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## Biological Conservation

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# Harvest portfolio diversification and emergent conservation challenges in an Alaskan recreational fishery

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## ARTICLE INFO

## Keywords:

Charter fishing  
Diversification  
Harvest portfolio  
Pacific halibut  
Recreational fisheries  
Rockfishes

## ABSTRACT

Diversification of harvest portfolios can benefit resource users by providing increased flexibility to respond to regulatory, economic, and environmental pressures. These adaptations, while important for maintaining harvesting opportunities, can lead to conservation challenges by shifting effort to other species or habitats. Using semi-structured interviews with charter fishing captains (N = 52) and logbook data, we examined shifts in the diversity of target species portfolios in a major recreational fishery in Alaska over three decades. To understand the role of regulation in affecting what species charter captains choose to target, we contrasted harvest portfolios in communities from two regions with differing histories of regulation. Portfolio structure was dynamic, with the majority of respondents reporting changes in the number of harvested species, relative preference for different species, or both since the 1990s. Diversification emerged primarily as a result of increased retention of historically less-preferred species, such as rockfishes, sablefish, and Pacific cod. Patterns of rockfish retention in charter logbook data mirrored patterns in targeting reported by respondents. Southeast Alaska captains largely attributed portfolio diversification and shifts in species preferences to greater restrictions on harvest of a primary target species (Pacific halibut), while Southcentral Alaska captains identified shifting customer interests and declines in some target species as driving changes. Our findings suggest that avoiding unintended conservation impacts of single-species regulations requires broader recognition of the multispecies nature of recreational fishing in management. Understanding fisher behaviors, values, and motivations is essential, so that managers may better anticipate the responses of fishers to new regulations.

## 1. Introduction

In fisheries and hunting systems, diversification of target species and harvesting activities can mitigate risk to individuals and increase adaptive capacity of resource-dependent communities (Folke et al., 2003; Hanazaki et al., 2013; Kasperski and Holland, 2013; Anderson et al., 2017). Maintaining a diverse portfolio of harvested species, for example, gives harvesters the flexibility to switch among target species based on changes in their abundance or availability (Brashares et al., 2004). Portfolio shifts may also arise when more restrictive regulations are imposed on a primary target species. Subsistence communities in Interior Alaska shifted towards greater use of waterfowl and moose to compensate for the loss of Chinook salmon resulting from fishing closures (Loring and Gerlach, 2010; Loring et al., 2011). Likewise, the near-closure of a Canadian groundfish fishery in the 1990s led to diversification of the commercial harvest portfolio through increased targeting of crustaceans (Hilborn et al., 2001).

Although important for maintaining harvesting opportunities in the

face of change, resource substitution or addition can increase exploitation rates on other species (Gentner, 2004; Loring, 2016) and result in effort shifts that compromise conservation goals (Sutton and Ditton, 2005). For instance, harvesters in West Africa intensified use of terrestrial mammals during years of low fish abundance, resulting in wildlife declines (Brashares et al., 2004). In fisheries, ecological sustainability of resource substitution can depend on aspects of fishing behavior, including the ability for fishers to harvest selectively (Katsukawa and Matsuda, 2003). Therefore, understanding the effects of regulations on harvesting behavior and patterns of resource use is important for evaluating potential ecosystem effects of management and conservation strategies (Metcalf et al., 2010).

Predicting shifts in resource use arising from regulations is particularly challenging in recreational fisheries because of the diversity of fisher behavior and motivations (Salas and Gaertner, 2004; Sutton and Ditton, 2005). Yet, recreational fisheries can have widespread impacts on species and habitats (Coleman et al., 2004; Cooke and Cowx, 2004; Arlinghaus and Cooke, 2009) and angler behavior can have important

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effects on conservation outcomes (Salas and Gaertner, 2004; Cooke et al., 2013). Here, we examined the role of regulations as a potential driver of resource substitution or addition in the Gulf of Alaska recreational charter fishery. Saltwater charter anglers pursue multiple species in Alaska, but Pacific halibut (*Hippoglossus stenolepis*) is a primary target (Lew et al., 2010). Declining spawning stock biomass and size-at-age of halibut, coinciding with enormous growth of recreational landings (IPHC, 2014), led to a suite of new halibut charter regulations beginning in the mid-2000s. To understand the role of regulation in affecting what species charter captains choose to target, we contrasted harvest portfolios in communities from two regions with differing histories of regulation.

We used a mixed methods approach to address three primary objectives. Using semi-structured interviews with charter operators in Southeast and Southcentral Alaska, we first evaluated shifts in the portfolio of species targeted on halibut charter fishing trips over the past three decades (Objective 1) and identified possible social, ecological, regulatory, and economic drivers of those shifts (Objective 2). We then summarized charter logbook data to determine whether interviewees' experiences matched broader, fleet-wide patterns in harvest (Objective 3). We hypothesized that increasing restrictions in allowable halibut harvest since the early 2000s may have led to greater retention of historically less-preferred species. We also expected that portfolio structure would differ between operators in Southeast and Southcentral Alaska, who have access to different species (Chan et al., 2017) and are subject to different management measures for halibut and other species. This study presents a novel application of the portfolio concept to recreational fisheries and shows that portfolio diversification can emerge from fishers' responses to restrictions on a preferred species. Accounting for fisher behavior and explicitly recognizing potential trade-offs among species are important for adopting a portfolio approach to managing recreational fisheries that promotes sustainability of livelihoods and ecosystems.

## 2. Materials and methods

### 2.1. Study communities and charter fishery characteristics

Our research was conducted primarily in the communities of Sitka and Homer, which are among the most popular sport fishing destinations in Alaska for both resident and non-resident anglers (Lew et al., 2010). They are also the major halibut charter ports in Southeast and Southcentral Alaska, where ~80% of the state's sport-caught halibut are harvested annually (Dykstra, 2017). Since the mid-2000s, major changes have taken place in charter halibut management in these areas, including establishment of sector-wide harvest limits and changes in the numbers and sizes of halibut that can be retained. The timing and types of regulatory changes have differed between Southeast and Southcentral regions, which fall into separate International Pacific Halibut Commission management areas (Appendix A). Briefly, the Southeast region has been subject to historically more restrictive charter halibut regulations compared to the Southcentral region.

Charter businesses in Alaska vary in their size, trip offerings (type and duration), and clientele (Chan et al., 2017). Businesses range from single owner-operator vessels to fishing lodges with multiple boats and vessel capacity varies from six passengers to more than twenty. Some charter businesses offer a mix of fishing, hunting, and/or wildlife viewing activities. In Southcentral Alaska, charter businesses offer single species (halibut only) and/or multispecies trips, while in Southeast Alaska, businesses primarily operate multispecies trips (Powers and Sigurdsson, 2014). In addition, businesses offer trips ranging from a half-day to multiple days in duration. The customer base in both regions is predominantly comprised of anglers from outside Alaska; in 2014, 97% and 74% of the angler-days reported were fished by non-resident anglers in Southeast and Southcentral Alaska, respectively (Powers and Sigurdsson, 2014).

### 2.2. Overview of mixed methods approach

We used triangulation (Jick, 1979) to address our objectives and hypotheses. In this view, quantitative and qualitative approaches are complementary, informing and extending the findings of each other to provide a more complete understanding of the same phenomenon (Jick, 1979; Rossman and Wilson, 1985). Changes in harvest portfolios were documented using semi-structured interviews with charter captains and analyzed using a combination of univariate statistics, network visualization, and network analysis. Drivers of those changes were assessed using qualitative analysis of charter captains' responses to open-ended interview questions, which allowed us to contextualize and interpret the quantitative depictions of harvest portfolio shifts ("elaboration" sensu Rossman and Wilson, 1985). Charter logbook data provided a means of corroborating temporal shifts in harvest portfolios identified from semi-structured interviews with charter captains. Together, these methods and data sources provide a richer, more holistic view of the nature and causes of harvest portfolio shifts than any one approach alone.

### 2.3. Interviews with charter captains

We conducted in-person interviews with charter captains operating their businesses in Sitka (Southeast) and Homer, Seward, and Ninilchik (Southcentral) in May and June of 2014 and 2015. Since 2011, charter vessels targeting halibut have been required to hold a Charter Halibut Permit (CHP; 50C.F.R. §300.67) and the annual list is publicly available (NOAA, 2017). To recruit interview respondents, we contacted CHP holders through angler association newsletters and by mail (i.e., letters sent to CHP holders with business addresses in the above communities in 2014–2015). Additional respondents were identified through snowball sampling, in which each interviewee refers other potential participants (Bernard, 2006). Our intention was not to conduct a representative survey of charter operators, but rather to identify individuals with long-term experience as a captain ( $\geq 5$  years) who could provide insight into changes in charter fishing practices. To confirm the adequacy of our sample size for characterizing the diversity of the harvest portfolios, we calculated a species rarefaction curve (Gotelli and Colwell, 2001) separately for each region (Appendix B).

During interviews, respondents were first asked to list all species they have targeted on charter trips (i.e., those harvested and retained by customers). Next, we asked them to "rank each species according to customer preference on a charter fishing trip," assuming that all species were available (i.e., legally harvestable and present on the fishing grounds). We tested and discussed the wording of this question through several pilot interviews with experienced charter captains to identify a way to elicit the relative importance of harvested species that would be interpreted similarly across interviewees. "Customer preference" was most easily understood and interpreted by charter captains as reflecting a combination of what types of fishing (species and locations) they were willing to offer their customers and what their customers desired to target on charter fishing trips. A ranking of 1 indicated that a species was most preferred (i.e., most targeted). Respondents were permitted to give the same rank to multiple species. We asked respondents to provide separate rankings for when they started operating charter trips ("past") and for recent years, including the current season ("present"). If a change in ranking was identified, we asked when it occurred and what the reasons were for the change. Each respondent could provide more than one reason for shifts in portfolios.

### 2.4. Interview data analysis

We defined harvest portfolios in terms of their diversity (number of species), composition (identity of species in the portfolio), and structure (relative species preferences). To address Objective 1, temporal changes in harvested species portfolios were assessed at two scales: 1) individual

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