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Research article

A comparison of regional and national values for recovering threatened and endangered marine species in the United States☆

Kristy Wallmo [a,*], Daniel K. Lew [b,c]

[a] Office of Science and Technology, National Marine Fisheries Service, USA
[b] Resource Ecology and Fisheries Management Division, Alaska Fisheries Science Center, National Marine Fisheries Service, USA
[c] Department of Environmental Science and Policy, University of California, Davis, USA

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ABSTRACT

It is generally acknowledged that willingness-to-pay (WTP) estimates for environmental goods exhibit some degree of spatial variation. In a policy context, spatial variation in threatened and endangered species values is important to understand, as the benefit stream from policies affecting threatened and endangered species may vary locally, regionally, or among certain population segments. In this paper we present WTP estimates for eight different threatened and endangered marine species estimated from a stated preference choice experiment. WTP is estimated at two different spatial scales: (a) a random sample of over 5000 U.S. households and (b) geographically embedded samples (relative to the U.S. household sample) of nine U.S. Census regions. We conduct region-to-region and region-to-nation statistical comparisons to determine whether species values differ among regions and between each region and the entire U.S. Our results show limited spatial variation between national values and values estimated from regionally embedded samples, and differences are only found for three of the eight species. More variation exists between regions, and for all species there is a significant difference in at least one region-to-region comparison. Given that policy analyses involving threatened and endangered marine species can often be regional in scope (e.g., ecosystem management) or may disparately affect different regions, our results should be of high interest to the marine management community.

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1. Introduction

In the field of non-market valuation, stated preference techniques like contingent valuation and stated preference choice experiments currently provide the only means to estimate non-consumptive use and non-use economic values for public goods such as threatened, endangered, or at-risk (TER) species. For these species, non-consumptive use value refers to the economic benefits individuals may derive from viewing, photographing, or learning about the species in the wild. Non-use value refers to the benefit individuals may derive from a species even if they never see or interact with it. Types of species-related non-use values can include the benefits derived from preserving the species for future generations or preserving the species now for future use (referred to as bequest and option value, respectively), as well as the benefits derived simply from knowing that the species exists (referred to as existence value). For brevity, in this paper we refer to economic benefit measures that reflect non-consumptive use and non-use collectively as 'non-consumptive values'.

These benefit measures can be used in analytical and policy contexts by agencies charged with evaluating the costs and benefits of regulatory actions (Lipton et al., 2014). In the U.S. for example, non-consumptive values may be used in designating critical habitat for species listed under the Endangered Species Act (ESA) and in evaluating species recovery actions (Congressional Research Service, 2003). In Canada non-consumptive values can be used in determining whether to list a species under the Species At Risk Act (SARA), the Canadian counterpart to the U.S. ESA, as the Act requires the government to "*assess regulatory and non-regulatory options to maximize net benefits to society as a whole*" in the listing decision process (Rudd, 2009). Aside from the analyses related to

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* Corresponding author. SSMC III, F/ST5, Economics and Social Analysis Division, 1315 East West Highway, Silver Spring, MD 20910, USA.
E-mail address: Kristy.Wallmo@noaa.gov (K. Wallmo).

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species listings, non-consumptive values can be used in natural resource damage assessment cases and in fulfilling the directives of management paradigms such as ecosystem-based management, which calls for the evaluation of the full suite of ecosystem impacts when considering alternative policies (Lipton et al., 2014). Sanchirico et al. (2013) illustrate the importance of this in their examination of economic efficiency under modeling scenarios that include the economic benefits of recovering Steller sea lions, an endangered marine mammal.

Although the past two decades have seen substantial growth of non-market valuation research related to environmental amenities (Kling et al., 2012), including studies focused specifically on TER species, economic benefit information associated with TER marine species has been emphasized as a commonly missing but critical piece of information with respect to ecosystem management (Millennium Ecosystem Assessment, 2005). Over thirty published studies have measured the economic benefits of enhancing, protecting, or preserving TER marine species, but most have valued large or charismatic species such as whales, seals and sea lions, and sea turtles (see Lew, 2015). Several studies include iconic or high profile salmonid species, but few estimates exist for lesser known marine species or marine plants. Some of these studies are summarized in one (or more) of three species valuation meta-analyses (Loomis and White, 1996; Richardson and Loomis, 2009; Martin-Lopez et al., 2008) which, though fairly comprehensive of the published literature at that time, do not include values from a number of more recent studies on TER marine species (see Rudd, 2009; Lew et al., 2010; Ojea and Loureiro, 2010; Boxall et al., 2012; and Wallmo and Lew, 2012 for examples).

Non-consumptive values for TER species are generally expressed in terms of willingness-to-pay (WTP) for some level of improvement in the species population or to prevent extinction. For TER marine species, WTP ranges up to $256 for improving the status of the Beluga whale (Boxall et al., 2012), with estimates for most marine species falling between $10 and $100[1] (Lew, 2015). Comparing WTP values among studies to determine whether one species is more economically valuable than another, though potentially useful, is typically infeasible because of variation among studies[2] (Wallmo and Lew, 2012). Even within a study, WTP for a single species may vary based on issues such as respondent heterogeneity or spatial variation (Kaul et al., 2013). The latter is illustrated in Giraud and Valcic (2004), where geographically embedded samples are used to estimate WTP for recovering the endangered Steller sea lion. Their results showed considerable variation in WTP depending on whether the spatial sampling scale was local (Alaska boroughs), state (Alaska), or national (U.S.).

It is generally acknowledged that WTP estimated from stated preference techniques are often spatially heterogeneous (Johnston et al., 2015). Though the treatment of spatial variation has taken several approaches, the majority of research involves the premise of distance decay, in which WTP for an environmental good is assumed to diminish as distance between the individual and the good increases. Previous research has shown evidence of a distance decay effect for goods including National Parks, habitat protection, and river water quality improvements (Bateman and Langford, 1997; Georgiou et al., 2000; Hanley et al., 2003), though many of these reflect use values (e.g., values derived from actively using the resource). Other research involving non-use values (e.g., existence or bequest values) for the Great Barrier Reef have shown no evidence of distance decay when analyzed at a national scale (Rolfe and Windle, 2012). Some authors have suggested that for goods for which non-use values likely dominate, such as TER species values, there is no reason to expect a distance decay effect (Hanley et al., 2003). In an explicit test for a distance decay effect in TER species values, Loomis (2000) examined WTP for preserving the Mexican spotted owl and 62 other threatened and endangered species found near the states of Arizona, Colorado, Utah, and New Mexico in the U.S. He found that beyond 1500 miles of the spotted owl habitat household WTP is very low; however, for households up to 2500 miles away WTP for protecting the 62 other species were about 40% of local household values. In the same study, WTP for protecting the California spotted owl were substantial at a distance of 1000 miles from the species habitat.

Spatial variation for TER species has also been examined in the context of WTP hot/cold spots, or WTP patchiness. Fundamentally, hot spot analysis characterizes spatial clusters of high (hot) and low (cold) values, defining regions of high density separated by regions of low density of a given phenomenon (Nelson and Boots, 2008). Differences between hot (cold) clusters and the surrounding values are tested to determine whether the spatial clustering pattern is statistically different than one of random chance (Johnston et al., 2015). The analysis can be conducted at varying spatial scales. In the only research to date on hot/cold spots for TER marine species, Johnston et al. (2015) find that the number of cold spots for the Upper Willamette River Chinook salmon and the Puget Sound Chinook salmon varies from zero at small scales to over 80 at a spatial scale of 1170 km. The authors find a similar pattern for hot spots for both salmon and six other TER marine species. Notably, the authors find no evidence of distance decay in values for any of the TER marine species included in the study (Johnston et al., 2015).

A third context for examining spatial variation includes the use of geographically embedded samples. To date two studies have examined WTP for TER marine species in this context. In a study focused on Steller sea lion preservation, Giraud and Valcic (2004) found that non consumptive values for protecting the species, found in waters off the coasts of Alaska, British Columbia, and the West Coast of the U.S., were larger as the geographic scale of the sample increased. Specifically, WTP estimates from a sample of U.S. households were highest, followed by WTP estimates from an embedded sample of Alaska-only households, followed by WTP estimates from an embedded sample of households in Alaskan Boroughs containing Steller sea lion critical habitat. In contrast, Wallmo and Lew (2015) found no differences in WTP estimated from a sample of U.S. households and an embedded sample of U.S. west coast households for recovering eight different TER marine species, including species found only in rivers in southern California (southern California steelhead *Oncorhynchus mykiss*) to species found worldwide (Humpback whale *Megaptera novaeangliae*).

In a policy context, spatial variation in TER marine species values is important to understand, as "using national values may result in an incomplete analysis when populations local to the resource face a disproportionate cost/benefit from the policy" (Giraud and Valcic, 2004). In this paper we present values for eight different TER marine species including the Hawksbill sea turtle Eretmochelys imbricata, Southern resident killer whale *Orcinus orca*, Humpback whale Megaptera novaeangliae, Southern California steelhead *Oncorhynchus mykiss*, Central California coast Coho salmon *Oncorhynchus kisutch*, Black abalone Haliotis cracherodii, Elkhorn coral Acropora palmata, and Johnson's seagrass Halophila johnsonii. We

[1] Values reported in 2013 U.S. dollars. All values converted using consumer price index and annual foreign currency conversion rates.

[2] Valuation studies often differ in the sampling unit (generally either household or individual), geographic scope of the sample (local, regional, or national level sample), payment frequencies used in valuation questions (one-time payment, annual, other frequency), size and type of species-level or population-level change (e.g., doubling the population size, preventing extinction, reducing the risk of extinction), valuation model specification, and quantity and quality of information provided to respondents, which may bias respondents' willingness to pay (Hoehn and Randall, 2002; Brouwer, 2000).