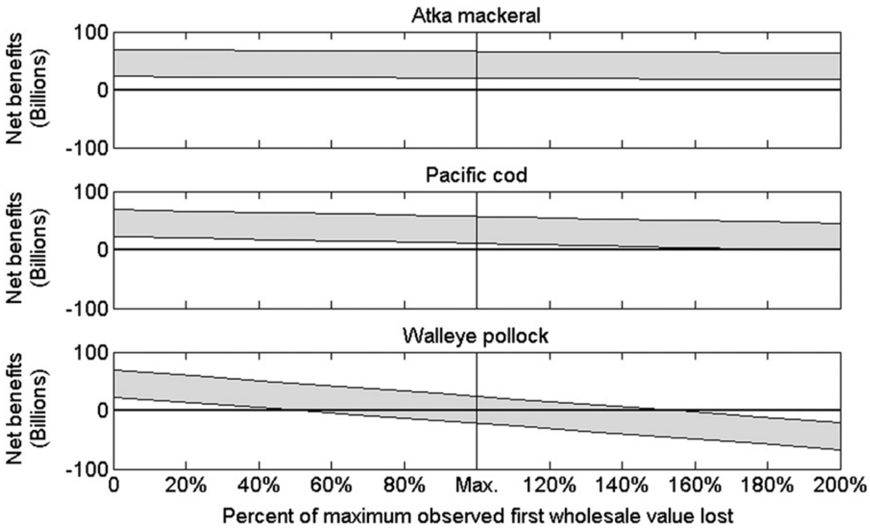

Fig. 2. Net economic benefits for wSSL conservation actions ($Billions). *Note*: The present value of the net benefits uses a 3% discount rate and is in 2007 US dollars. The horizontal axis corresponds to the percentage of maximum observed first wholesale value for the fishery from 1990 to 2009 and ranges up to 200% to capture the uncertainty surrounding indirect fisheries effects, such as losses to communities (max = 100%). The net benefit (billions) calculations assume that the fishery management actions correspond to the outcomes of the choice experiment that respondents were valuing. In the increasing version of the survey, the conservation outcome being valued is an increase in the wSSL population in a 60-year time frame by 10,000 (from a base population of 60,000 individuals with no change in its ESA status).

WTP, less the costs, which are the foregone economic returns in the fisheries that are assumed to be lost in perpetuity. The present value (PV) of net benefit is the value of the stream of benefits and costs put in today's dollars and can be expressed by the following formula:

$$\mathrm{Pv} = a\left(\begin{array}{c}\text{Number}\\ \text{of}\\ \text{Households}\end{array}\right) \bullet \sum_{t=1}^{20}\left(\frac{\text{WTP}}{(1+r)^{t-1}}\right) - b\left(\frac{\begin{array}{c}\text{Max .obs.}\\ 1^{\text{st}}\ \text{wholesale}\end{array}}{r}\right)$$

where r is the discount rate, a is the adjustment factor on the extent of the market, and b is the percent of the maximum observed first wholesale values that is varied from 0 to 200%.[7] The upper bound estimate is when $a = 1$, and the lower bound estimate is when $a = 0.4726$.

Fig. 2 illustrates the range of the potential present value of net benefits for different conservation actions. Using a lower bound estimate of WTP (about $26.7 billion) and the upper bound estimate of the costs to the fishing sector, in the Atka mackerel fishery the present value of net benefits is positive even when 200% of the fishery's maximum wholesale value is lost in perpetuity. The costs to the Atka mackerel fishery need to be on the order of 800% of the wholesale value for the costs to outweigh the lowest level of conservation benefits.

The results for the pollock fishery, which is the largest fishery by volume in the US, show a different story due to the significant economic benefits from the fishery. In this fishery, the net benefits in the pollock fishery are negative at the lower bound of WTP if hypothetical restrictions equivalent to a $\sim$50% reduction in value of the fishery are imposed to promote wSSL conservation. The results for the Pacific cod fishery fall in between Atka mackerel and pollock.

3. Implications for EBM policy analysis

Based on the WTP estimates for increasing the population of the wSSL, we conjecture that the allocation of areas for the conservation of marine mammals has considerable support from the US public. However, before these (and other) WTP estimates are used to evaluate a set of conservation actions a number of issues need to be addressed. First, the benefit–cost comparison assumes (heroically) that the hypothetical restrictions placed on the fishery result in the enhancement of the wSSL, as valued in the choice experiment questions utilized by Lew et al. [28].[8] For example, a complete closure of the Atka mackerel fishery, which corresponds to the loss of the maximum first wholesale level forever, is assumed to increase the wSSL population in a 60-year time frame by 10,000 (from a base population of 60,000 individuals with no change in its ESA status) [28].

In reality, significant uncertainty exists on whether a particular regulation will result in an increase in the wSSL population. Environmental change is also a factor in the decline and recovery of the wSSL [34], and the predicted changes in climate and ocean temperature over the next 60 years might limit the ability of the wSSL population to increase regardless of fishery restrictions (see Table 1). Uncertainties also exist on the costs as fish prices and input prices will change over time, as will the WTP estimates of conserving the wSSL.

Second, there is the question of what operational objective to use in designing and evaluating EBM approaches to management. Using a benefit-cost analysis criterion that chooses a policy that maximizes expected net benefits will result in an economically efficient outcome. In a BCA analysis, if a researcher fails to

[7] Recent guidance from the US Office of Management and Budget (Circular A-4, September 17, 2003) recommends 3% and 7% as benchmarks for the discount rate. Several challenges have been levied against the use of these benchmarks, most notably with regard to the use of discounting of environmental policies with very long time horizons. In these cases, the US Environmental Protection Agency [19] recommends using discount rates in the range of 0.5%–3% (see, also[33]). A discount rate of 3% is used for expositional reasons, but the magnitude of the rate does not qualitatively change the results, in part because both the costs and benefits are discounted.

[8] The empirical evidence, however, illustrates that there is potentially room within the gap between benefits and costs associated with the impacts on fisheries to consider the potential costs of complimentary policies, such as captive breeding and release. Consideration of these policies, however, is beyond the scope of the paper.

consider the economic values of conservation, the BCA will be biased towards supporting commercial uses [17].

Quantifying the economic benefits of conservation is not without controversy (e.g., [35]), however, and there are other approaches, such as cost-effectiveness analysis and management strategy evaluation. In the wSSL case, a cost-effectiveness approach would find the least-cost method of meeting a population target without necessitating the valuation of that population (see e.g., [17] for more in-depth discussion of the different methods). Whether the target population adequately reflects the preferences of society for species preservation, however, is an open question and the same uncertainties regarding the ability to map policy actions to changes in the wSSL population exist.

Regulators might also consider the distributional effects and the potential for the winners to compensate the losers (e.g., Kaldor–Hicks decision criteria [36]). This topic is particularly important in cases where isolated communities without access to diverse labor markets are dependent on an industry affected by a conservation action. As mentioned earlier, there is precedent for compensation in the recovery of wSSL. There are also other possible non-economic criteria to allocate marine resources [17,37]. For example, social and cultural objectives (e.g., prosperity of coastal communities), political objectives, and biological objectives are expressed policy goals and are also be important to consider. Furthermore, future research should investigate whether the US population has non-market values for preserving vibrant fishing communities beyond those that are captured in labor markets, in a manner similar to values for species preservation.

Finally, the choice experiment in Lew et al. [28] bundled a change in the wSSL population and its ESA status. Respondents were asked to simultaneously value both a change in future wSSL population levels and the ESA classification of that population (i.e., "Endangered," "Threatened," or "Recovered"). Policy analysis with *these* WTP estimates, therefore, has to consider not only how a regulation will increase the population of the wSSL but also how this increase will affect ESA status. To simplify our analysis, an empirically plausible scenario under which the ESA status of the wSSL does not change was utilized. While the multifaceted nature of Lew et al. [28] scenarios complicates the task of applying these estimates in a policy analysis, it also illustrates the potential role of indicators (e.g., ecosystem health index) in ecosystem valuation research as a means for the public to judge and value different population changes. Integrating ecological indicators [38] and ecosystem valuation is an important area for future research.

4. Implications for coastal and marine spatial planning

Another tenet of the US National Ocean Policy is the use of coastal and marine spatial planning (CMSP) as a means to implement EBM [2]. Proponents of CMSP highlight its ability to achieve a better alignment of governance with ecosystem boundaries [3] and the proactive nature of the planning process [39]. In fact, the newly-created regional planning commissions (RPC) in the US could soon be allocating space for a myriad of marine commercial and non-commercial activities [40]. CMSP is also ongoing in Australia, Canada, and in a number of northern European countries [41].

While the RPCs might achieve the goal of better alignment with ecosystem boundaries in the US, the general marine conservation benefits in Alaska (and other places) will still clearly spill over beyond the jurisdiction of the RPCs, the physical range of the species, and the communities experiencing the direct impacts. To illustrate potential issues in CMSP surrounding the extent of the market of conservation benefits (i.e., who is affected) relative to the geographic range of the species and impacted communities, Fig. 3 shows the present value of the benefits and the present value of the costs separately, assuming that the maximum observed first wholesale value (max in Fig. 2) is lost in perpetuity. A policy that severely curtails the fishery would have costs of this magnitude. In Fig. 3, the cumulative present value of the benefits (i.e., of WTP) is displayed as a cumulative function of the US households that are added by state as the geographic distance increases between a state's population centroid (denoted by their abbreviation) and the population centroid

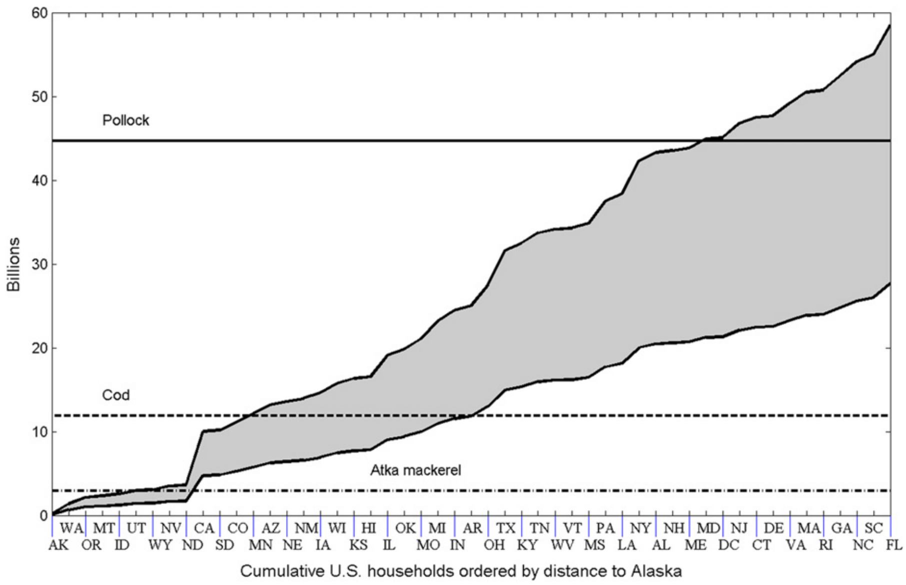

Fig. 3. Cumulative US State level benefits and costs ordered by distance from Alaska. *Note*: We present the estimates for the opportunity costs and benefits in the maximumcase, which corresponds to a 100 percent loss in first wholesale values. When the gray shaded region of benefits is greater (less) than the opportunity cost (OC) for a particular fishery, the benefits are greater (lower) than the costs. The opportunity costs correspond to the case where the maximum observed first wholesale level from 1990 to 2009 is lost in perpetuity. The present value of the benefits is multiplied by the number of households added to the cumulative total, as the geographic distance from Alaska increases. The calculations assume that the fishery management actions correspond to the outcomes of the choice experiment that respondents were valuing.

of Alaska. Because large states like California have a disproportionate number of households, the WTP estimates have discrete and sometimes large jumps.

Comparing the WTP and opportunity costs, with all caveats including the uncertainty of the effectiveness of fishery regulations in achieving recovery notwithstanding, the WTP estimates exceed the loss of the maximum first wholesale value forever in the Atka mackerel fishery when only households that reside in Alaska, along with those in Washington State, Oregon, and Montana are the extent of the market. Another way to state the result is that only 12 out of every 100 US households (potentially residing far from Alaska) would need to contribute to conserving the wSSL for the net benefits for the severely curtailed Atka mackerel fishery to be positive. For Pacific cod, Utah, Wyoming, Nevada, North Dakota, and California residents need be within the extent of the market for the maximum WTP estimates to exceed the opportunity costs. Finally, in the Alaska pollock fishery, the opportunity costs of a complete closure outweigh the economic benefits, at the minimum WTP estimate.

Given that the Alaska RPC will be operating at the scale of the State of Alaska (Federal waters), the ability of the RPC to incorporate the public good values into their deliberations and planning is an open question. It is not clear, for example, that the members of the Alaska RPC will feel comfortable making planning decisions that affect Alaska households based on the preferences of households residing elsewhere in the US. In our application, costs were assigned to commercial fishermen in Alaska, and benefits were assumed to accrue to all US households, as the Steller sea lion is viewed as a national resource to protect. The same issues are present, for example, with transboundary resources where it is not clear whether and how to incorporate the costs and benefits to other countries (e.g., [42]). The divergence between where conservation benefits and costs are realized needs to be a central topic in the discussions on how to develop the analytic frameworks that will inform the design and implementation of policies for EBM.

Moreover, even confined to US values, our analysis as represented in Fig. 3 fails to capture a potential interdependency in valuing conservation actions in one CMSP region with values in other CMSP regions that are also undertaking conservation actions. Specifically, the WTP estimates for wSSL conservation are based on scenarios that are independent of possible conservation actions undertaken for other species and regions. The potential impacts of this interdependency is a critical gap in valuation research warranting immediate attention [28,43,44], as strategies for implementing CMSP are currently under development [40].

Another potential stumbling block on the way to implementing CMSP is that the allocation of space to conservation (e.g., marine reserves) has historically conflicted with commercial and recreational fishery management. Furthermore, regional fishery management councils (RFMCs) still have authority over fishery management decisions, and it is unclear how their decisions and mandate will interface with CMSP and the regional planning bodies. Judging from past experience with RFMC decisions [45,46], the allocation of space to the conservation of marine public goods is one area where tensions between RPCs and RFMCs are likely to be significant.

The analysis and findings in this paper, and the questions they raise, are a starting point for a much needed and long overdue conversation on how to incorporate conservation into ecosystem-based management, and more specifically, coastal and marine spatial planning. For example, in the US context, the National Ocean Council needs to provide guidelines to the regional planning bodies on how the economic values of conservation are to be considered in the allocation process and how CMSP will interact with fishery management decisions. Without explicit consideration of these issues both in the US and in the other places engaging in CMSP [41], it is unclear whether CMSP will better conserve ocean resources than the status quo.

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