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Using stakeholder engagement to inform endangered species management and improve conservation

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ABSTRACT

Successful endangered species conservation requires understanding, support, and participation from user groups and stakeholders in conjunction with biological information. A representative survey of the boat-based angling population in Puget Sound, WA, USA, was conducted to provide baseline information regarding angler knowledge about rockfish, fishing practices, perceptions of threats to rockfish, and preferences for recovery measures to inform the recovery plan for three rockfish species listed under the Endangered Species Act. Generalized linear models were used to evaluate the hypothesis that variation in stakeholders' perceived threats to rockfish and preferences for rockfish recovery measures is related to their fishing practices and knowledge of rockfish biology. Knowledge of rockfish longevity and past experience fishing for rockfish were important predictors of support for conservation measures and willingness to take personal action to recover rockfish. These findings highlight the important role education may play in garnering the necessary long-term support for rockfish recovery. Further, locations where anglers fished in Puget Sound were found to shape perceptions of threats to rockfish, suggesting that place-based management options should be considered where biologically appropriate. This study illustrates both the utility and complexity of species management in social–ecological systems and provides a framework for comprehensively engaging stakeholders and understanding their relationships with endangered and threatened species prior to the development of a recovery plan. Such engagement may not only better inform management and outreach decisions but also pave the way toward more collaborative and effective endangered species management and conservation.

1. Introduction

Successful endangered species conservation requires understanding, support, and participation from user groups and other stakeholders in conjunction with biological information [1–3]. This stakeholder engagement is fundamental for resource management that relies largely upon self-regulation and self-reporting by user groups, as is the case for many recreational fisheries [4,5]. Recreational fisheries are the dominant or sole users of coastal fish stocks in many developed, temperate regions around the world [6]. In the United States alone, over 11 million recreational saltwater anglers took approximately 72 million fishing trips in 2012, which generated approximately $58 billion in sales impacts to the economy and supported over 381,000 full- and part-time jobs [7]. Recently, there has been increased recognition by the National Marine Fisheries Service (NMFS) that successful management of this large and diverse fishery sector requires greater insight into anglers' attitudes, motivations, and behaviors [8]. In a nationwide survey conducted in 2013, nearly 85% of 9,226 anglers surveyed agreed that "ensuring that the opinions of all recreational fisheries stakeholders are considered in policy-making" is important [8]. Often, policy-makers incorporate participation from stakeholders during planning processes or through solicitation of public comments after draft management plans have been developed. This study presents a systematic way to engage recreational anglers whose actions may affect conservation efforts prior to the outset of planning. This approach lays the foundation for improved understanding of and continued engagement with stakeholders, essential elements of successful endangered species recovery [2].

There are a number of complex, often interrelated, social, cultural, psychological, and economic factors that could affect stakeholders' support for conservation or compliance with management actions. The degree of stakeholder support for conservation policies may be related to stakeholders' knowledge of conservation issues, knowledge

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of potential conservation actions, the extent to which individuals believe they can control events that affect them, stakeholder attitudes, commitment to a particular conservation action, and sense of responsibility [9]. Stakeholder support for a particular conservation strategy may vary based on people's perceptions of the legitimacy of and need for that action [9–11]. Furthermore, the economic, social, and/or cultural value of the focal species [1,12] and the types, sources, breadth, and depth of specific environmental information stakeholders have access to (i.e., their "information environments") may inform their perceptions of and adherence to management and conservation policies [13].

To inform conservation and recovery planning for rockfish (*Sebastes* spp.) in Puget Sound, Washington, USA, this study documented stakeholders' knowledge of rockfish biology and rockfish fishing regulations, perceptions about threats to rockfish, fishing practices, and preferences for recovery measures. In Puget Sound, rockfishes are species of conservation concern that have been historically harvested in both recreational and commercial fisheries. Over-harvest was identified as the main cause of the decline of rockfishes [14,15]. Rockfishes' long-lives and low intrinsic productivity [16] combined with some species' relatively large size and evolutionary distinctiveness all contribute to their vulnerability to fishing [17]. They exhibit sporadic successful recruitment [18], and older female rockfish have healthier young that exhibit a higher chance of survival than those of younger rockfish [19,20]. Rockfish in Puget Sound presently face a number of threats, ranging from degraded habitat and water quality to derelict fishing gear and fisheries bycatch [14,15]. To complicate matters further, rockfishes have swim bladders that keep them at neutral buoyancy, and as rockfish are brought up from deep water they often suffer from barotraumas that may result in injury or death [21,22].

Three rockfish species – yelloweye rockfish (*Sebastes ruberrimus*), canary rockfish (*Sebastes pinniger*), and bocaccio (*Sebastes paucispinis*) – were listed for protection under the Endangered Species Act (ESA) in 2010 in Puget Sound and the Georgia Basin [15] (hereafter referred to as Puget Sound). Thirteen species of rockfishes have been listed as Washington State Species of Concern [23]. In response the rockfish ESA listing, the Washington State Department of Fish and Wildlife (WDFW) released a Puget Sound Rockfish Conservation Plan in 2011, which includes a number of recovery measures [24]. The WDFW conservation plan includes the use of Rockfish Conservation Areas or Marine Protected Areas to protect rockfish from catch and bycatch [25,26], removal and prevention of derelict fishing gear which have been documented to catch rockfish and degrade their habitat [27], the use of artificial reefs to enhance degraded habitats [28], the investigation of hatchery production of rockfish in order to augment wild populations [29], and habitat restoration [30,24]. Despite the moratorium on commercial rockfish harvest in Puget Sound in 1999 [14], the closure of several other commercial fisheries with incidental rockfish catch, and a prohibition of recreational rockfish retention in 2010, rockfish remain vulnerable to incidental mortality in commercial and recreational fisheries [15,31,32]. The commercial rockfish closure in 1999 may also have resulted in decreased economic incentives to recover rockfish [12].

While there are a number of regional studies that examine rockfish biology and the history of the fishery e.g. [14,15,31], few have engaged recreational anglers in the recovery process and examined the underlying knowledge and perceptions that may ultimately affect support for recovery measures. Therefore, a primary objective of this study was to engender stakeholder engagement in the rockfish recovery process by seeking understanding into how anglers' knowledge and practices influence their views of rockfish conservation. Recreational anglers were surveyed to evaluate the hypothesis that variation in stakeholders' perceived threats to rockfish and preferences for rockfish recovery measures are related to their knowledge of rockfish biology and fishing practices. Furthermore, the expectation that stakeholders' perceptions of risk and threats to rockfish correspond to their preferences for rockfish recovery measures was evaluated.

2. Methods

2.1. Study area

Puget Sound makes up the southern arm of an inland sea located on the Pacific Coast of North America and is connected to the Pacific Ocean by the Strait of Juan de Fuca. Puget Sound is a fjord-like estuary covering 6039.3 km^2 (2331.8 square miles). It can be subdivided into biogeographic basins that encompass contiguous, ecologically unique, and spatially isolated freshwater, estuarine, and marine habitats [33,34]. These five interconnected basins include: (1) The San Juan/Strait of Juan de Fuca Basin, (2) Main Basin, (3) Whidbey Basin, (4) South Puget Sound, and (5) Hood Canal. Sills largely define boundaries between the biogeographic basins, except where the Whidbey Basin meets the Main Basin. The sills, in combination with bathymetry, freshwater input, and tidal exchange, influence environmental conditions such as movement and exchange of biota from one basin to the next, water temperatures and water quality, and water exchange [34–36]. In addition, environmental conditions of each basin are influenced by differing levels of human populations and development.

2.2. Respondent selection and survey methods

In-person surveys of recreational anglers ($N=443$) were conducted at public boat launches and marinas with the heaviest boat-based angler traffic throughout Puget Sound [37] between July–September 2011. This period overlapped with fishery openings for salmon and crab, during which the majority of incidental rockfish is caught due to high fishing effort for salmon [14]. This timeframe did not include the season for lingcod or halibut, when anglers may encounter rockfish incidentally due to their co-occurrence in benthic habitats [14].

Anglers were surveyed at 15 public boat launches and marinas in five regions included in the rockfish ESA-listing area (i.e., all Marine Areas (MAs) east of Port Angeles, 6-13): San Juan/North Puget Sound (MAs 6 and 7), Whidbey Basin (MAs 8-1 and 8-2), Main Basin/Central Puget Sound (MAs 9, 10, and 11), South Puget Sound (MA 13), and Hood Canal (MA 12) [15] (Fig. 1).

The number of licensed recreational anglers who fished or planned to fish within the greater Puget Sound region varies from year to year [38]. Therefore, this study utilized the five year average number of anglers from 2006–2011 ($N=182{,}114$) [38] to calculate a target sample size of 598, with a margin of error of 4% and 95% confidence [39]. For the boat-based angling population, the sample size achieved a margin of error of 4.75% with 95% confidence. Anglers at piers, shorelines, and other stakeholders including divers, charter captains, and anglers at recreational angler association meetings were also surveyed. For consistency, and because the largest number of respondents were boat-based, only boat-based anglers were included in this analysis, though some of these anglers also responded they fished in different areas, were divers, or members of associations.

The 41-question survey was designed to enhance understanding of the recreational boat-based angling community's knowledge of rockfish biology, rockfish fishing regulations, and species identification abilities; perceptions of threats to rockfish; fishing practices; and preferences for rockfish recovery planning [40]. For example, survey respondents were asked to select one or more issues they considered to be "the greatest threats to rockfish in Puget Sound/San Juan Islands." They were offered a list of responses including habitat loss, pollution, commercial fisheries, derelict fishing gear, recreational fisheries, predation from marine mammals, predation from lingcod,