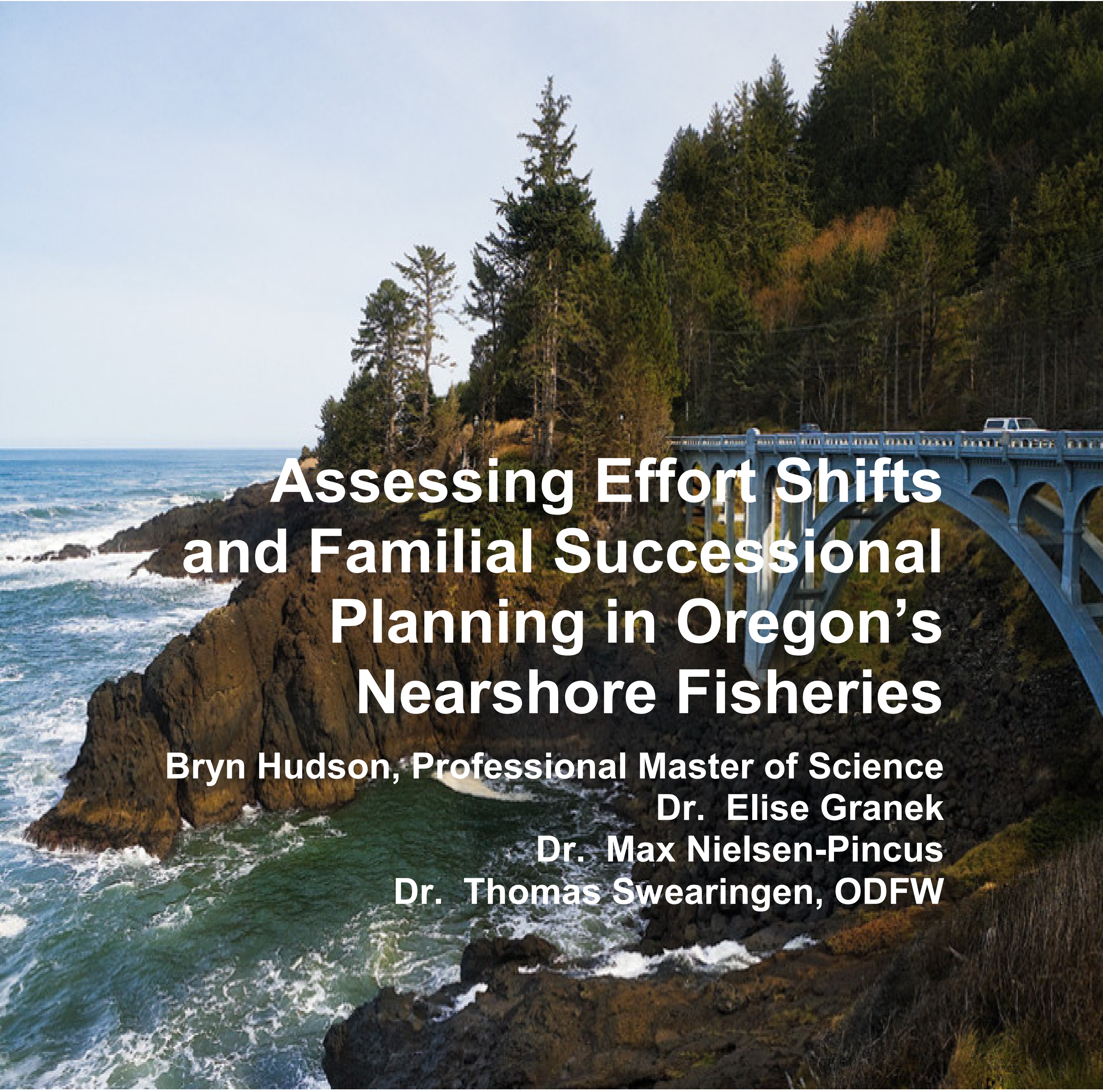

Assessing Effort Shifts and Familial Successional Planning in Oregon's Nearshore Fisheries

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Executive Summary

Overview and Objectives

In 2008, Governor Theodore Kulongoski signed Executive Order 08-07 declaring that marine reserve designations in Oregon's Territorial Sea (0-3 nautical miles from shore) have the potential to provide coastal communities and ocean users with opportunities for continued economic growth and prosperity. Shortly after Executive Order 08-07, the Ocean Policy Advisory Council released the objectives, principles and guidelines for reserve implementation. The overall goal of the reserve system is to "conserve marine habitats and biodiversity; provide a framework for scientific research and effectiveness monitoring; and avoid significant adverse social and economic impacts on ocean users and coastal communities" (OPAC 2008). From 2012-2016, five marine reserves were implemented within Oregon's Territorial Sea: Otter Rock and Redfish Rocks were established in 2012, Cascade Head and Cape Perpetua in 2014, and Cape Falcon in 2016. Oregon Department of Fish and Wildlife (ODFW) was designated as the lead agency responsible for implementation and managing the Oregon Marine Reserve System.

While marine reserves and protected areas have been shown to have long-term benefits for aquatic systems, social controversies surrounding these policies have partially limited widespread implementation (Klein et al. 2008a, 2008b; Pollnac et al. 2010). Eliminating fishing grounds has the potential for short-term negative economic and social impacts. Economic considerations and societal perceptions of reserves are at the forefront of the ODFW Marine Reserves Program human dimensions research agenda. Oregon resident, visitor, local business, and recreational/commercial fisher studies have been conducted in order to understand opinions surrounding marine conservation. There are currently few quantitative studies in Oregon regarding how coastal fishing communities have responded to climatic, political, and economic variability within their system. The ultimate goals of this research are to understand how social, economic, behavioral, and familial dynamics are shifting over time in Oregon's commercial nearshore fishing communities. The research objectives are:

(1) Provide baseline summary statistics regarding fishing behavior, opinions of management and community engagement, reserve implementation, and general demographics among Oregon's nearshore fleets,
(2) Identify and assess which internal and external factors explain the variability observed in fishing effort and success in Oregon's nearshore fisheries, and
(3) Evaluate shifting familial succession expectations across fishery affiliation and port group.

Methods

A questionnaire (see Appendix A) was mailed to current permit holders in Oregon's commercial Dungeness crab, salmon and groundfish fisheries and charter fishers (survey N=1161, unique permit N=1446). Participants were asked to provide information regarding spatial and temporal shifts in fishing behavior, operating expenditures, family succession planning, and basic demographics. After allowing seven months for respondents to return their survey, 230 surveys, representing 300 permits were received. A 21% response rate was achieved for this study. Summary statistics, including mean, standard deviation and standard error were calculated for all continuous, numeric variables. Survey responses and summary statistics were disaggregated by fishery. Any data transformations or standardizations are indicated in relevant tables/figures.

An external comparative analysis revealed that survey respondents were representative of the entire sampling frame (The Research Group LLC 2018). The review for representativeness was primarily based on landed value distribution. Other measures reviewed for representativeness were vessel size, operating port, and permit owner residency. The analysis concluded that respondents for this study closely adhered to known survey frame characteristics suggesting that calibration schemes to improve representation were not needed. However, an analysis of non-respondents' opinions, although beyond the scope of this study, would strengthen the conclusions.

Variable frequencies and percentages for each survey question were generated in order to identify specific patterns in participant responses. Bivariate statistical analyses were further conducted in order to extrapolate emerging patterns in survey responses between fishery affiliations and port groups. Multivariate statistical analyses were conducted in order to identify differences in fishing effort between fishery affiliations, operating port group, and sampling year. Further models were produced to analyze which socioeconomic drivers contributed to variability in CPUE and probability of expectations of familial succession.

Results

- Fishers in the groundfish fishery were newer to fishing, when compared to respondents from the charter and Dungeness crab fisheries. While most respondents participated fulltime in their respective fishery, groundfish fishers participated primarily as part-time in that fishery. Participants in the charter and Dungeness crab fisheries depend more heavily on their respective fisheries than participants in the groundfish and salmon fisheries depended on those respective fisheries.
- First generation fishers made up the largest proportion of respondents and the proportions of second, third and fourth-or-greater generation fishers tappers off as generational involvement increases.
- Slightly less than a majority of fishers did not anticipate that his/her child would continue in the family fishing business. Regardless of the respondents' generational standing within the commercial fishing industry, most did not expect their children to continue to participate in the family fishing business, with the exception of fourth-or-greater generation fishers, whose expectations of family succession were much higher.
- In the Dungeness crab and salmon fisheries, the fourth-or-greater generational class is expected to grow, while the second and third-generational classes are expected to shrink. In the charter fishery, the second-generation class is expected to grow and the third-generation glass is expected to shrink.
- In Tillamook County, the second and third-generational classes are expected to shrink, while in Lincoln County the second and fourth-or-greater generational proportions are expected to grow.
- Responses regarding perceptions of fishery management were more neutral for fishers that did not operate in Oregon. Fishers operating out of the Brookings port group reported more negative views regarding agency advocacy for their personal interests than fishers from Tillamook, Lincoln, and Curry counties.
- Respondents from the salmon fishery reported the largest decreases in catch rates between 2011 and 2017, followed by respondents from the charter fishery.
- The specific drivers of personal catch rates were fishery dependent, suggesting that different fisheries are subject to a unique suite of impacts; Charter: regulations, ocean conditions, and catch limits; Dungeness crab: weather conditions, ocean conditions, and market prices; Groundfish: catch limits, ocean conditions, and operating expenses; Salmon: regulations, ocean conditions, and catch limits.
- Respondents from salmon and charter fisheries reported the largest decreases in fishery related profits between 2011 and 2017.
- The specific drivers of personal profits were fishery dependent, suggesting that different fisheries are subject to a unique suite impacts; Charter: regulations, ocean conditions, and catch

limits; Dungeness crab: ocean conditions, market prices, and operating expenses; Groundfish: Catch limits, ocean conditions, and operating expenses; Salmon: regulations, operating expenses, and catch limits.

- Selections for drivers of personal fishing effort were fishery dependent, suggesting that different fisheries are subject to a unique suite impacts; Charter; weather conditions, regulations, and ocean conditions; Dungeness crab; weather conditions, market prices, and ocean conditions; Groundfish: catch limits, ocean conditions, and weather conditions; Salmon: regulations, ocean conditions, and operating expenses.
- Respondents from the Dungeness crab fishery derived a significantly higher percentage (60%) of their household income from that specific fishery. Respondents from the salmon fishery derived a significantly higher proportion of household income (36%) from the salmon fishery than the proportion of household income (28%) respondents from groundfish fishery derived from that fishery.
- Respondents from the groundfish fishery fished fewer days annually (43 days) than respondents from the other fisheries. Charter fishers operated the most frequently in the nearshore (72 days), while salmon fishers operated the least frequently in the nearshore (22 days).
- Dungeness crab fishers fished the most average daily hours (23 hours), while charter fishers fished the fewest average hours per day (6 hours). Dungeness crab fishers reported the highest average number of nearshore daily fishing hours (21 hours). Dungeness crab fishers also previously fished significantly more days in areas that are now marine reserves (13 days) than respondents from the other fisheries.
- Salmon fishers reported significantly fewer annual days fished and days fished in the nearshore, and fewer daily hours fished in the year 2017.
- Dungeness crab fishers exhibited significantly more effort for each of the years sampled, followed by the salmon and then groundfish fishers. Fishing effort was also significantly lower during the year 2017 within the salmon fishery.
- Dungeness crab fishers reported marginal declines in effort from 2014 to 2017, possibly as a result of the 2016 and 2017 crab season delays, which were due to several factors, including lower meat yield, elevated levels due of domoic acid, and/or contract negotiations.
- Salmon fishers reported significant declines in fishing effort from 2014 to 2017, corresponding with the fishery closures south of Florence for the 2016-2017 season due to low stock returns.
- Fishers from the Dungeness crab fishery reported a significantly lower proportion of their operating expenses were fuel expenditures (16%) and a significantly higher proportion of their operating expenses were crew expenditures (33%) in comparison to all other sampled fisheries. Respondents from the groundfish fishery reported significantly higher costs associated with crew expenditures (20%) when compared with the salmon fishers (13%).
- A majority of the respondents (61%) reported that marine reserve implementation generally has not had any perceived impacts on their fishery participation. When asked to indicate specific types of reserve impacts, a majority of the respondents, in aggregate and across all sampled fisheries, again indicated that reserves have had no clear impact their ability to participate in the fishing industry.
- A plurality of the respondents (42%) indicated that none of the specific marine reserves have had an impact on their fishing operation, a pattern that persisted when respondents were disaggregated by fishery. When disaggregated across port groups, selections of the marine reserve that had the greatest perceived impact on fishing operations were typically representative of a port group's general proximity to each marine reserve.
- Fishing vessels were largest among Dungeness crab fishers (43 feet) and smallest among groundfish fishers (28 feet). The Clatsop and Lincoln County port groups had the largest average vessels (44 feet and 42 feet), while Tillamook and Curry County vessels were the smallest (24 feet and 27 feet).

Management Implications

- **Climatic and oceanic variability impacts fishery dynamics.** Reported shifts in fishing effort correlated with periods of low fish stock availability and changing ocean conditions such as warming or hypoxia, which often resulted in fishery closures as well as market price fluctuations. Large-scale warming events have resulted in domoic acid-producing algal blooms that have led to delays in 2016 and 2017 Dungeness crab fishing season. Furthermore the most recent spatial and temporal closures in the freshwater salmon fishery occurred during the 2017-fishing season. Reduced expectations for familial continuation in fishing was also present in fisheries that have been directly impacted by closures, while fisheries that appeared more resilient were projected to experience less variability in familial retention. For this reason, climatic fluctuations must be considered when evaluating natural resource industry dynamics.

- **Larger fishing operations may be more resilient to oceanic, regulatory, economic, and market variability.** Large vessel size and increased travel capacity were modestly correlated with high catch per unit effort. Larger fishing operations allow for more gear storage than smaller vessels and are typically able fish for longer periods of time in highly variable weather conditions, due to increased fuel capacity and general size. These fishers generate more revenue per trip and are less vulnerable to changing ocean and weather conditions.

- **Salmon fishers that have diversified business operations may effectively cope with oceanic, regulatory, economic, and market fluctuation.** Due to the volatile nature of salmon populations, business operations geared towards mobility (to locate and fish salmon) and flexibility (to shift effort between fisheries) may suggest higher catch per unit effort.

- **In the future, commercial fleets may be dominated by large, intergenerational fishing operations.** Fishers with smaller, first generation fishing operations and higher proportional engagement in nearshore fishing may be particularly vulnerable to climatic, economic, regulatory, and ecological variability. These fishers are also less likely to anticipate their children will remain in the family fishing business. Challenges to maintaining profitability in an industry dominated by large-scale diversified fishing operations may drive smaller operations to scale-up, shift to new markets or exit the commercial fishing industry.

- **Local economies may drive familial succession and catch per unit effort.** Patterns in familial succession and CPUE modestly mirrored shifts in local industry as well as location-specific fleet characteristics. In the Tillamook County port group, reduced succession correlated with the industry shift from the commercial to recreational fishing sector and the historic decline in dory fishing. The opposite was observed in the Lincoln County group, which encompasses the largest fleet on the Oregon coast. Perhaps the ability to establish a fishing operation in a large, competitive geographic location means that a business is already scaled-up to a size that is profitable. For this reason, fishery dynamics should continue to be studied with consideration of microeconomics and site-specificity.

- **Trends in the charter fleet are difficult to predict.** Due to the nature of the business (primarily day trips with tourists), this fleet may be particularly susceptible to volatility. Rough weather, ocean conditions, and area closures may disproportionately impact this specific fishery. Such volatility is homogenous across all fisheries. However, since charter fleets are more dependent on tourism revenues, rather than profitable landings, volatility could lead to shifts from commercial fishing to recreational fishing, as has occurred to some degree in

Tillamook County. However, because the charter fleet displays vastly different business operations and behaviors, responses from that fishery did not receive advanced statistical analyses. For that reason, drawing conclusions about charter fishing effort shift within the current research is difficult. Additional study of this fleet is warranted.

- **Fishers may be shifting between fisheries.** Interactions between fisheries must be taken into account when fishery specific patterns are not apparent. Increases and decreases in effort may be indicative of fishers shifting from one fishery to another due to internal volatility or stability. Because neither groundfish nor salmon fisheries appear to provide a majority of those fishers' household income, they may participate in multiple fisheries. Some may actually be only part time fishers. Furthermore, high CPUE measurements may indicate stability in fish stock availability, which may explain why anticipated familial succession appears to be constant within the groundfish fisheries.

- **A shift may be occurring from commercial to recreational fishing**. Higher anticipation of familial succession among second-generation charter fishers in comparison to other sampled fisheries may reinforce a shift from commercial to recreational fishing. However, the low number of charter respondents limits the certainty of such interpretations.

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Introduction

Marine Reserves in Oregon

In 2008, Governor Theodore Kulongoski signed Executive Order 08-07 declaring that marine reserve designations in Oregon's Territorial Sea (0-3 nautical miles from shore) have the potential to provide coastal communities and ocean users with opportunities for continued economic growth and prosperity. The Ocean Policy Advisory Council (OPAC), which is comprised of representatives from state agencies, non-governmental organizations, fishers and local coastal groups, then initiated a planning process for marine reserve designations.

Shortly after Executive Order 08-07, OPAC released the objectives, principles and guidelines for marine reserve implementation. The overall goals of the reserve system were to "conserve marine habitats and biodiversity; provide a framework for scientific research and effectiveness monitoring; and avoid significant adverse social and economic impacts on ocean users and coastal communities" (OPAC 2008). Key recommendations highlighted collaborative methods, utilizing local knowledge by heavily engaging with communities of interest. During the planning process, priority was given to proposals submitted by groups that worked collaboratively with coastal community members, ocean users, and other interested parties. This collaboration further reinforced the theme of bottom-up management in the state of Oregon. Following OPAC recommendations, House Bill 3013 in 2009 and Senate Bill 1510 in 2012, put forth procedures for adopting rules to establish, study, monitor, evaluate and enforce marine reserves at Otter Rock, Redfish Rocks, Cape Falcon, Cascade Head, and Cape Perpetua.

From 2012 to 2016, those five marine reserves were established within Oregon's Territorial Sea: Otter Rock and Redfish Rocks were established in 2012, Cascade Head and Cape Perpetua in 2014, and Cape Falcon in 2016. These marine reserves were proposed and selected as reserve sites based on ecological data and relative community/cultural importance. Each marine reserve is unique in geomorphic and ecological composition as well as the diverse array of ocean users each supports. While research has shown marine reserves and protected areas to provide long-term benefits for aquatic systems, social controversies surrounding these policies have partially limited widespread implementation (Klein et al. 2008a, 2008b; Pollnac et al. 2010). Coastal resident, visitor, local business, and recreational/commercial fisher studies have been conducted in Oregon to understand opinions surrounding marine conservation. However, there are currently few quantitative studies regarding how coastal fishing occupational communities have responded to reserve implementation and, more broadly, to variability within their fisheries. The ultimate goals of this research are to understand the impacts of reserve implementation and how social, economic, behavioral, and familial dynamics are shifting over time in Oregon's commercial nearshore fishing communities.

Socioeconomic Drivers of Variability

Due to Oregon's commitment to public engagement in natural resource management, it is imperative to understand how the behaviors and perceptions of individuals within each stakeholder group are changing over time and potentially impacted by marine reserves. Factors such as climatic variability, market dynamics, conservation policy, and generational structures have potential to alter the ways in which ocean users interact with and rely on resource extraction. Investigation into shifting behaviors and community dynamics can provide information to local policy makers regarding relevant stakeholders, the best ways to engage with them, and the ways in which future policy may impact them.

Fishing effort is a measurement of the resources required for fishing, such as time, capital, labor, or gear (Pascoe and Robinson 1996; Del Valle et al. 2003; Ruttan 2003). Catch per unit effort, typically measured by weight of catch per a certain time period for a specific type of gear, is an effective measurement used to quantify effort. This measurement is an important tool that aids fishery managers in accurately evaluating fish stocks and managing fisheries by estimating areas that are most heavily fished and how fisher behaviors respond to market, ecological, and climatic variability (Branch et al. 2006; McCluskey and Lewison 2008). If the total effort of a fleet increases and landings remain constant, fish stocks may be declining and profitable extraction may be more difficult. Since the turn of the century, several of Oregon's fisheries have experienced periods of lower productivity and yield. Fishers' geographic locations and a variety of other socioeconomic variables, such as industry investment and scale of business, have been shown to drive overall effort, as well as fishing success (Kirkley et al. 2001; Smith et al. 2010; Davis et al. 2017).

"Sense of place" is a common factor that helps shape a person's perceptions of the socioeconomic impacts of marine reserves (Dalton 2004). Sense of place is often defined as a symbolic relationship to a specific place, derived from shared cultural, behavioral or emotional experiences of a group of people (Low 1992; Cross 2001). Coastal community and fishing occupational community ethnographies in Oregon have revealed that sense of place shapes patterns of ocean usage and opinions on conservation and marine reserves (Package and Conway 2010a, 2010b, 2010c; Hall and Murphy 2012; Eardley and Murphy 2013; Murphy and Hall 2013). Differing opinions exist among these communities ranging from perceptions that fishing effort will be directly displaced by reserves to resentment of government interference in the commercial fishing industry (Marino 2015). Furthermore, proximity to a reserve has the potential to disproportionately impact some fishers based on their traditional fishing strategies and their geographic location along the coast. Given of the spectrum of local perceptions pertaining to the reserves, port of operation was an important consideration in this study.

Fishing capacity and scale of business operation are frequently cited factors that heavily impact a fisher's capability in the fishing industry (Kirkley et al. 2001; Smith et al. 2010; Davis et al. 2017). Larger fishing vessels are typically indicative of scaled-up businesses that allow fishers to increase fishing capacity and maintain resilience to variability in operating conditions. These larger business operations, however, are also often associated with higher operating costs in terms of fuel, crew, and insurance expenditures (Davis et al. 2017). In order to effectively manage fisheries, it is imperative to understand differing business operations and the related dynamics of fishing success when evaluating the effort and fishing pressure that each fishery supports.

Age structure and youth recruitment are two very important demographics to consider that allow managers to evaluate how workforce structure is changing and predict workforce dynamics. The United States baby boom era (1946-1964) resulted in large population increases among that age cohort that resulted in uneven age class distributions. Studies project that by 2030, 20% of the national population will be over the age of 65 (Sade 2012). "Graying" is a commonly used term to describe the shift within the workforce in which the average age of participants increases in tandem with the decrease of youth recruitment. Rural industries in particular, such as timber, agriculture, and commercial fishing, have experienced this graying effect (Gale 2003; Cramer and Conway 2016). Urban migration and socioeconomic barriers of entry into these industries have largely contributed to the decline in participation of younger generations (Heberle 1938; Mabogunje 1970). Commercial fishing industries are observing a steady global decrease in recruitment and participation among younger age classes; this issue is particularly pervasive in many of Oregon's commercial fleets (Donkersloot 2011; Cramer and Conway 2016; Saputra 2016; Caracciolo 2017).

Human migration is defined as groups of people moving from one place to another and typically occurs in four different ways; rural-rural, rural-urban, urban-rural, and urban-urban. The reasons why people choose to migrate from one community to another are defined as "push-pull" factors (Heberle 1938). Urban areas are often associated with higher wages, higher standards of living, and enhanced social connectivity. In conjunction with the technological revolution, urban areas have increased mid-level career opportunities that have frequently been eliminated in rural economies, such as industrial or agricultural markets (Heberle 1938; Mabogunje 1970). This type of rural to urban migration has had a direct impact on the commercial fishing industry and has ultimately contributed to decreases in fisheries participation over time (Donkersloot 2011; Caracciolo 2017).

Another commonly cited reason for decreased participation in rural, labor-intensive industries is the existence of significant barriers to entry. Barriers to entry are typically defined as high financial start-up costs that prevent economically viable entrance of newer competitors (Demsetz 1982). Industries, such as fishing or agriculture, require large sums of upfront capital or natural resource investment (e.g., a fishing vessel or large acreage). If not inherited, the burden falls upon the new competitor to acquire sufficient capital needed to enter the market. In the fishing industry, the implementation of many catch share programs (purchased rights to take a finite amount of fish) has increased values of individual take quotas, posing a substantial up-front financial burden and access issue for many new fishers (Carothers 2011; Carothers and Chambers 2012; Caracciolo 2017). An increase in operating expenses and risk associated with fishing may also limit new or continuous investments (Davis et al. 2017). While overall vessel revenue has been increasing since the 1960s, the number of fishing vessels has drastically decreased, indicating an increase in income among those who have been able to afford to participate and increase the scale of their business operations (The Research Group 2013b). For younger generations, fishing as a profession is often perceived to be incapable of supporting families in the modern economy, due to low yields and lack of quality and quantity of jobs (Power et al. 2014). Due to these barriers of entry and the perceived inadequacy of fishing as a career path, the commercial fishing industry on the West Coast is likely to continue to experience decreases in youth recruitment and retention.

Oregon Marine Reserve's Human Dimensions Program

The legislatively mandated goal of the ODFW Marine Reserves Program is to evaluate how ecological and socioeconomic systems are responding to marine reserve implementation (ODFW 2017a). ODFW's human dimensions research is focused on understanding how different groups of ocean users depend on and interact with the ocean and the coastal economy of Oregon. While reserves have been shown to enhance localized biodiversity and adjacent fishery production (Gell and Roberts 2003; Halpern 2003), eliminating fishing grounds has the potential for short-term negative socioeconomic impacts (Klein et al. 2008a, 2008b; Pollnac et al. 2010).

The economic impacts and social perceptions of reserves are at the forefront of the Marine Reserves Human Dimensions Project research agenda. Spatial analyses and stakeholder surveys before and during reserve implementation have found a suite of positive and negative beliefs about marine reserves. Fishers predicted decreases in revenue from commercial fishing and recreational fishing, while revenue from tourism was predicted to increase (The Research Group LLC and Golden Marine Consulting 2012; The Research Group LLC 2013a; Swearingen et al. 2017). Coastal business and resident surveys found that a majority of coastal communities did not feel that the reserves would have an economic impact on the local economy (Needham et al. 2016; Epperly et al. 2017). Intercept surveys have revealed overall positive perceptions of the marine reserve system among visitors not from the Oregon coast (Swearingen and Epperly 2016; Swearingen et al. 2016). There have also been extensive research efforts to develop community profiles of several relevant fishing port towns in order to understand community demographics, cultural attributes, and resilience to external stressors (Package and Conway 2010a, 2010b, 2010 c; Hall and Murphy 2012; Eardley and Murphy 2013; Murphy and Hall 2013; Ackerman et al. 2016). Due to the short time frame since implementation, however, the actual economic and social impacts of marine reserve implementation in Oregon are still largely unknown. Data gaps remain in understanding how commercial fishing behaviors and dynamics have shifted in response to marine reserve designation. Furthermore, quantitative research regarding familial succession within Oregon's nearshore fisheries is also sparse.

Projects Goals and Objectives

The goal of this research was to evaluate marine reserve impacts and assess the ways in which opinions, behaviors, and familial dynamics within Oregon's nearshore fishing fleets are shifting. Data were collected from permit holders within the commercial Dungeness crab, salmon troll and groundfish fisheries as well as the charter fleet. These fisheries operate more frequently in the state nearshore waters. These fishers are thus most likely to be impacted by state policy changes or to react to variability in physical or socioeconomic conditions within those areas. The research objectives of this project were:

(1) Provide baseline summary statistics regarding fishing behaviors, opinions of agency management and community engagement, reserve implementation, and general demographics among Oregon's nearshore fleets,
(2) Identify and assess which internal and external factors explain the variability observed in fishing effort and success in Oregon's nearshore fisheries, and
(3) Evaluate shifting familial succession expectations across fishery affiliation and port group.

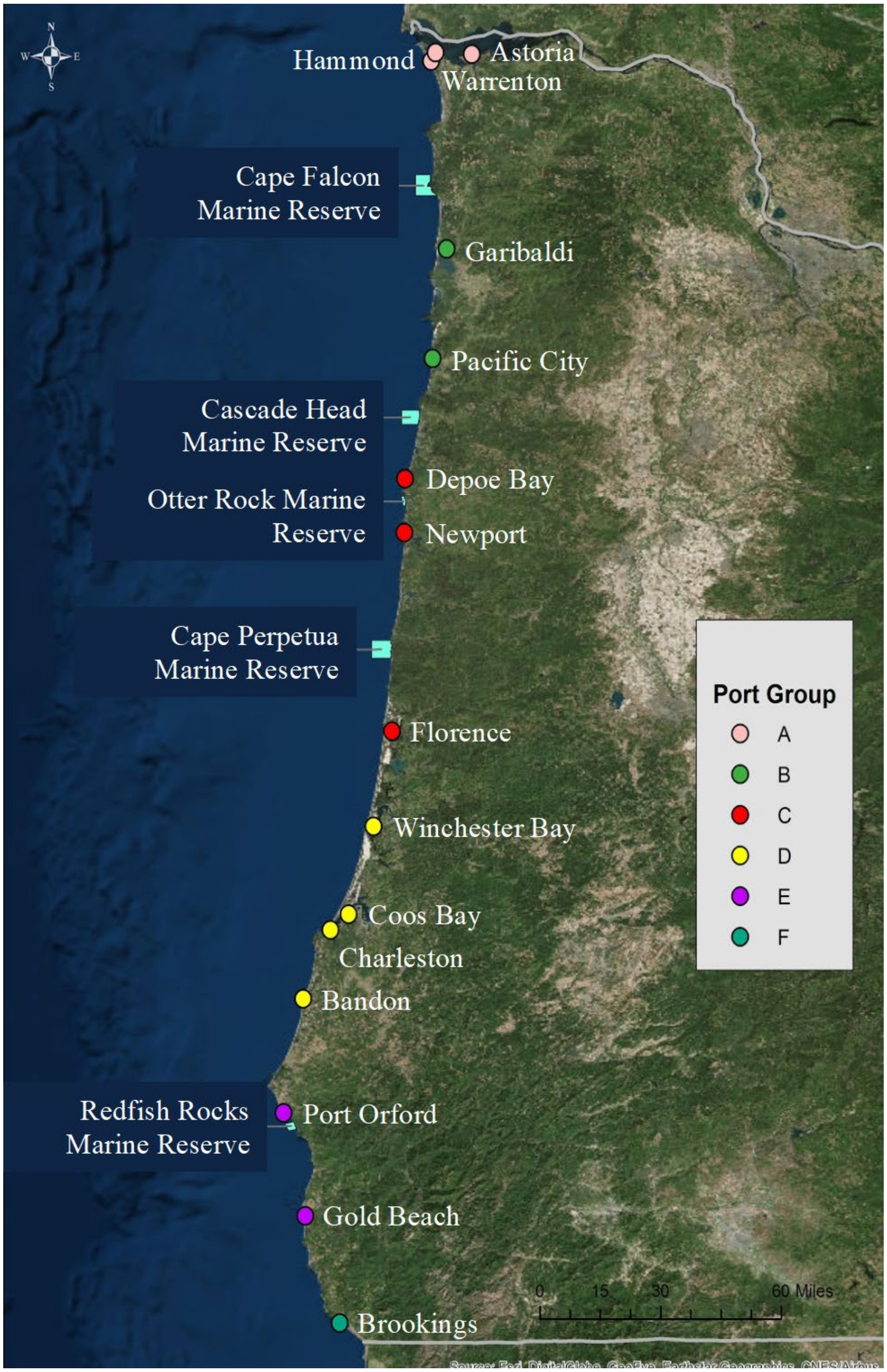
Methods

Survey Design

A mail questionnaire was used to conduct a survey for this study. Mail surveys are often used over other commonly used survey methods, such as telephone and face-to-face interviews, due to low associated costs and simplicity (Dillman 2011). In order to ensure consistent language and tone acceptable to Oregon fishers, survey questions were developed in collaboration with members of the commercial fishing community. The Dungeness crab and salmon commissions, as well as the Oregon Trawlers Association, and volunteers within the fishing community provided feedback regarding survey design. Furthermore, meetings with Fishermen Involved in Natural Energy (FINE), Fishermen's Advisory Committee for Tillamook County (FACT), Port Orford Ocean Resource Team (POORT), ODFW fishery managers and several other fishers along the coast helped streamline questions to collect relevant information that would effectively quantify fishing effort.

The survey contained 15 questions that addressed the following subject matter: fisher demographics (fishery, port, familial information), perceptions of management, drivers of profit, landing and effort variability, operating expense breakdown, fishing effort logistics, and perceptions of marine reserves (see Appendix A). The survey used 5-point-Likert scale, multiple choice, ranking, and open-ended response options. In order to reduce respondent burden, fishers that held permits in more than two fisheries were instructed to select the two that contributed the most to their household income and complete the survey with respect to those two fisheries. Researchers assumed that two fisheries captured the majority of fishery related household income. This assumption may have created modest limitations to the collected data. Fishers were also instructed to choose their primary port of operation from seven fishing port groups. Grouping fishers by operating port group is a commonly used aggregation method when collecting fisheries data. The standard ODFW port groups are used in this study (Figure 1; Rodomsky and Calavan 2015; Rodomsky et al. 2016; Rodomsky and Calavan 2017).

Figure 1. Primary operating port group distribution and proximity to marine reserves.



A= Clatsop County: Astoria, Warrenton, and Hammond
B= Tillamook County: Garibaldi and Pacific City
C= Lincoln County: Newport, Depoe Bay, and Florence (Coastal Lane Co.)
D= Coos County: Coos Bay, Bandon, Charleston and, Winchester Bay (Coastal Douglas Co.)
E= Curry County: Port Orford and Gold Beach
F= Brookings

An operating expenditure profile was constructed by asking fishers to report the approximate percentage of operating expenses for fuel, crew, and other expenses for the years 2011, 2014, and 2017. Fishing effort was assessed for 2011, 2014, and 2017 in terms of:

- Percentage of household income derived from commercial fishing
- Total days fished
- Days fished in the nearshore (0-3 miles from shore)
- Total hours gear was deployed/day
- Total hours gear was deployed in the nearshore/day (0-3 miles from shore)
- Total miles traveled before deploying fishing gear/day
- Days previously fished in areas that are now marine reserves
- Percentage of fishery income supported by catch from areas that are now marine reserves

To facilitate additional analyses, secondary landing, revenue, and vessel feature data from ODFW (2017b) and the Pacific Fisheries Information Network (2017) were compiled for each survey respondent.[1]

Sampling Frame and Survey Implementation

Using permit lists provided by the Oregon Department of Fish and Wildlife, mail questionnaires were sent to current permit holders in the commercial Dungeness crab, salmon and groundfish fisheries, and the charter fishery (Total N=1,097) using a standard mail survey protocol (Dillman 2011). Permit holders received five items via mail during the two-month sampling period: (1) an announcement post card two weeks prior, (3) a reminder postcard two weeks after receiving the (2) first survey. Non-respondents were mailed (4) a replacement survey, with a financial incentive ($2.00 USD bill) enclosed, four weeks after receiving the initial survey, then (5) a reminder postcard was sent six weeks after the initial survey was mailed.

A total of 230 surveys were returned, representing 300 individual permits. Respondents that did not complete the entire questionnaire mainly skipped questions regarding operating expenditures, fishing effort logistics or marine reserve perceptions.

Data Analysis

Summary statistics, including mean, standard deviation, and standard error were calculated for all continuous, numeric variables. Survey responses and summary statistics were separated by fishery or port group when appropriate. Pearson's chi-squared tests were performed to identify patterns in response distributions between fishery affiliations and port groups. Kruskal-Wallis and Wilcox-pairwise tests were used to evaluate differences in median responses to opinions regarding management, catch rate and profit variability, and perceived impacts of marine reserves between fisheries and between operating port groups. Analyses of variance (ANOVA) were performed to identify patterns in operating expenditures, effort logistics, and vessel characteristics. Any data transformations or standardizations are indicated in the relevant table or graph.

Total fishing effort was calculated by multiplying the total days fished in a year by the average number of hours that fishing gear was deployed per day to give the total hours that fishing gear was deployed per year for 2011, 2014, and 2017. Repeated measures two-way ANOVAs were calculated in order analyze differences in fishing effort. Fishery, operating port group, and sampling year were factors with

[1] To protect confidentiality, these date were anonymously correlated to completed responses by ID number under ODFW contract with The Research Group LLC.

respondent identification number included as an error term to account for the non-independence between temporal samples.[2] Pair-wise comparisons between fisheries, operating ports, and sampling year were performed where significant differences in effort were observed.[3] [4]

CPUE was calculated by dividing a fisher's total annual landings (in pounds) by their reported total annual effort (hours fished). The repeated measures ANOVA revealed no significant variability in CPUE over time between 2011, 2014, and 2017.[5] As a result, CPUE measurements from each year were averaged to create a single CPUE value for each survey respondent. Linear mixed effects models were generated to analyze which socioeconomic drivers contributed to variability in CPUE. Due to the differences in fishing methods between each fishery, data were disaggregated by fishery in order to generate three unique models. Vessel length, number of vessels owned, average nearshore effort (measured in total annual hours fished in the nearshore), average fuel expenditure ratio, average number of days previously fished in what are now marine reserves, average percentage of income derived from what are now marine reserves, seasonal delays/closures, and an average financial dependence on fishing were used as fixed effects, while operating port and respondent identification number were used as random effects[6]. Averages were obtained using measurements collected from the years 2011, 2014, and 2017. In order to incorporate seasonal delays and closures, each delay in the years 2011 to 2017 was given a value of 0.5 and each closure was given a value of 1, to account for the magnitude of fishing lost by the delay or closure. If the seasonal delay or closure was not spatially distributed evenly, only port groups directly adjacent to closures received those values. All closures/delays for each fishery from 2011 to 2017 were added and applied as one value.

A binomial logistic regression model evaluated the impacts of fishery dynamics and scale of business operations on the expectations of familial continuation in the commercial fishing industry.[7] Fishery affiliation, primary operating port group, average annual catch per unit effort (landings per total hours fished for years 2011, 2014 and 2017), respondent's generational standing within the fishery, financial dependence on fishery income (percentage of household income), vessel length, and number of vessels owned were used as predictor variables for family succession expectations.[8] [9] Continuous predictor variables were standardized to make coefficients more comparable. In order to keep familial succession responses binomial, respondents that indicated "Maybe" for familial succession were combined with respondents that indicated "No". Respondents who did not have children were excluded from the analysis, as they do not take part in familial successional planning.

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[2] The assumption of sphericity, equal variance between all possible pairs of within-subject conditions, was tested for each parameter using the Mauchly test and adjusted using Greenhouse-Geisser corrections.

[3] Several parameters did not meet the assumption of sphericity and were adjusted using Greenhouse-Geisser corrections, Bonferroni-Holm tests were used for pair-wise comparisons.

[4] Normality and equal variance assumptions of repeated measures ANOVA were assessed via inspection of model residuals and total fishing effort values were square rooted in order to meet assumptions.

[5] Fishing effort in 2017 for the salmon fishery was significantly less than 2011 and 2014 and was excluded from linear mixed effects models in order to eliminate outliers.

[6] Backwards-stepwise Akaike Information Criterion (AIC) model selection was used in order to eliminate fixed effects that did not contribute to variability in average CPUE and a variance inflation factor (VIF) analysis evaluated predictor variables for multicollinearity. CPUE values were log-transformed in order to obtain normal distribution. All independent variables were standardized to make regression coefficients more easily comparable.

[7] Expectations of familial succession were evaluated using a success-failure binomial probability, with 1 indicating expected succession of offspring in the family fishing business and 0 indicating no expected succession by offspring.

[8] Backwards-stepwise Akaike information criterion (AIC) model selection was used to in order to eliminate variables that did not contribute to familial succession and a variance inflation factor (VIF) analysis evaluated predictor variables for multicollinearity.

[9] Model fit was assessed using a Chi Squared p-value of the deviance of the residuals, as well as McFadden and Nagelkerke R^2 values. An analysis of variance (ANOVA) was used to compare the full logistic model to the final logistic model.

Results Section I- Questionnaire Responses

Response Rates

In total, 1161 surveys, representing 1446 unique permit holders (some fishers owned permits in multiple fisheries). After allowing seven months for respondents to return their survey, 230 surveys, representing 300 permits were received. A 21% response rate was achieved for this study, which is comparable to other survey studies conducted with commercial fishing communities (Himes-Cornell and Kent 2014; Rodomsky and Calavan 2017). In total, 46 surveys were undeliverable and 18 possible respondents were either deceased or retired and were removed from the sample when calculating response rates (Table 1).

Table 1. Survey Response by mailing round, non-response and permit representation.

Response	N
Total Surveys Mailed to Unique Addresses	1161
Total Permits Represented in Surveys Mailed to Unique Addresses	1446
1ST Round Returned Surveys	122
2nd Round Returned Surveys	108
Total Returned Surveys	230
Total Permits Represented in Returned Surveys	300
Undeliverable[1]	46
Retired/Deceased/Does not use Permit[1]	18
Non-Response Surveys	867
Total Response Rate	21%

[1]Removed from potential respondents

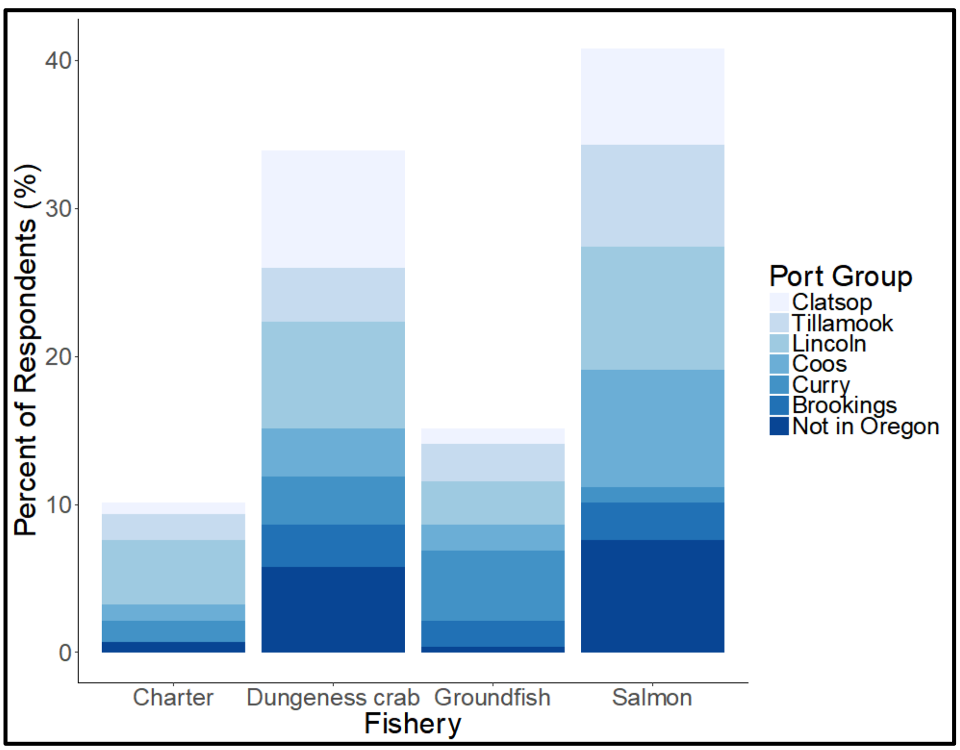
Fishers from the groundfish fishery responded at the highest rates (44%), however, salmon fishers comprised the plurality of survey respondents (42%; Table 2; Figure 2). Survey responses were received from all port groups. PacFIN data combined Curry and Brookings port totals, therefore only one response rate was calculated for the combined groups, and represented the highest response rate (62%). Fishers from Tillamook County responded at the second highest rate (58%) and fishers from Coos County responded at the lowest rate (22%). Roughly 460 of the contacted permits were not connected to a specific landing port and for that reason, port group response rates may be slightly inflated. A few respondents who primarily landed in ports outside for Oregon were excluded from the analyses (Table 2).

Table 2. Respondent distribution by fishery affiliation aggregated by port group.

County (Group)	Dungeness crab	Groundfish	Salmon	Charter	Total	Permits Contacted	Response Rate[1]	% Responses
Clatsop	22	3	18	2	43	111	39%	16%
Tillamook	10	7	19	5	36	60	58%	13%
Lincoln	20	8	23	12	51	208	25%	19%
Coos	9	5	22	3	36	166	22%	13%
Curry	9	13	3	4	25	73[2]	62%	9%
Brookings	8	5	7	0	20	73[2]	62%	7%
Not in Oregon	16	1	21	2	38	N/A	N/A	14%
No Port	4	2	15	2	21	457[3]	N/A	8%
Total	98	44	128	30	300	-	-	-
Permits Contacted	378	101	892	75	1371	-	-	-
Response Rate[4]	26%	44%	14%	40%	21%	-	-	-
% Responses	33%	15%	42%	10%	100%	-	-	-

[1] Some response rates may be inflated due to large number of missing port data
[2] PacFIN combined Curry and Brookings port groups, response rates calculated as one group
[3] No PacFIN port data connected to permit

Figure 2. Respondent fishery by port.



N= 300; Charter=30; Dungeness crab=98; Groundfish=44; Salmon=128

Representativeness Analysis

To assess potential nonresponse bias, an external comparative analysis revealed that survey respondents were representative of the entire sampling frame (The Research Group LLC 2018). The review for representativeness was primarily based on landed value distribution. Other measures reviewed for representativeness were vessel size, operating port, and permit owner residency. Permit identification numbers and associated characteristics were cross-referenced with survey respondents and compared to the characteristics of the sampling frame. The analysis concluded that respondents for this study closely adhered to known survey frame characteristics suggesting that calibration schemes to improve representation were not needed. Although beyond the scope of this study, a comparative analysis of nonrespondents' opinions on critical questions would strengthen validity of the conclusions herein.

Variable Frequencies

To assess respondent geographic distribution, fishers were asked to identify his/her primary operating port. Respondents that landed primarily in Lincoln County represented that largest percentage of survey respondents (19%), while respondents that landed primarily in Brookings represented the smallest percentage of survey respondents (7%; Table 3). Respondents that landed in a port not in Oregon were excluded from analyses because landings data were not available for ports outside of Oregon. Respondents that did not specify an operating port were also excluded from analyses because they could not be categorized.

Table 3. Distribution of respondent port groups

Q1. Currently, what is your primary operating port?

County (Group)	Total	% of Total Responses[1]
Clatsop (A)	43	16%
Tillamook (B)	36	13%
Lincoln (C)	51	19%
Coos (D)	36	13%
Curry (E)	25	9%
Brookings (F)	20	7%
Not in Oregon (H)[2]	38	14%
No Port[2]	21	8%

[1] Percent of total responses equal the number of permits represented for each fishery or port divided by 270 (the number of total permits held by subjects that responded to the study)
[2] Responses excluded from analyses

To assess the demographics of each fishery, respondents were asked to provide a personal fishing profile regarding: the number of years of each fishery participation, degree of participation (full-time vs. part-time), and financial dependence. The responses for each fishery displayed a unique spread of demographics (Table 4). Respondents from the charter (30 years) and Dungeness crab (22 years) fisheries participated in their respective fisheries for a significantly longer period of time than respondents from the groundfish fishery (16 years).[10] In general, fishers in the groundfish fishery were newer to fishing, when compared to respondents from the charter and Dungeness crab fisheries.

Table 4. Commercial Fishery Participation

Q2. For each commercial fishery in Oregon that you participated since 2011, how many years have you fished?

Fishery	Years fished		
	N	Mean	SE
Charter	19	30	4.72
Dungeness crab	101	22	1.60
Groundfish	51	16[1]	1.70
Salmon	128	20	1.50
Participants from all fisheries have not fished for the same amount of time: F=5.29, p=0.0014 [1] Significantly less than the charter (p=0.002) and Dungeness crab (p=0.02) fisheries			

To assess the degree to which fishers participated in each fishery, respondents were asked to indicate if s/he were a fulltime participant. A majority of respondents from the Dungeness crab (83%), charter (81%), and salmon (58%) fisheries identified as full-time fishers, while more participants from the groundfish fishery (59%) identified as part-time participants (Table 5).[11] While most respondents participate full-time in their respective fishery, groundfish fishers participate primarily part-time in that fishery.

Table 5. Commercial Fishery Participation.

Q2. For each commercial fishery in Oregon that you participated since 2011, do you participate fulltime?

Fishery	Fulltime fishery participation	Part-time fishery participation
	N (%)	N (%)
Charter	17 (81%)	4 (19%)
Dungeness crab	83 (83%)	17 (17%)
Groundfish	21 (41%)	30 (59%)
Salmon	75 (58%)	55 (42%)
Responses were not split 50/50: χ^2=22.6, p=1.3e-05; Dungeness crab χ^2=115, p=<2.2e-16; Groundfish χ^2=27.9, p=8.8e-07; Salmon χ^2=69.9, p=7.6e-16		

[10] ANOVA and Tukey pairwise comparisons test for differences in average years fished between fishery affiliations.
[11] Pearson's chi-squared test for differences between observed proportions and random proportions (50/50 chance).

Fishers were further asked to indicate the proportion of household income derived from fishing (Table 6). Respondents from the charter (63%) and Dungeness crab (54%) fisheries derived a significantly larger percentage of household income from their respective fisheries than respondents from the groundfish (26%) and salmon (34%) fisheries.[12] This indicates that participants in the charter and Dungeness crab fisheries depend more heavily on those respective fisheries than participants in the groundfish and salmon fisheries.[13]

Table 6. Commercial Fishery Participation.

Q2. For each commercial fishery in Oregon that you participated since 2011, what percentage of your household income was derived from each fishery?

Fishery	% Household income (HHI) derived from fishery		
	N	Mean	SE
Charter	15	63%	9.0
Dungeness crab	91	54%	2.95
Groundfish	46	26%[1A]	4.09
Salmon	116	34%[1B]	3.02

Different fisheries provided different amount of financial support: F=14.3, p=1.22e-08
[1A] Significantly less than charter (p=0.0003) and Dungeness crab (p=2.3e-06) fisheries
[1B] Significantly less than charter (p=0.004) and Dungeness crab (p=2.0e-05) fisheries

[12] ANVOVA and pairwise Tukey's test for differences in % fishing HHI between fishery affiliations.
[13] Respondents were not asked to explain their additional sources of household income.

To identify current generational profiles, respondents were asked how many generations their family had participated in Oregon's fisheries (Table 7). In general, more than half of respondents (53%) identified as first generation fishers, while only 6% of fishers identified as fourth-or-greater generation participants.[14] Among all respondents, 47% were intergenerational fishers. When disaggregated for comparisons across fisheries, the largest proportion of respondents identified as first generation fishers, and the smallest proportion of respondents were fourth-or-greater generation. There was not a statistically significant difference between generation class distributions between fisheries.[15] There was, however, a significant difference in generation class distribution between port groups. When disaggregated for comparisons across port groups, a majority (69% and 63%) of respondents from Curry and Lincoln Counties identified as first generation fishers while 13% of respondents from Clatsop County identified as fourth generation fishers (the largest proportion of any port group). With the exception of respondents from the charter fishery and from Curry County and Brookings, respondents identifying as second or third generation fishers each represented roughly 10-30% of total responses.[16] When aggregated and disaggregated for comparisons across fisheries and port groups, first generation fishers made up the largest proportion of respondents and the proportions of second, third, and fourth-or-greater generation fishers tappers off as generational involvement increases.

Table 7. Fisher generation classes.

Q3. How many generations has your family participated in Oregon's fisheries?

Fishery	**Aggregate[1]**	**Charter**	**Dungeness crab**	**Groundfish**	**Salmon**
Generation Class	N (%)	N (%)	N (%)	N (%)	N (%)
1	155 (53%)	15 (65%)	34 (44%)	25 (63%)	50 (55%)
2	71 (24%)	1 (4%)	23 (30%)	9 (23%)	26 (29%)
3	51 (17%)	7 (30%)	14 (18%)	6 (15%)	10 (11%)
4	17 (6%)	0 (0%)	6 (8%)	0 (0%)	5 (5%)

Port Group[2]	**Clatsop**	**Tillamook**	**Lincoln**	**Coos**	**Curry**	**Brookings**
Generation Class	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
1	21 (47%)	17 (45%)	40 (63%)	19 (49%)	18 (69%)	9 (45%)
2	9 (20%)	12 (32%)	9 (14%)	12 (31%)	8 (31%)	9 (45%)
3	9 (20%)	9 (24%)	12 (19%)	5 (13%)	0 (0%)	2 (10%)
4	6 (13%)	0 (0%)	2 (3%)	3 (8%)	0 (0%)	0 (0%)

N=294
[1] All generation classes did not receive equal selections: χ^2=121.3, p=<2.2e-16
[2] Generation class was port group dependent: χ^2=30.7, p=0.009

[14] Pearson's chi-squared test was used to evaluate if all generation classes received an equal number of selections.
[15] Pearson's chi-squared test was used to evaluate if fishery generation class is independent of fishery affiliation and/or port group.
[16] Pearson's chi-squared test was used to evaluate if fishery generation class is independent of fishery affiliation and/or port group.

In order to characterize their expectations of familial succession, respondents were asked to indicate whether or not s/he anticipated that their children would participate in the family's fishing operation (Table 8). Slightly less than half of fishers (47%) indicated that they did not anticipate their children would continue to participate in the family's fishing operation.[17] Among all respondents, 18% were unsure of their family successional plans, and only a small minority of respondents (27%) anticipate their children will continue in the family fishing business. There was not a significant difference in expectations for familial succession by fishery affiliation or by port group.

Table 8. Anticipated familial succession.

Q4. Do you anticipate that your children will participate in your family's fishing operation?

Fishery	**Aggregate[1]**	**Charter**	**Dungeness crab**	**Groundfish**	**Salmon**
Expectation of Familial Succession	N (%)	N (%)	N (%)	N (%)	N (%)
Yes	81 (27%)	7 (30%)	25 (32%)	8 (20%)	21 (23%)
Maybe	52 (18%)	4 (17%)	13 (17%)	6 (15%)	16 (18%)
No	137 (47%)	10 (32%)	32 (42%)	25 (63%)	44 (48%)
No Children	24 (8%)	23 (7%)	7 (9%)	1 (3%)	10 (11%)

Port Group	**Clatsop**	**Tillamook**	**Lincoln**	**Coos**	**Curry**	**Brookings**
Expectation of Familial Succession	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Yes	20 (44%)	5 (13%)	21 (33%)	6 (15%)	5 (19%)	4 (20%)
Maybe	7 (16%)	9 (24%)	11 (17%)	6 (15%)	2 (8%)	4 (20%)
No	17 (38%)	21 (55%)	26 (41%)	22 (56%)	15 (58%)	10 (50%)
No Children	1 (2%)	3 (8%)	5 (8%)	5 (13%)	4 (15%)	2 (10%)

N=294
[1] Expectations of familial succession did not receive equal selections: χ^2=80.1, p=<2.2e-16

[17] Pearson's chi-squared test used to evaluate if all expectations of familial succession received an equal number of selections.

Respondents were asked to indicate their degree of agreement with a series of questions regarding perceptions of management (Table 9; Figure 3). A majority (64%) of respondents thought to some degree that public agencies have not done a good job advocating for their own personal interests. A total of 58% of respondents also stated that agencies had not done a good job advocating for their fisheries. Opinions were more neutral concerning the quality (28%) and frequency (40%) of agency to stakeholder communication and of accessibility to scientific research occurring on the Oregon coast (25%). A majority (55%) of respondents felt comfortable expressing their opinions about fisheries management. Most respondents (62%) also knew where to obtain information about policy/regulatory changes on the Oregon coast. Additional bivariate analyses exploring differences in opinions of management between fisheries and port groups are presented in Table 23 and Figure 13.

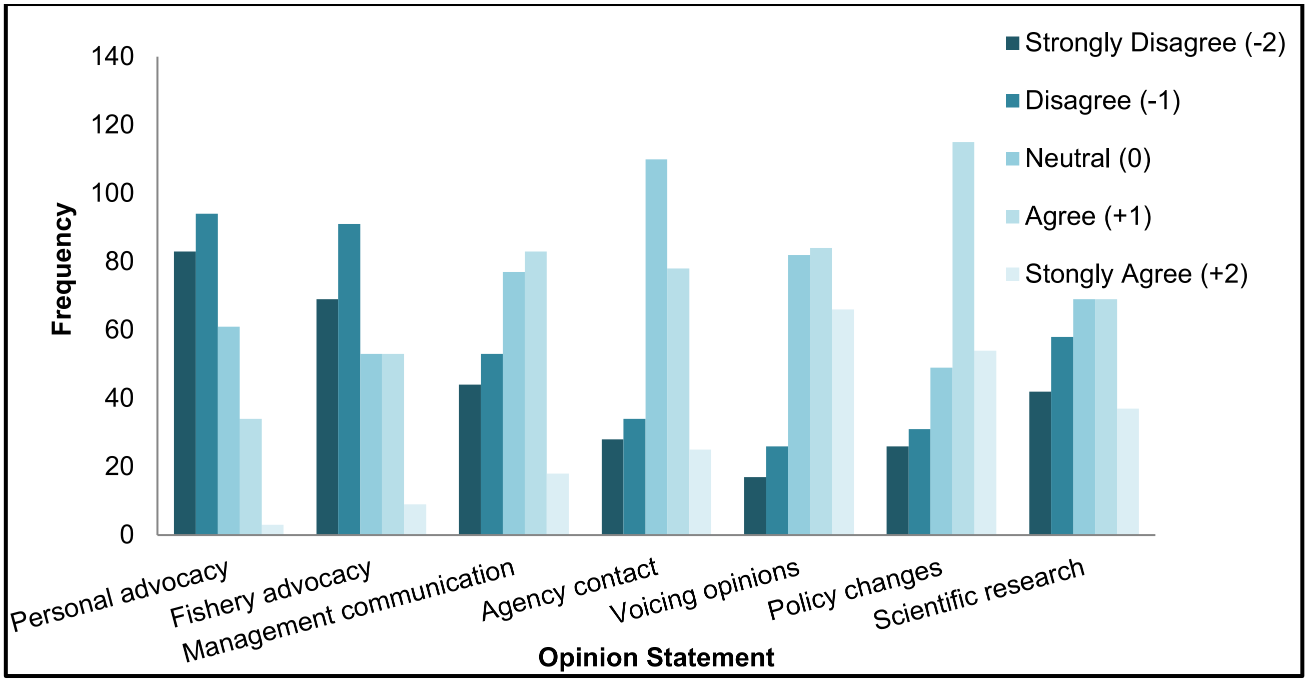
Table 9. Perceptions of management.

Q5. To what degree do you agree/disagree with each statement below?

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
	N (%)	N (%)	N (%)	N (%)	N (%)
Public agencies have done a good job advocating for my personal interests	83 (30%)	94 (34%)	61 (22%)	34 (13%)	3 (1%)
Public agencies have done a good job advocating for the interests of the fisheries in which I participate	69 (25%)	91 (33%)	53 (19%)	53 (19%)	9 (4%)
Public agencies adequately communicated issues regarding Oregon fishery management to my local community	44 (16%)	53 (19%)	77 (28%)	83 (30%)	18 (7%)
I am satisfied with the amount of contact I have with agency representatives	28 (10%)	34 (12%)	110 (40%)	78 (29%)	25 (9%)
I feel comfortable voicing my opinions about Oregon ocean management and policy to public agencies	17 (6%)	26 (9%)	82 (30%)	84 (31%)	66 (24%)
I know where to obtain information about policy changes regarding Oregon ocean issues	26 (9%)	31 (11%)	49 (18%)	115 (42%)	54 (20%)
I know where to obtain information about scientific research regarding Oregon ocean issues	42 (15%)	58 (21%)	69 (25%)	69 (25%)	37 (14%)
Responses ranged from Strongly disagree (-2) to Strongly agree (+2) N=275					

Figure 3. Perceptions of management.

Q5. To what degree do you agree/disagree with each statement below?



N=275
Median Responses: Personal advocacy=-1; Fishery advocacy=-1; Management communication=0; Agency contact=0; Voicing opinions=+1; Policy changes 6=+1; Scientific research=0

To assess perceived variability of catch rates, respondents were asked to indicate observed patterns in personal catch rates since the year 2011 (Table 10). Respondents from the Dungeness crab (56%) and groundfish (38%) fisheries reported some increases and some decreases, respondents from the charter fishery (33%) reported moderate declines, and salmon fishers (62%) reported large declines in catch rates since 2011. When these data were disaggregated for comparisons across fishery affiliation,[18] the participants in the salmon fishery reported statistically significant larger decreases in catch rates than all other fisheries. Respondents from the charter fishery reported significantly larger decreases than Dungeness crab fishers (Figure 4)[19]. In general, respondents from the salmon fishery reported the largest decreases in catch rates, followed by respondents from the charter fishery.

Table 10. Perceived temporal variability of personal catch rates.

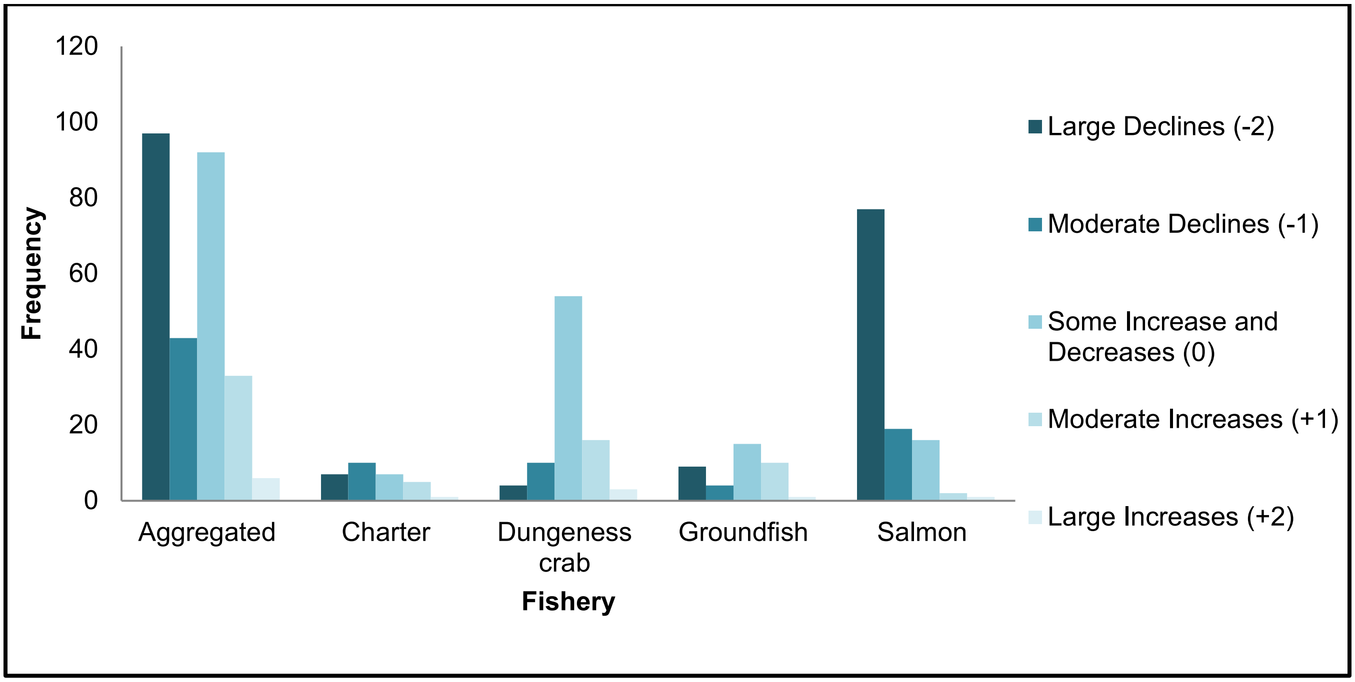
Q6. Since 2011, which best describes the extent to which your catch rates have been generally increasing or decreasing?

Fishery	Large Declines	Moderate Declines	Some Increase and Decreases	Moderate Increases	Large Increases
	N (%)	N (%)	N (%)	N (%)	N (%)
Aggregated	97 (33%)	43 (15%)	92 (32%)	33 (11%)	6 (2%)
Charter	7 (23%)	10 (33%)	7 (23%)	5 (17%)	1 (3%)
Dungeness crab	4 (4%)	10 (10%)	54 (56%)	16 (16%)	3 (3%)
Groundfish	9 (23%)	4 (10%)	15 (38%)	10 (25%)	1 (3%)
Salmon	77 (62%)	19 (15%)	16 (13%)	2 (2%)	1 (1%)
Response options ranged from large decreases (-2), some increases and decreases (0), and large increases (+2) N=291; Charter=30; Dungeness crab=97; Groundfish=40; Salmon=124					

[18] Kruskal-Wallis test used to evaluate differences in median responses between fisheries.
[19] Wilcox pairwise test used to evaluate differences in median responses for catch rate variability.

Figure 4. Perceived temporal variability of personal catch rates.

Q6. Since 2011, which best describes the extent to which your catch rates have been generally increasing or decreasing?



N=291; Charter=30; Dungeness crab=97; Groundfish=40; Salmon=124

Median responses were significantly different between fisheries: χ^2=82.9, p=<2e-16; Median Responses: Aggregated=0; Charter=-1; Dungeness crab=0; Groundfish=0; Salmon=-2

Salmon fisher perceptions significantly lower than: Charter (p=0.001); Dungeness crab (p=<2e-16); Groundfish (p=4.7e-06)

Charter fisher perceptions significantly lower than: Dungeness crab (p=0.00048)

To compare which climatic, economic, and social drivers are perceived to be primarily responsible for variability in catch rates, respondents were asked to select up to three factors from a provided list (Table 11).[20] Regulations and ocean conditions were selected as the top two drivers of personal catch rate variability (20% and 17%, respectively), and weather conditions, catch limits, and operating expenses were selected in equal proportions as the third most significant driver (13%). When data were disaggregated for comparisons across fishery affiliations, there was a statistically significant difference in responses[21]. Charter fishers and salmon fishers both indicated that regulations (30% and 27%, respectively), ocean conditions (19%, 15%), and catch limits (19%, 16%) were the main drivers of catch rates. Dungeness crab fishers indicated that weather conditions, ocean conditions, and market prices were the main drivers of catch rates (19%, 18%, 18%). Groundfish fishers indicated that catch limits, ocean conditions, and operating expenses were the main drivers of catch rates (21%, 20%, 14%)[22]. Selections for drivers of catch rate variability were variable across fishery affiliations, suggesting that different fisheries are subject to a unique suite impacts.

Table 11. Perceived top three drivers of personal catch rates.

Q7. What do you see to be the main factors influencing the trends in your catch rates?

Fishery[1]	**Aggregate[2]**	**Charter[2]**	**Dungeness crab[2]**	**Groundfish[2]**	**Salmon[2]**
Driver of Variability	N (%)	N (%)	N (%)	N (%)	N (%)
Regulations	**156 (20%)**	**22 (30%)**	31 (12%)	13 (13%)	**90 (27%)**
Ocean Conditions	**134 (17%)**	**14 (19%)**	**48 (18%)**	**21 (20%)**	**51 (15%)**
Weather Conditions	103 (13%)	9 (12%)	**50 (19%)**	14 (13%)	30 (9%)
Catch Limits	101 (13%)	**14 (19%)**	10 (4%)	**22 (21%)**	**55 (16%)**
Operating Expenses	102 (13%)	8 (11%)	38 (10%)	**10 (14%)**	46 (14%)
Market Prices	81 (10%)	0 (0%)	**48 (18%)**	11 (11%)	22 (7%)
Catch Per Unit Effort	61 (8%)	3 (4%)	23 (9%)	9 (9%)	26 (8%)
Other	36 (5%)	3 (4%)	14 (5%)	4 (4%)	15 (4%)

N=774; Charter=73; Dungeness crab=262; Groundfish=104; Salmon=335 (respondents could select up to three drivers)
[1] Selections of drivers were fishery specific: χ^2=95.33, p=1.9e-11
[2] Drivers did not receive an equal number of selections: Aggregate χ^2=105.4, p=< 2.2e-16; Charter χ^2=40.9, p=8.6e-07; Dungeness crab χ^2=53.7, p=2.7e-09; Groundfish χ^2=19.7, p=0.006; Salmon χ^2=97.9, p=<2.2e-16

[20] To avoid a leading question design, respondents were also given an "Other" response option so they could suggest additional important factors.
[21] Pearson's chi-squared test used to evaluate if selections of drivers of catch rate variability were independent of fishery affiliation.
[22] Pearson's chi-squared test used to evaluate if drivers of catch rate variability received an equal number of selections.

To evaluate perceived variability in fishery related profits, respondents were asked to indicate any observed patterns in personal profits since the year 2011. Respondents from the Dungeness crab (64%) and groundfish (43%) fisheries reported some increases and some decreases, respondents from the charter fishery (40%) and salmon fishers (55%) reported large declines in personal profits since 2011 (Table 12). When these data were disaggregated for comparisons across fishery affiliation[23], respondents for both the salmon and charter fisheries reported statistically significant larger decreases in personal profits than Dungeness crab and groundfish fishers (Figure 5).[24] Similar to their responses concerning catch rate variability, fishers in the salmon and charter fisheries also reported significantly larger decreases in fishery related profits.

Table 12. Perceived temporal variability of personal profits.

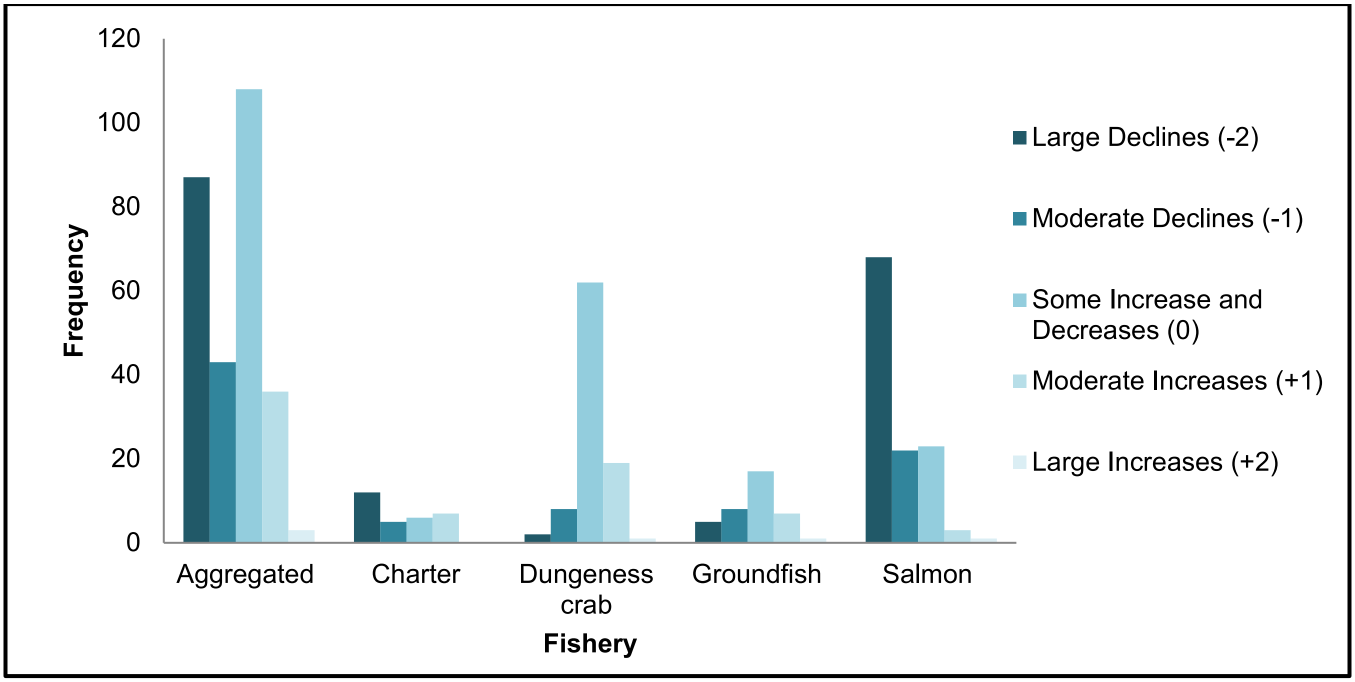
Q8. Since 2011, which best describes the extent to which your personal fishery related profits have been generally increasing or decreasing?

Fishery	Large Declines	Moderate Declines	Some Increase and Decreases	Moderate Increases	Large Increases
	N (%)	N (%)	N (%)	N (%)	N (%)
Aggregated	87 (30%)	43 (15%)	108 (37%)	36 (12%)	3 (1%)
Charter	12 (40%)	5 (17%)	6 (20%)	7 (23%)	0 (0%)
Dungeness crab	2 (2%)	8 (8%)	62 (64%)	19 (20%)	1 (1%)
Groundfish	5 (13%)	8 (20%)	17 (43%)	7 (18%)	1 (3%)
Salmon	68 (55%)	22 (18%)	23 (19%)	3 (2%)	1 (1%)
Response options ranged from large decreases (-2), some increases and decreases (0), and large increases (+2) N=291; Charter=30; Dungeness crab=97; Groundfish=40; Salmon=124					

[23] Kruskal-Wallis test used to evaluate differences in median responses for fishery related profit variability between fisheries.
[24] Wilcox pairwise test used to evaluate differences in median responses for fishery related profit variability.

Figure 5. Perceived temporal variability of personal profits.

Q8. Since 2011, which best describes the extent to which your personal fishery related profits have been generally increasing or decreasing?



N=291; Charter=30; Dungeness crab=97; Groundfish=40; Salmon=124

Median responses were significantly different between fisheries: χ^2=78.3, p=<2e-16; Median Responses: Aggregated=0; Charter=-1; Dungeness crab=0; Groundfish=0; Salmon=-2

Salmon fisher perceptions significantly lower than: Dungeness crab (p=<2e-16); Groundfish (p=3.1e-06)

Charter fishery perceptions significantly lower than: Dungeness crab (p=0.00043)

In order to assess which climatic, economic, and social drivers are perceived to be primarily responsible for variability in fishery related profits, respondents were asked to select up to three factors from a provided list (Table 13).[25] When aggregated, regulations, operating expenses, and ocean conditions were identified as the largest drivers of profit (17%, 17%, 16%; respectively). When data were disaggregated for comparisons of selections across fisheries, there was a statistically significant difference in responses.[26] Profits in the charter fishery appeared to be driven by regulations, ocean conditions, and weather conditions/catch limits (32%, 17%, 15%). Market prices, operating expenses, and ocean conditions were selected as the main drivers of profit in the Dungeness crab fishery (22%, 19%, 17%). Groundfish fishers indicated that catch limits, operating expenses, and ocean conditions/market prices were the main drivers of profit (22%, 18%, 18%). While, catch limits and operating expenses were still important, regulations appeared to be the largest drivers of profits within the salmon fishery (15%, 18%, 22%).[27] Selections for drivers of personal profit variability were variable across fishery affiliations, suggesting that different fisheries are subject to a unique suite impacts.

Table 13. Perceived top three drivers of your fishery related profits.

Q9. What do you see to be the main factors influencing the trends of your fishery related profits?

Fishery[1]	**Aggregate[2]**	**Charter[2]**	**Dungeness crab[2]**	**Groundfish[2]**	**Salmon[2]**
Driver of Variability	N (%)	N (%)	N (%)	N (%)	N (%)
Regulations	**115 (17%)**	**21 (32%)**	23 (10%)	11 (12%)	**60 (22%)**
Ocean Conditions	**104 (16%)**	**39 (17%)**	**39 (17%)**	**15 (16%)**	39 (14%)
Weather Conditions	84 (13%)	**10 (15%)**	37 (16%)	11 (12%)	26 (10%)
Catch Limits	75 (11%)	**10 (15%)**	3 (1%)	**21 (22%)**	**41 (15%)**
Operating Expenses	**111 (17%)**	7 (11%)	**43 (19%)**	**13 (18%)**	**48 (18%)**
Market Prices	92 (14%)	0 (0%)	**51 (22%)**	**15 (16%)**	26 (10%)
Catch Per Unit Effort	55 (8%)	4 (6%)	22 (10%)	6 (6%)	23 (8%)
Other	28 (4%)	2 (3%)	13 (6%)	3 (3%)	10 (4%)

N=664; Charter=65; Dungeness crab=231; Groundfish=95; Salmon=273 (respondents could select up to three drivers)
[1] Selections of drivers were fishery specific: χ^2=90.5, p=1.34e-10
[2] Drivers did not receive an equal number of selections: Aggregate χ^2=74.8, p=1.61e-13; Charter χ^2=37.3, p=4.2e-06; Dungeness crab χ^2=64.5, p=1.9e-11; Groundfish χ^2=18.4, p=0.01; Salmon χ^2=51.9, p=6.1e-09

[25] To avoid a leading question design, respondents were also given an "Other" response option so they could suggest additional important factors.
[26] Pearson's chi-squared test used to evaluate if selections for drivers of profits were independent of fishery affiliation.
[27] Pearson's chi-squared test used to evaluate if all drivers of profits received an equal number of selections.

Fishing effort is another variable used to evaluate fishery dynamics. In order to assess which climatic, economic, and social drivers are perceived to be primarily responsible for variability in fishing effort, respondents were asked to select up to three factors from a provided list.[28] When aggregated, weather conditions, regulations, and ocean conditions, were selected as the top three drivers of fishing effort among fishers (18%, 17%, 17%; Table 14). When data were disaggregated for comparisons across fisheries, there was a statistically significant difference in response patterns[29]. Respondents from the charter fishery indicated that the previously mentioned drivers were selected as the top three drivers of effort (26%, 23%, 19%). Weather conditions, market prices, and ocean conditions were the top drivers of effort within the Dungeness crab fishery (21%, 20%, 17%). Groundfish fishers indicated that catch limits, ocean conditions, and weather conditions primarily drove their effort (22%, 17%, 14%). Regulations, ocean conditions, and operating expenses were the largest drivers of effort among salmon fishers[30] (24%, 17%, 16%; Table 14). Similar to the trends observed within personal catch rates and profits, selections for drivers of fishing effort were variable across fishery affiliations, further suggesting that different fisheries are subject to a unique suite impacts.

Table 14. Perceived top three drivers of personal fishing effort.

Q10. Since 2011, what are the main factors that explain the variability in your fishing effort? Select up to three factors.

Fishery[1]	**Aggregate[2]**	**Charter[2]**	**Dungeness crab[2]**	**Groundfish[2]**	**Salmon[2]**
Driver Variability	N (%)	N (%)	N (%)	N (%)	N (%)
Regulations	103 (17%)	13 (23%)	23 (10%)	10 (11%)	57 (24%)
Ocean Conditions	105 (17%)	11 (19%)	38 (17%)	15 (17%)	41 (17%)
Weather Conditions	107 (18%)	15 (26%)	46 (21%)	13 (14%)	33 (14%)
Catch Limits	59 (10%)	7 (12%)	5 (2%)	20 (22%)	27 (11%)
Operating Expenses	88 (15%)	3 (5%)	36 (16%)	11 (12%)	38 (16%)
Market Prices	69 (11%)	0 (0%)	44 (20%)	10 (11%)	15 (6%)
Catch Per Unit Effort	50 (8%)	4 (7%)	19 (9%)	7 (8%)	20 (8%)
Other	24 (4%)	4 (7%)	9 (4%)	4 (4%)	7 (3%)

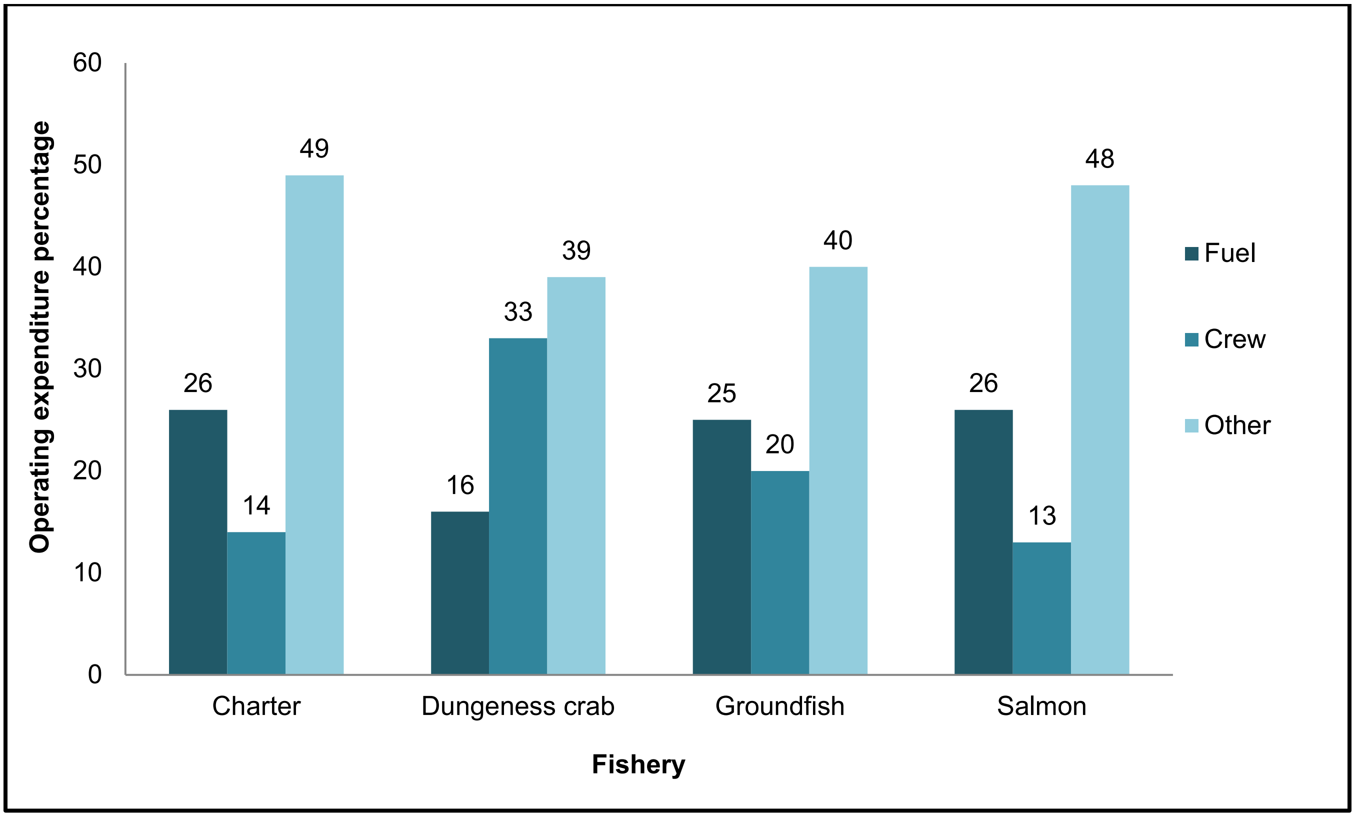
N=664; Charter=65; Dungeness crab=231; Groundfish=95; Salmon=273 (respondents could select up to three drivers)
[1] Selections of drivers were fishery specific: χ^2=82.5, p=3.1e-09
[2] Drivers did not receive an equal number of selections: Aggregate χ^2=84.5, p=1.6e-15; Charter χ^2=27.9, p=2.0e-04; Dungeness crab χ^2=63.2, p=3.5e-11; Groundfish χ^2=14.9, p=0.04; Salmon χ^2=60, p=1.5e-10

[28] To avoid a leading question design, respondents were also given an “Other” response option so they could suggest additional important factors.
[29] Pearson’s chi-squared test used to evaluate if selections for drivers of effort were independent of fishery affiliation.
[30] Pearson’s chi-squared test used to evaluate if all drivers of effort received an equal number of selections.

Operating expenditure profiles were created to evaluate how different fisheries allocate operating costs (Figure 6). Respondents were asked to provide information regarding the percentage of operating expenditures allocated to fuel, crew, and other expenses for the years 2011, 2014, and 2017. In aggregate, fuel expenditures accounted for 23%, crew expenditures accounted for 20%, and other expenditures accounted for 44% of total operating expenditures. Analyses revealed that operating expenditures did not vary by sampling years. However, there were significant differences in operating expenditure allocation between fisheries.[31] Fishers from the Dungeness crab fishery reported significantly lower costs associated with fuel expenditures (16%) and reported significantly higher costs associated with crew expenditures (33%) than all other fisheries. Fishers from the groundfish fishery report significantly higher costs associated with crew expenditures (20%) when compared the salmon fishers (13%).

Figure 6. Average operating expenditure percentages, disaggregated by fishery affiliation.

Q11. Please explain how the percentage of each cost has contributed to your total operating expenses in the years 2011, 2014, and 2017.



N=158; Charter=19; Dungeness crab=60; Groundfish=22; Salmon=57

Fuel costs are significantly different between fisheries (F=3.64, p=0.0014)

Dungeness crab expenditures significantly higher than: Charter p=0.007; Groundfish p=0.01; Salmon p=<2e-16

Crew costs are significantly different between fisheries (F=22.6, p=6.8e-12)

Dungeness crab expenditures significantly higher than: Charter p=1.3e-12; Groundfish p=3.1e-07; Salmon p=<2e-16

Groundfish expenditures significantly higher than: Salmon p=2.1e-05

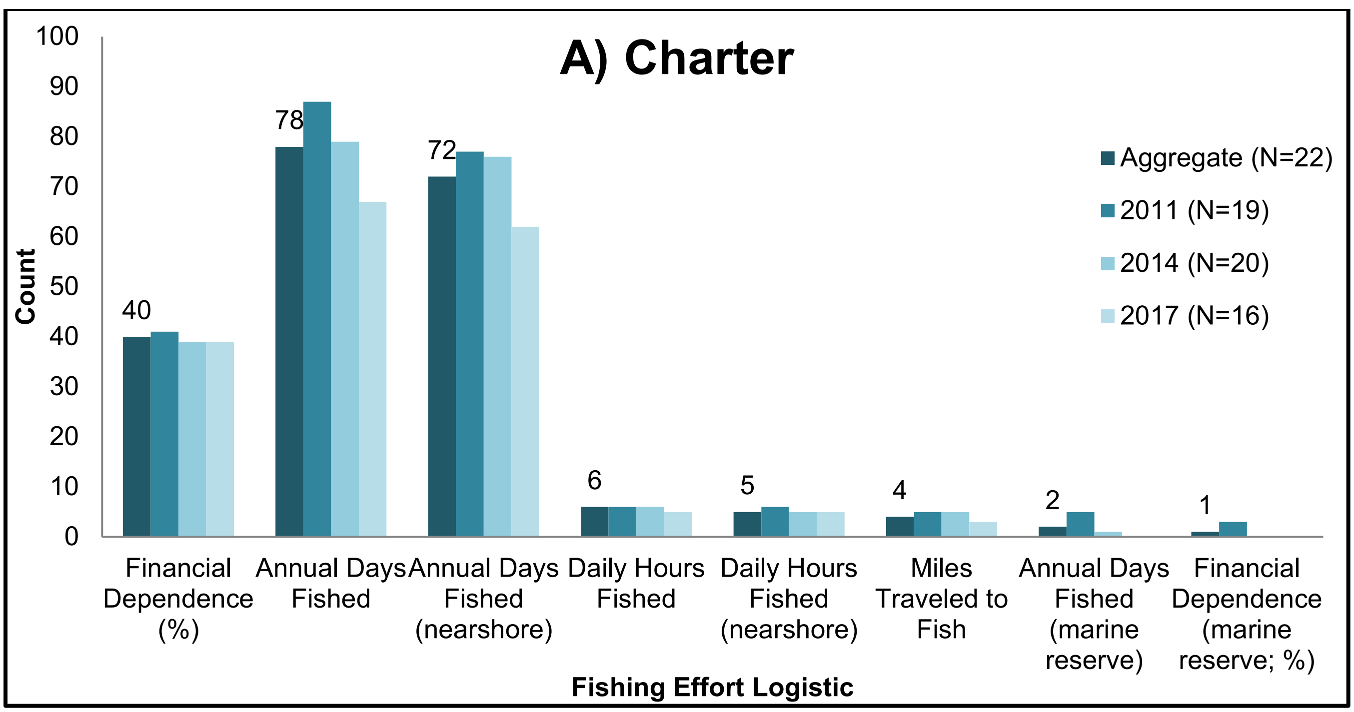
[31] Repeated Measures Analysis of Variance (ANOVA) and Holms pairwise comparisons test used to evaluate if differences in operating expenditures existed between fisheries and sampling years.

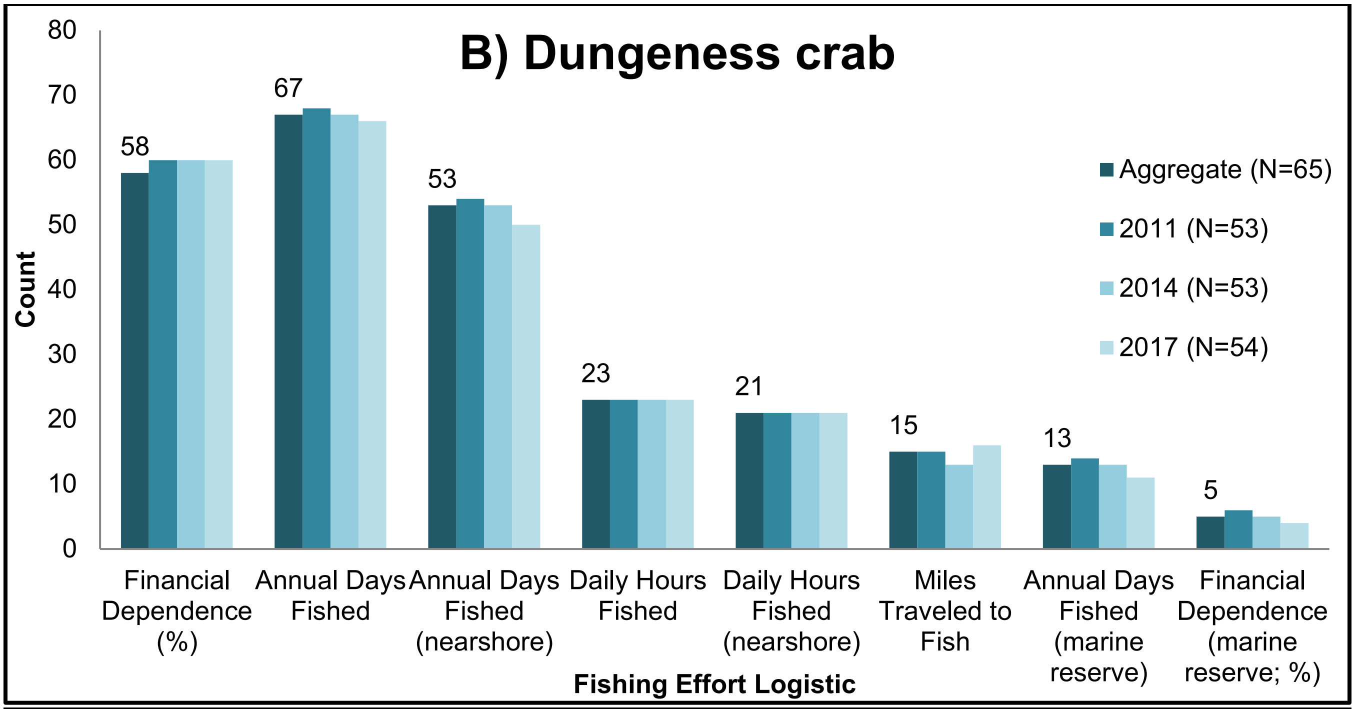
In order to evaluate differences in fishing behavior between fisheries over time, respondents were asked to provide estimate values for a range of fishing measures for the years 2011, 2014, and 2017. Charter fishers fished the most days annually (78 days; Figure 7A). Dungeness crab fishers displayed the highest financial dependence up on that fishery (60%), fished the most hours per day (23 hours), and previously fished the most days in areas that are now marine reserves (15 days; Figure 7B). Fishers in the groundfish fishery fished fewer days per year (45 days; Figure 7C) compared to other fisheries. Salmon fishers spent the largest percentage of time fishing offshore (63% outside three miles; Figure 7D), while participants in other fisheries spent a majority days fishing nearshore (inside three miles).

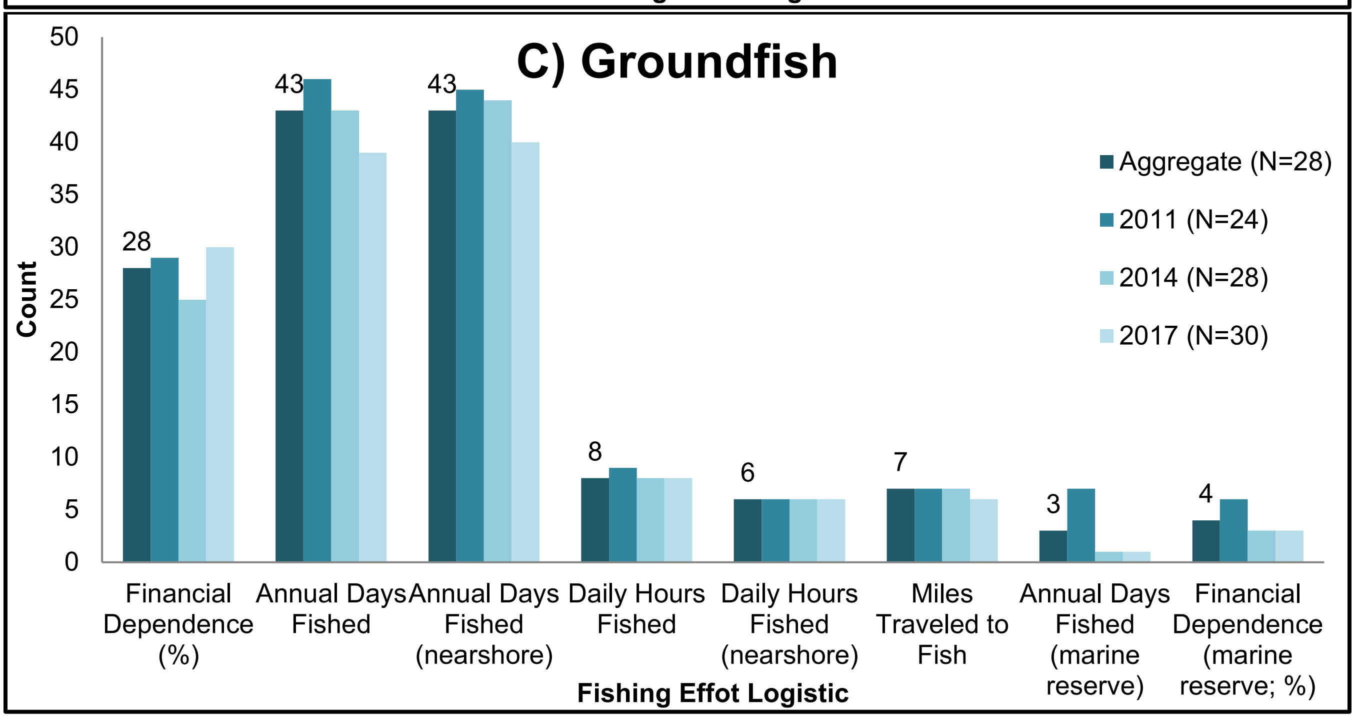
Subsequent bivariate analyses (Figure 14; Table 24-29) were performed to further analyze the observed differences in fishing behaviors between fisheries. With the exception of annual days, annual hours, and annual nearshore hours fished in the salmon fishery (Figure 15), there were not significant differences in effort logistics between the years 2011, 2014, and 2017.

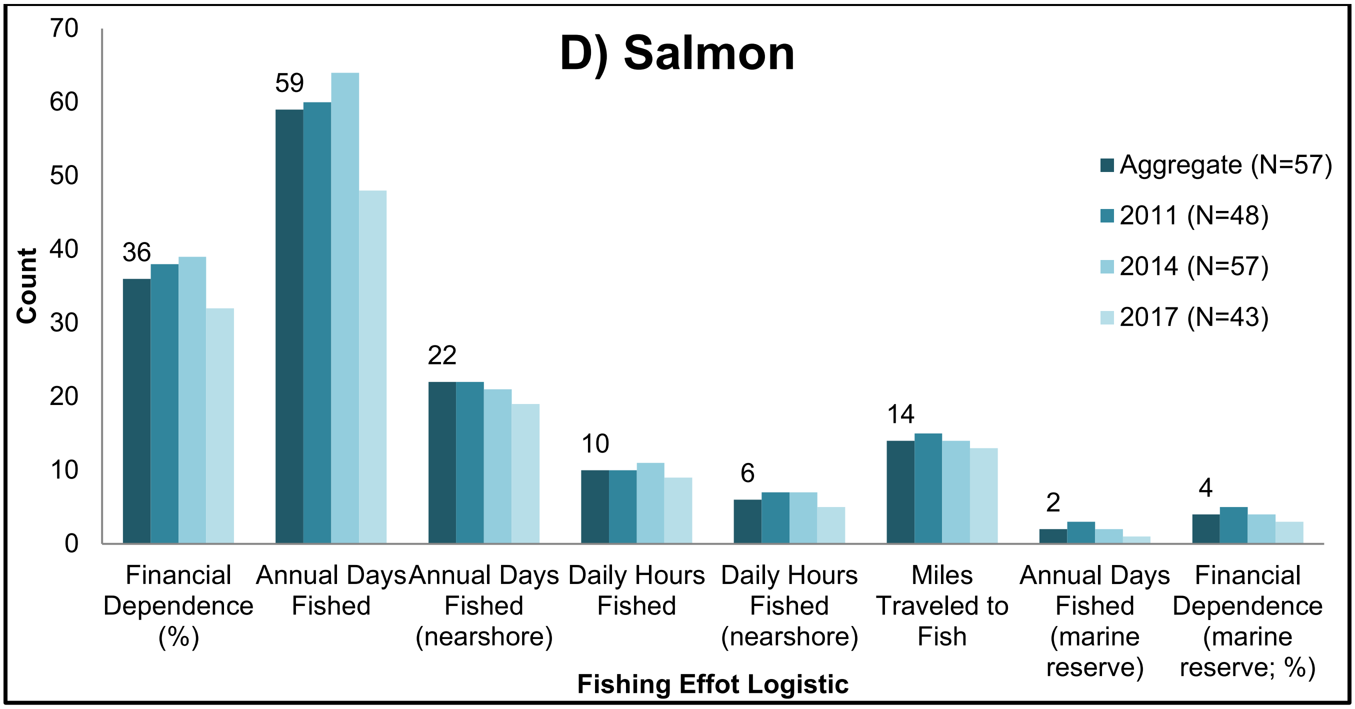
Figure 7. Fishing effort logistics for charter fishery.

Q12. To the best of your memory, please describe your fishing effort for each fishery in which you participate over the last seven years (2011-2017).




B) Dungeness crab
Count
Aggregate (N=65)
2011 (N=53)
2014 (N=53)
2017 (N=54)
58
67
53
23
21
15
13
5
Financial Dependence (%)
Annual Days Fished
Annual Days Fished (nearshore)
Daily Hours Fished
Daily Hours Fished (nearshore)
Miles Traveled to Fish
Annual Days Fished (marine reserve)
Financial Dependence (marine reserve; %)
Fishing Effort Logistic


C) Groundfish
Count
Aggregate (N=28)
2011 (N=24)
2014 (N=28)
2017 (N=30)
28
43
43
8
6
7
3
4
Financial Dependence (%)
Annual Days Fished
Annual Days Fished (nearshore)
Daily Hours Fished
Daily Hours Fished (nearshore)
Miles Traveled to Fish
Annual Days Fished (marine reserve)
Financial Dependence (marine reserve; %)
Fishing Effot Logistic



To evaluate the perceived impacts of marine reserve implementation, respondents were asked to indicate the degree of impact that marine reserve implementation has had on their ability to participate in their respective fishery. When prompted to indicate whether or not marine reserves have had any impact, positive or negative, on fishery participation, the general consensus among a substantial majority of respondents (65%) was that marine reserve implementation has not had a clear impact (Table 15). A total of 33% of respondents cited some degree of perceived negative impacts, and only 3% of respondents felt that there had been positive impacts due to marine reserve implementation. When these data were disaggregated for comparisons across fishery affiliation, there were no differences in perceived impacts (Table 16).[32] In general, marine reserve implementation has not had any clear perceived impacts on fishery participation.

[32] Kruskal-Wallis test used to evaluate for differences in median responses between fisheries.

Table 15. Degree of perceived impacts due to marine reserve implementation.

Q13. Which best describes the type of impact that the establishment of no-take marine reserves has had on your ability to partake in at least one Oregon fishery in which you participate?

Fishery	Largely Negative	Moderately Negative	No Clear Impact	Moderately Positive	Largely Positive
	N (%)	N (%)	N (%)	N (%)	N (%)
Aggregated	24 (14%)	32 (19%)	106 (63%)	4 (2%)	1 (1%)
Charter	6 (30%)	3 (15%)	11 (55%)	0 (0%)	0 (0%)
Dungeness crab	10 (13%)	25 (32%)	38 (49%)	4 (5%)	1 (1%)
Groundfish	9 (26%)	10 (29%)	13 (37%)	2 (6%)	1 (3%)
Salmon	16 (15%)	19 (18%)	61 (58%)	1 (1%)	9 (8%)

Responses ranged from Largely Negative (-2) to No Clear Impact (0) to Largely Positive (+2)
N=239; Charter=20; Dungeness crab=78; Groundfish=35; Salmon=106
Median Responses: Aggregated=0; Charter=0; Dungeness crab=0; Groundfish=0; Salmon=0

When fishers were asked identify the three primary types of impacts they have experienced due to marine reserve implementation, the overwhelming response (61%) was that there were no impacts due to reserve implementation (Table 16).[33] When data were disaggregated to compare across fisheries, there were no statistically significant differences in responses.[34] In general, respondents across all of the sampled fisheries indicated that reserves have not had a clear impact on their ability to participate in the fishing industry.

Table 16. Top perceived impacts of marine reserve implementation.

Q14. How has marine reserve establishment impacted your ability to partake in any of the Oregon fisheries in which you participate? Select up to three impacts.

Fishery[1]	Aggregate	Charter	Dungeness crab	Groundfish	Salmon
Perceived Impact	N (%)	N (%)	N (%)	N (%)	N (%)
Displacement of Fishing	69 (14%)	4 (10%)	28 (18%)	9 (14%)	28 (12%)
Increased Spatial Competition	62 (13%)	2 (5%)	26 (17%)	8 (12%)	26 (12%)
Increased Distances Traveled to Fish	59 (12%)	3 (7%)	21 (14%)	8 (12%)	27 (12%)
No Impacts	297 (61%)	33 (79%)	80 (52%)	40 (62%)	144 (64%)

N=487; Charter=42; Dungeness crab=155; Groundfish=65; Salmon=225
Drivers did not receive an equal number of selections: Aggregate χ^2=336.8, p=< 2.2e-16; Charter χ^2=64.5, p=6.5e-14; Dungeness crab χ^2=59.2, p=8.6e-13; Groundfish χ^2=182, p=< 2.2e-16; Salmon χ^2=46.3, p=4.8e-10

In order to evaluate which specific marine reserves have had the greatest impact on fishery operations, fishers were asked to indicate which marine reserve (if any), had the greatest and second greatest impact on their personal fishing operation. When aggregated, a plurality (42%) of respondents

[33] Pearson's chi-squared test used to evaluate if all impacts received an equal number of selections.
[34] Pearson's chi-squared test used to evaluate if selections for impacts were independent of fishery affiliation.

indicated that none of the designated marine reserves have had an impact on fishing operations (Table 17).[35]

Table 17. Highest degree of perceived impact among marine reserves.

Q15. Identify which marine reserve (if any) has had the greatest impact on your fishing operations? Select the first and second most impactful marine reserve.

Marine Reserve	N (%)
Cape Falcon	41 (22%)
Cascade Head	18 (10%)
Otter Rock	4 (2%)
Cape Perpetua	22 (12%)
Redfish Rocks	21 (11%)
All Reserves	2 (1%)
No Reserves	78 (42%)
N=186 All marine reserve options did not receive an equal number of selections: χ^2=153.99; p=<2.2e-16	

When data were disaggregated to compare across fisheries, there were significantly different responses between fisheries.[36] In each fishery, a plurality of respondents still most frequently indicated that none of the designated reserves have had an impact on fishing operations. Thereafter, the second most frequently cited source of impact was typically fishery specific, with charter fishers selecting Cascade Head Reserve, Dungeness crab and salmon fishers selecting Cape Falcon Reserve, and groundfish fishers selecting Redfish Rocks Reserve (Table 18). Selections for the marine reserve that has created the greatest impact on fishing operations were typically representative of the specific type of habitat utilized by the target species of each fishery (e.g., sandy bottom=Dungeness crab, rocky bottom=groundfish).

Table 18. Highest degree of perceived impact among marine reserves, by fishery.

Marine Reserve	Charter	Dungeness crab	Groundfish	Salmon
	N (%)	N (%)	N (%)	N (%)
Cape Falcon	3 (13%)	19 (30%)	4 (12%)	15 (23%)
Cascade Head	7 (29%)	4 (6%)	3 (9%)	4 (6%)
Otter Rock	0 (0%)	2 (3%)	1 (3%)	1 (2%)
Cape Perpetua	3 (13%)	8 (13%)	2 (6%)	9 (14%)
Redfish Rocks	2 (8%)	7 (11%)	10 (30%)	2 (3%)
All Reserves	0 (0%)	1 (2%)	0 (0%)	1 (2%)
No Reserves	9 (38%)	22 (35%)	13 (39%)	34 (52%)
Charter (N=24); Dungeness crab (N=63); Groundfish (N=33); Salmon (N=66) Selection for marine reserve was fishery specific: χ^2=35.61; p=0.008				

[35] Pearson's chi-squared test used to evaluate if all marine reserve options received an equal number of selections.
[36] Pearson's chi-squared test was used to evaluate if selections of the marine reserve with the greatest impact on fishing operations were independent of fishery affiliation.

Responses were disaggregated to compare perceived marine reserve impacts across port groups, and responses were significantly different.[37] Respondents from Clatsop and Tillamook counties indicated that Cape Falcon Reserve (64%) had the greatest impact on fishing operations; respondents from Lincoln County reported that Cape Perpetua Reserve (32%) and Cascade Head (30%) had the greatest impact on fishing operations; respondents from Curry County (69%) felt that Redfish Rocks Reserve had created the greatest impact (Table 19). A larger proportion of respondents from the Coos and Brookings port groups indicated that none of the designated marine reserves have had an impact on fishing operations, likely because there are no marine reserves located in the general proximity of either of those groups. Selections for the marine reserve that was perceived to have the greatest impact on fishing operations were typically representative of a port group's proximity to each marine reserve.

Table 19. Highest degree of perceived impact among marine reserves, by port group.

Marine Reserve	Clatsop	Tillamook	Lincoln	Coos	Curry	Brookings
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Cape Falcon	21 (64%)	16 (43%)	0 (0%)	4 (14%)	0 (0%)	0 (0%)
Cascade Head	0 (0%)	3 (8%)	15 (30%)	0 (0%)	0 (0%)	0 (0%)
Otter Rock	0 (0%)	0 (0%)	4 (8%)	0 (0%)	0 (0%)	0 (0%)
Cape Perpetua	1 (3%)	0 (0%)	16 (32%)	5 (17%)	0 (0%)	0 (0%)
Redfish Rocks	0 (0%)	0 (0%)	0 (0%)	0 (0%)	18 (69%)	3 (27%)
All Reserves	0 (0%)	0 (0%)	0 (0%)	2 (7%)	0 (0%)	0 (0%)
No Reserves	11 (33%)	18 (49%)	15 (30%)	18 (62%)	8 (31%)	8 (73%)
Clatsop (N=33); Tillamook (N=37); Lincoln (N=50); Coos (N=29); Curry (N=26); Brookings (N=11) Selection for marine reserve was port group specific: χ^2=240.43; p=<2.2e-16						

[37] Pearson's chi-squared test was used to evaluate if selections of the marine reserve with the greatest impact on fishing operations were independent of port group.

In evaluating which reserves have had the second greatest impact on fishing operations, a large majority (74%) of respondents indicated that none of the designated reserves have had an impact on fishing operations (Table 20).[38] When disaggregated for comparisons across fisheries and port groups, a majority of respondents in each fishery indicated that none of the designated reserves have impacted fishing operations. Nevertheless, there were significant but modest differences in responses by fishery and port[39] (Table 21 and Table 22). Selections of the marine reserve that has had the second impact on fishing operations were typically representative of a fisheries target species' habitat and a port group's proximity to each marine reserve.

Table 20. Second highest degree of perceived impact among marine reserves.

Marine Reserve	N (%)
Cape Falcon	5 (3%)
Cascade Head	18 (10%)
Otter Rock	12 (6%)
Cape Perpetua	8 (4%)
Redfish Rocks	3 (2%)
All Reserves	2 (1%)
No Reserves	138 (74%)

N=186
All marine reserve options did not receive an equal number of selections: χ^2=572.78; p=<2.2e-16

Table 21. Second highest degree of perceived impact among marine reserves, by fishery.

Marine Reserve	Charter	Dungeness crab	Groundfish	Salmon
	N (%)	N (%)	N (%)	N (%)
Cape Falcon	0 (%)	1 (2%)	1 (3%)	3 (5%)
Cascade Head	0 (%)	9 (14%)	1 (3%)	8 (12%)
Otter Rock	9 (38%)	1 (2%)	1 (3%)	1 (2%)
Cape Perpetua	1 (4%)	3 (5%)	1 (3%)	3 (5%)
Redfish Rocks	0 (%)	2 (3%)	1 (3%)	0 (%)
All Reserves	0 (%)	1 (2%)	0 (%)	1 (2%)
No Reserves	14 (58%)	47 (73%)	29 (85%	50 (76%)

Charter (N=24); Dungeness crab (N=64); Groundfish (N=34); Salmon (N=66)
Selection for marine reserve was fishery specific: χ^2=53.29; p=2.36e-05

[38] Pearson's chi-squared test used to evaluate if all marine reserve options received an equal number of selections
[39] Pearson's chi-squared test used to evaluate if selections for of the marine reserve with the second greatest impact on fishing operations were independent of fishery and port group

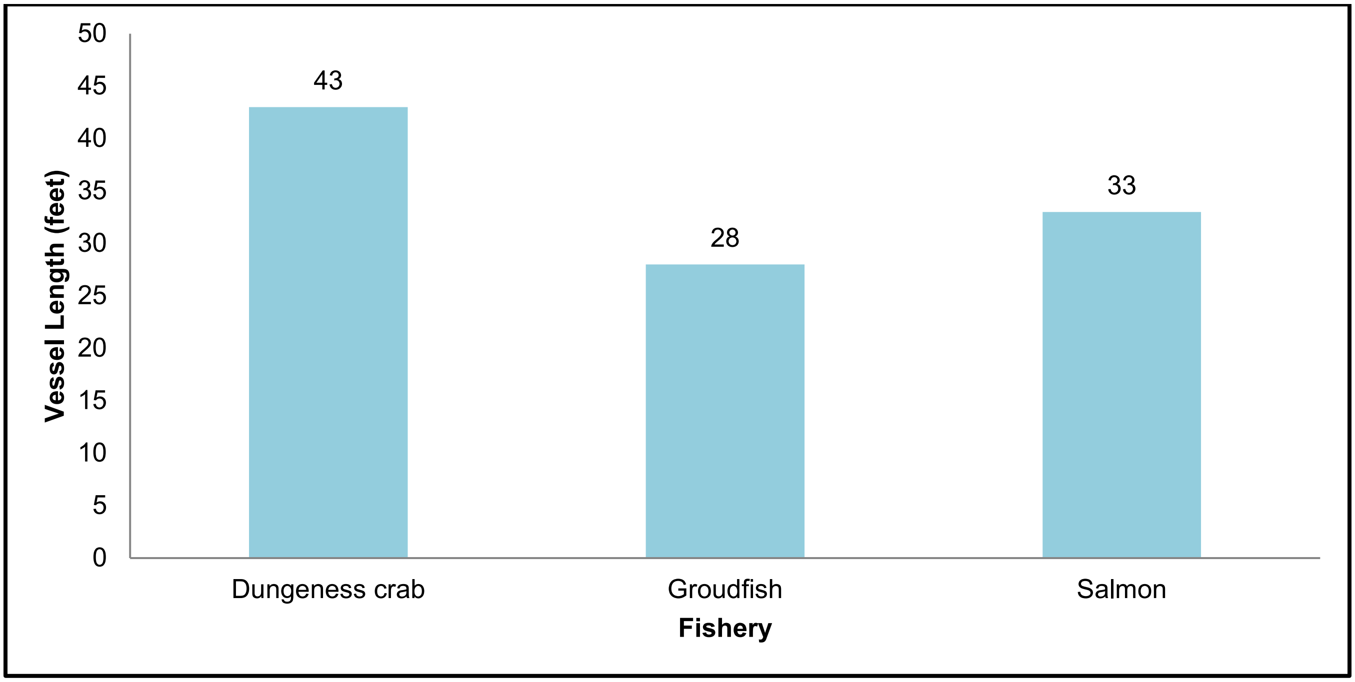
Table 22. Second highest degree of perceived impact among marine reserves, by port group.

Marine Reserve	Clatsop	Tillamook	Lincoln	Coos	Curry	Brookings
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Cape Falcon	0 (0%)	0 (0%)	3 (6%)	0 (0%)	0 (0%)	2 (15%)
Cascade Head	6 (18%)	6 (16%)	3 (6%)	3 (10%)	0 (0%)	0 (0%)
Otter Rock	0 (0%)	0 (0%)	12 (24%)	0 (0%)	0 (0%)	0 (0%)
Cape Perpetua	0 (0%)	0 (0%)	5 (10%)	0 (0%)	2 (8%)	1 (8%)
Redfish Rocks	0 (0%)	0 (0%)	0 (0%)	1 (3%)	0 (0%)	2 (15%)
All Reserves	0 (0%)	0 (0%)	0 (0%)	2 (7%)	0 (0%)	0 (0%)
No Reserves	27 (82%)	31 (84%)	27 (54%)	23 (79%)	24 (92%)	8 (62%)
Clatsop (N=33); Tillamook (N=37); Lincoln (N=50); Coos (N=29); Curry (N=26); Brookings (N=13) Selection for marine reserve was port group specific: χ^2=84.44; p=2.25e-07						

Respondents' vessels records were used in the separate representativeness report. These data were anonymously compiled with survey responses (by identification number). Analyses revealed that fishing vessels were the largest among Dungeness crab fishers (43 feet) and smallest among groundfish fishers (28 feet; Figure 8). For each fishery and port group, the median number of vessels owned was one. The Clatsop and Lincoln County port groups had the largest average vessels (44 feet and 42 feet), while Tillamook and Curry County vessels were the smallest[40] (24 feet and 27 feet; Figure 9).

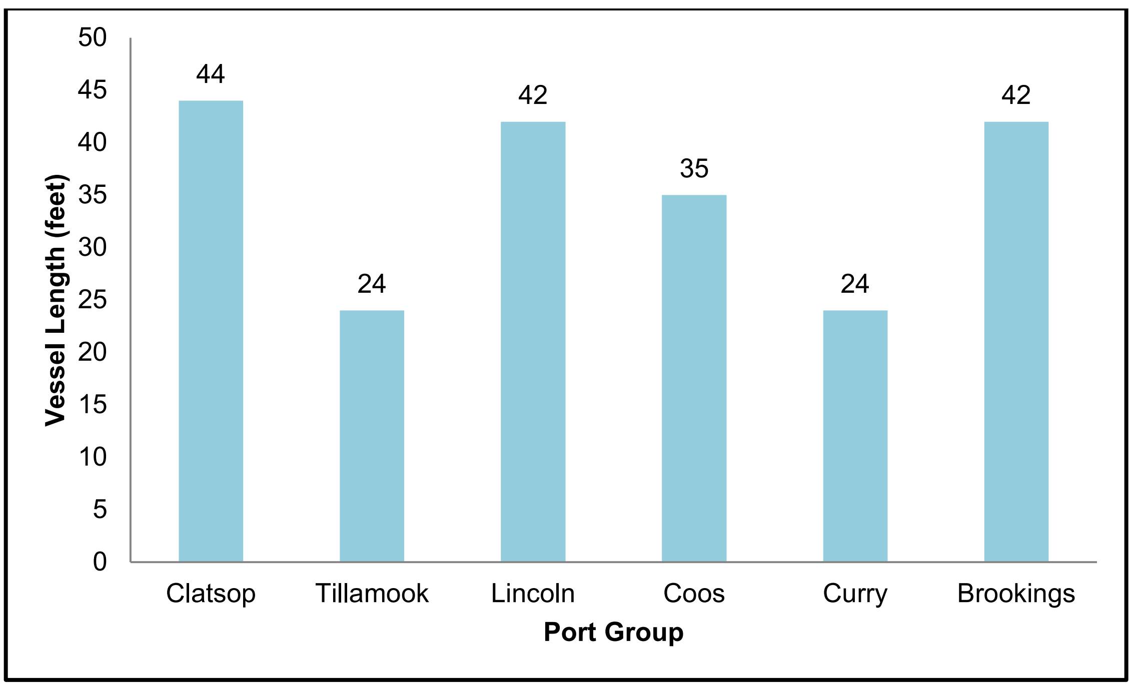
[40] ANOVA and Pairwise Tukey's test used to evaluate for differences in vessel length between fisheries and port groups.

Figure 8. Average vessel length, by fishery affiliation.



Dungeness crab=73; Groundfish=32; Salmon=84
Dungeness crab vessels were significantly larger than groundfish (p=1.0e-07) and salmon (p=2.3e-05)

Figure 9. Average vessel length, by port group.

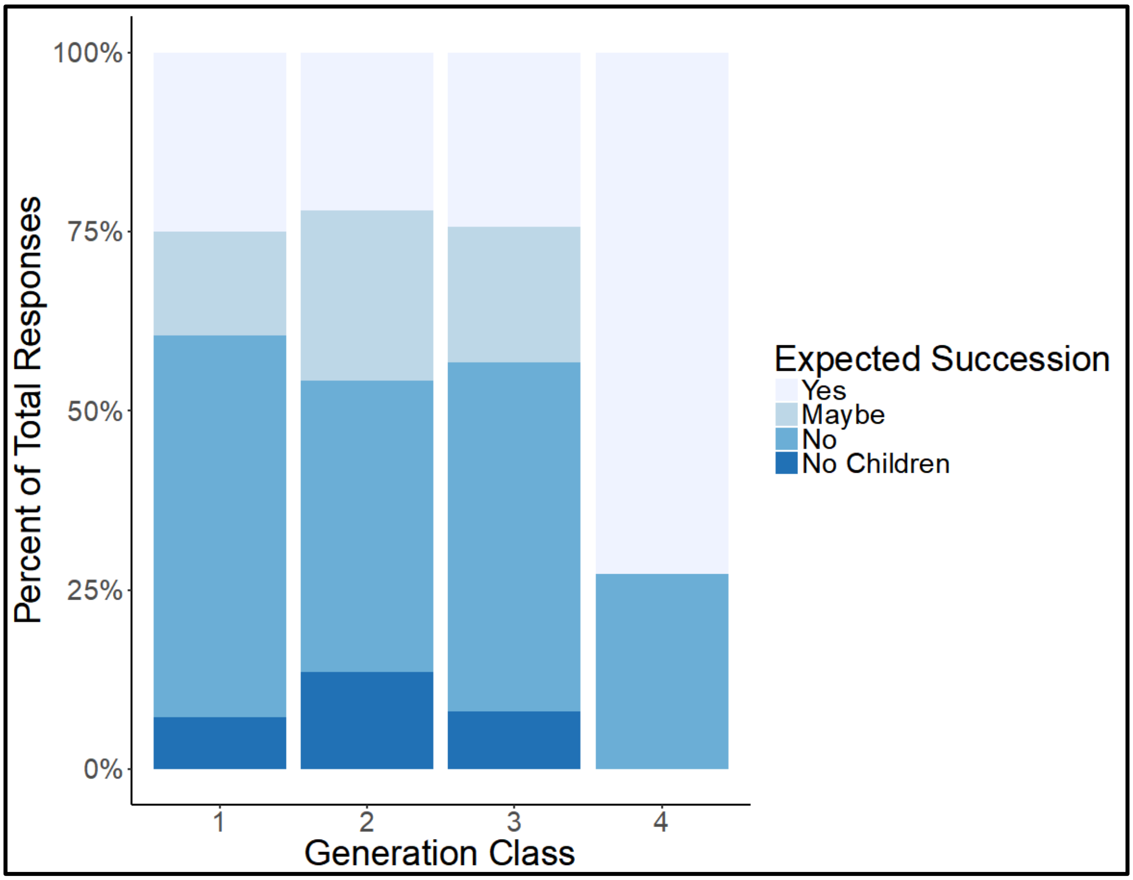


Clatsop=44; Tillamook=24; Lincoln=42; Coos=35; Curry=24; Brookings=42
Clatsop County vessels significantly larger than: Tillamook (p=1.0e-07), Coos (p=0.03) and Curry (p=2.0e-6) counties
Tillamook County vessels significantly smaller than: Lincoln (p=2.0e-07), Coos (p=0.013), and Brookings (p=0.025) groups
Lincoln County vessels significantly larger than Curry County (p=1.2e-05)

Bivariate Analyses

A series of analyses were performed to compare the relationship between a fisher's generational class and their expectations of familial succession . There were statistically significant differences in family successional expectations between generations of fishers.[41] First, second, and third generation fishers generally did not expect their children to continue in the family fishing operation, but this response pattern did not persist among fourth-or-greater generation fishers (Figure 10). In general, most respondents' did not expect their children to continue in the family fishing operation, but expectations of succession were much higher among fourth-or-greater generation fishers.

Figure 10. Anticipated familial succession in fishing by generational involvement in fishing.



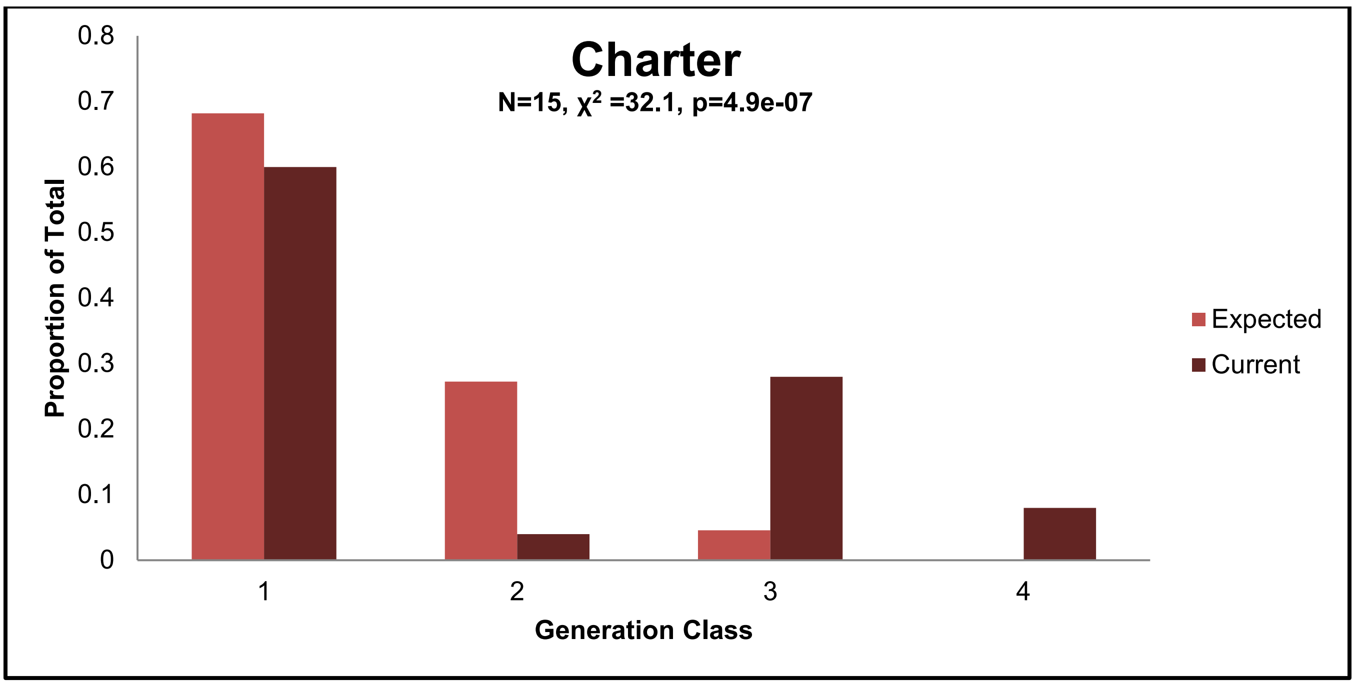
N=249, χ^2=18.75, p=0.027

[41] Pearson's chi-squared test was used to evaluate whether expectations of familial succession are related to fisher generational standing.

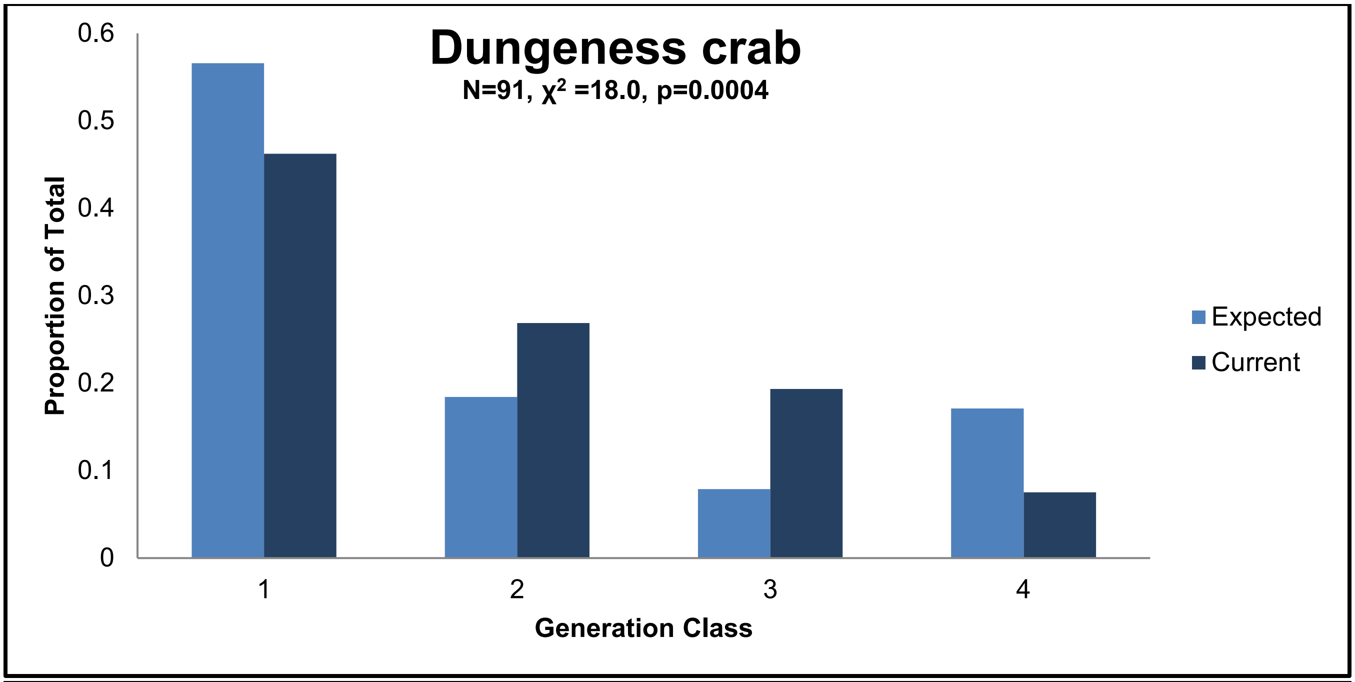
Further analyses were performed to determine if the next generational profile of fishers would reflect the generational profiles of current fishers.[42] To facilitate this analysis, expectations of familial succession were used to project expected generational profiles. Current generation class proportions were based on the reported current generational standing among the entire sample (Q3). Expected generation class proportions were based on fisher expectations for involvement of their offspring within the family fishing business (Q4) in the future. For example, a current first-generation fisher (Q3) that expected his/her offspring to continue in the family fishing business (Q4) would indicate an expected second-generation fisher within that family.

When data were disaggregated for comparisons across fisheries, current and expected generational proportions were significantly different for respondents in the Dungeness crab, salmon, and charter fisheries (Figure 11). Based on respondent expectations, in the Dungeness crab and salmon fisheries the fourth-or-greater generation proportion is expected to grow in the future, while the second and third-generation proportions are expected to shrink. In the charter fishery, the second-generation proportion is expected to grow and the third-generation proportion is expected to shrink. There are no related trends for respondents in the groundfish fishery.

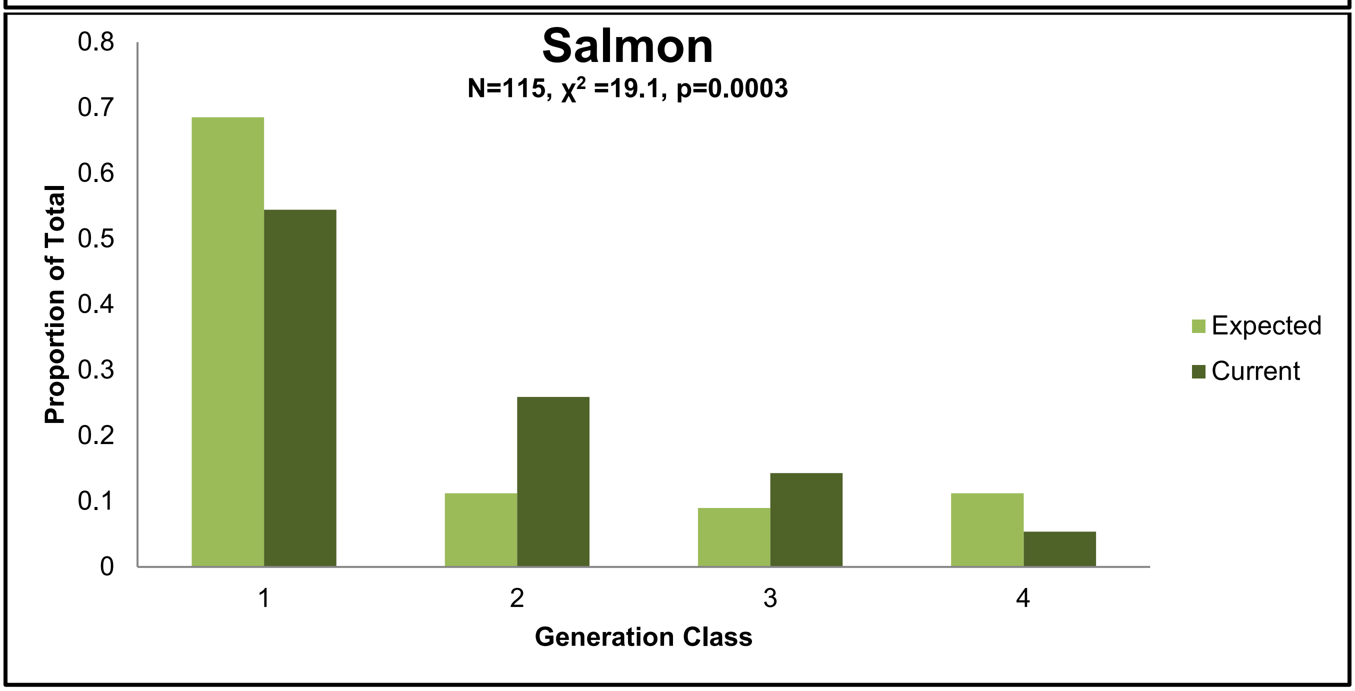
Figure 11. Current and expected generational class proportions by fishery.



[42] Chi-squared goodness of fit test was used to evaluate whether current and expected generation class proportions are different.



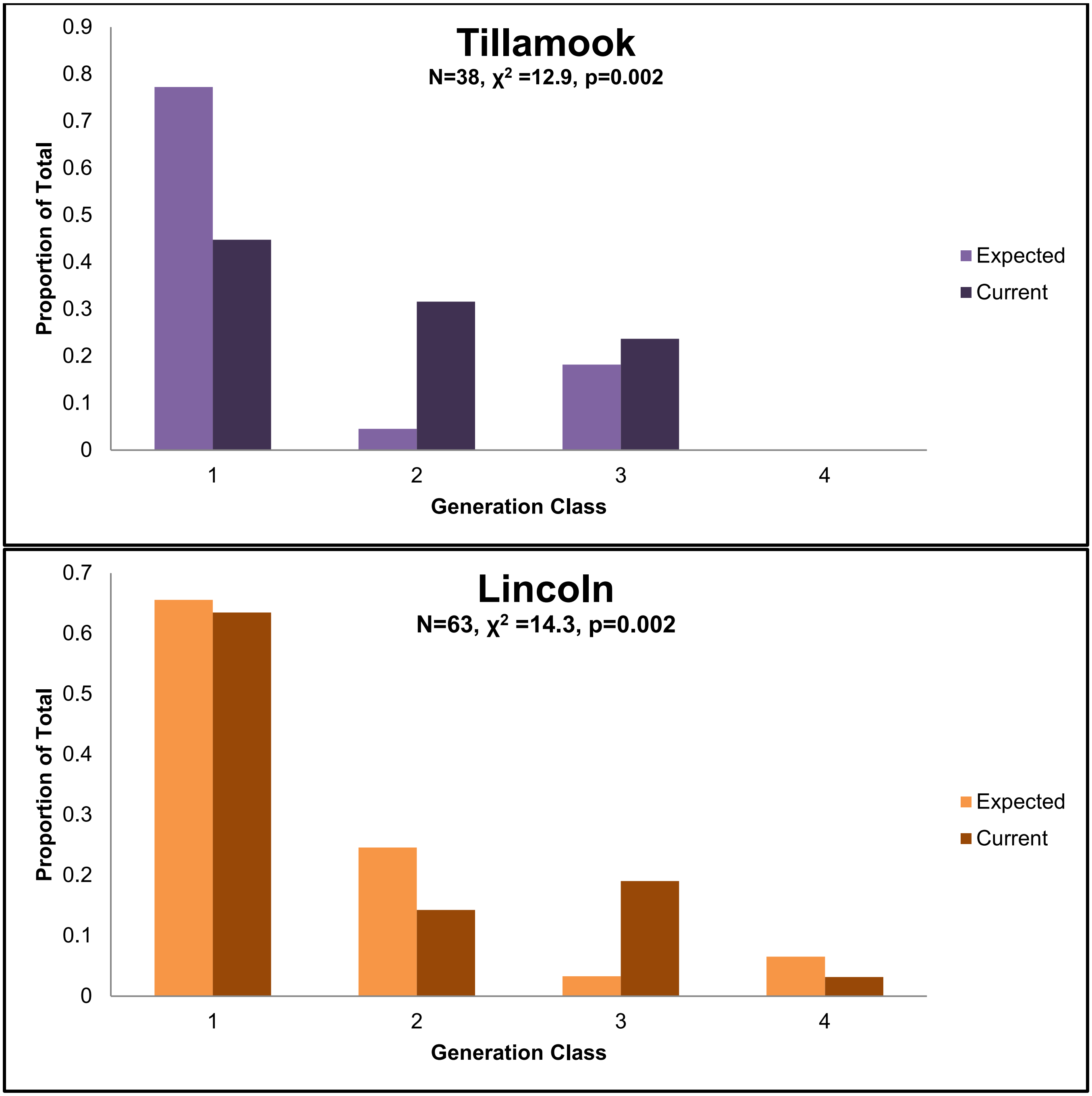
Dungeness crab
N=91, χ2 =18.0, p=0.0004
Proportion of Total
0.6
0.5
0.4
0.3
0.2
0.1
0
1
2
3
4
Generation Class
Expected
Current



Salmon
N=115, χ2 =19.1, p=0.0003
Proportion of Total
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1
2
3
4
Generation Class
Expected
Current

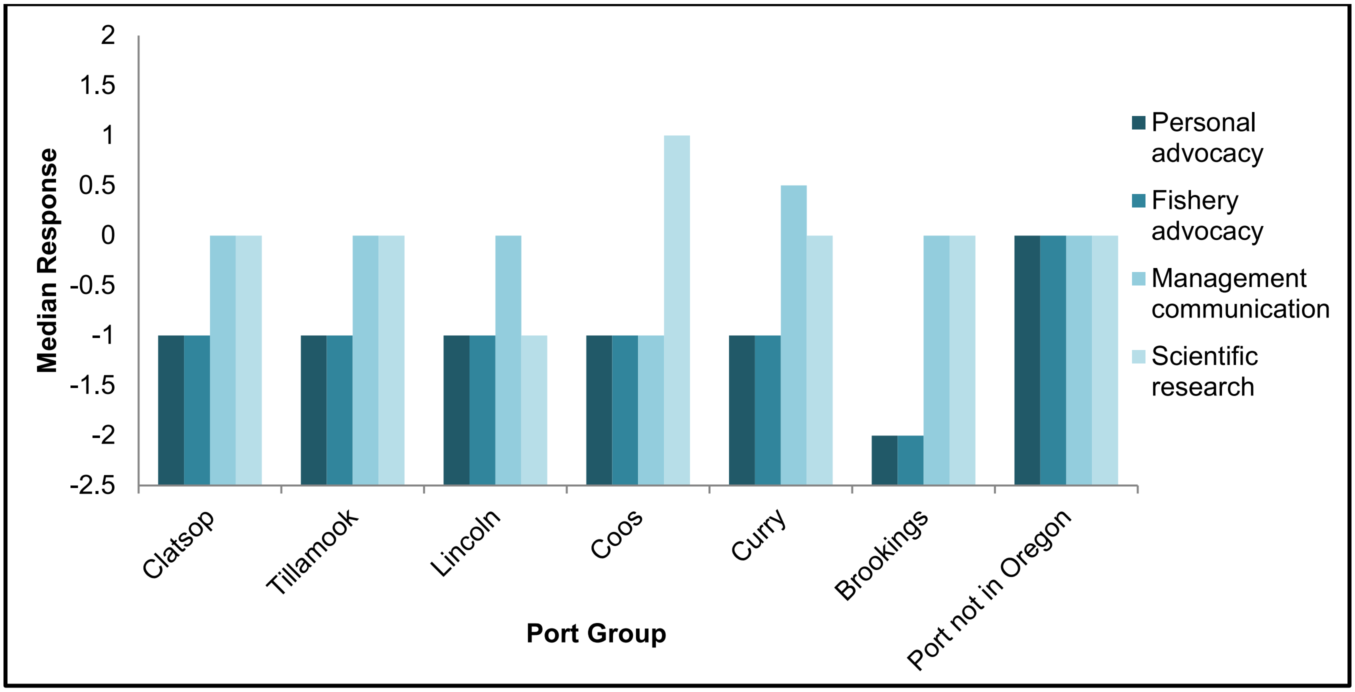
When data were disaggregated for comparisons across port groups, current and expected generational proportions were significantly different for respondents in Tillamook and Lincoln counties (Figure 12). Based on respondent expectations, second and third-generation proportions are expected to shrink in Tillamook County, while in Lincoln County the second and fourth-or-greater generation proportions are expected to grow.

Figure 12. Differences between current and expected generational class proportions by port group.



An evaluation of differences in opinions regarding agency management (Q5) was performed to understand how these opinions might vary among respondents by port group or by fishery. These comparisons assessed variance in perceptions of agency management related to agency advocacy for personal interests of the respondents or the interests of their respective fisheries, agency communication about fishery management to communities, and the accessibility of agency scientific research. When disaggregated for comparisons across port groups, responses were more neutral for fishers that did not operate in Oregon. Fishers operating out of the Brookings port group reported more negative views regarding agency advocacy for personal interests than fishers from the Tillamook, Lincoln, and Curry counties (Figure 13; Table 23). There was not a statistically significant difference in responses by fishery affiliation.

Figure 13. Significantly different respondent perceptions of management, by port group.



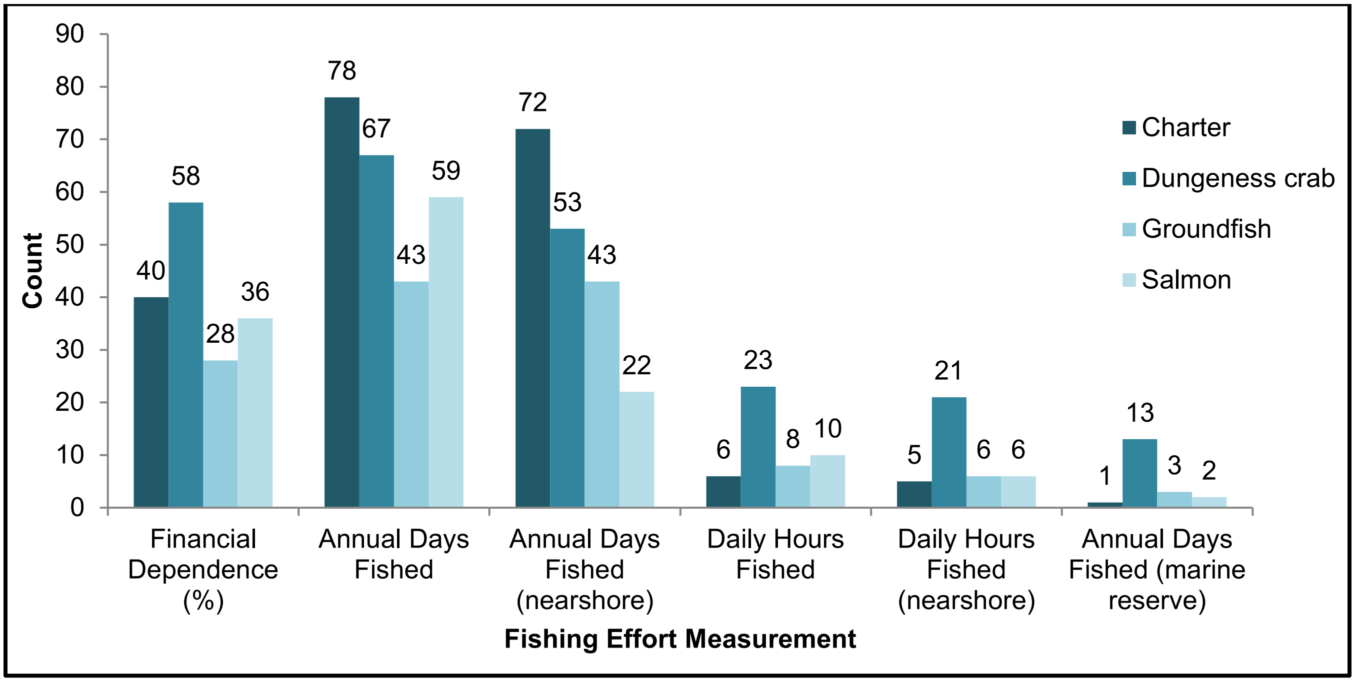
Responses ranged from strongly disagree (-2) to strongly agree (+2)
Clatsop=44; Tillamook=41; Lincoln=63; Coos=39; Curry=28; Brookings=20; Port not in Oregon=40

Table 23. Pairwise tests for significant differences in perceptions of management.

Statement #1: Public agencies have done a good job advocating for my personal interests						
Pairwise test	Clatsop	Tillamook	Lincoln	Coos	Curry	Brookings
Brookings	-	p=0.04	p=0.04	-	p=0.03	-
Not in Oregon	p=0.02	-	-	p=0.05	-	p=0.008
Statement #2: Public agencies have done a good job advocating for the interests of the fisheries in which I participate						
Pairwise test	Clatsop	Tillamook	Lincoln	Coos	Curry	Brookings
Not in Oregon	-	-	-	p=0.03	-	p=0.029
Statement #3: Public agencies adequately communicated issues regarding Oregon fishery management to my local community						
Pairwise test	Clatsop	Tillamook	Lincoln	Coos	Curry	Brookings
Not in Oregon	p=0.02	p=0.02	-	p=0.01	-	-
Statement #7: I know where to obtain information about scientific research regarding Oregon ocean issues						
Pairwise test	Clatsop	Tillamook	Lincoln	Coos	Curry	Brookings
Not in Oregon	p=0.05	-	p=0.05	-	-	-
Wilcox test for statements where there were statistically significant differences in median response A p-value <0.05 indicates that median response was different between the paired port groups						

Analyses were conducted in order to evaluate how a suite of fishing effort measurements differed across fisheries and between sampling years. In addition, pairwise tests were the conducted to explore differences in effort (Q12).[43] Results indicated that there were significant differences between fisheries for the following fishing effort measurements: 1) financial dependence on their respective fishery, 2) number of annual days fished, 3) number of annual days fished in the nearshore, 4) number of daily hours fished, 5) number of daily hours fished in the nearshore, and 6) number of annual days fished in areas that are now marine reserves (Figure 14). Results also indicated that there were significant differences between sampling years in the salmon fishery for the following fishing effort measurements: 1) number of annual days fished, 2) number of annual the number of daily hours fished, and 3) number of daily hours fished in the nearshore.

Figure 14. Significant differences in fishing effort measurements, between fishery affiliations.



Significant differences across fisheries: Financial dependence (F=6.79, p=2.2e-04) annual days fished (F=1.56, p=0.02), annual days fished in the nearshore (F=4.19, p=0.007), daily hours fished (F=165, p=7.5e-42), daily hours fished in the nearshore (F=82.6, p=9.1e-29), and annual days fished in areas that are now marine reserves (F=3.18, p=0.027)
Significant differences between sampling years for salmon fishery: annual days fished (F=2.65, p=0.03), daily hours fished (F=3.78, p=0.01), and daily hours fished in the nearshore (F=4.82, p=5.0e-04)

[43] Repeated Measures ANOVA and Bonferroni-Holm pairwise comparisons used to evaluate differences in fishing effort measurements across fisheries and between sampling years.

The first pairwise analysis revealed that respondents from the Dungeness crab fishery derived a significantly higher percentage of their household income from that fishery than respondents from the other sampled fisheries. Furthermore, respondents from the salmon fishery derived significantly more household income from the salmon fishery than respondents from the groundfish fishery derived from that fishery (Table 24).

Table 24. Pairwise comparisons of financial dependence measurements, between fishery affiliations.

Fishery Pair	Dungeness crab	Groundfish	Salmon
Charter	p=0.0064	p=0.0535	p=0.901
Dungeness crab	-	p=1.5e-10	p=6.1e-05
Groundfish	-	-	p=0.03
Holm pairwise test assumes no difference in effort measurement between fisheries A p-value <0.05 indicates a significant differences in measurement between the fisheries			

The second pairwise test indicated that respondents from the groundfish fishery fished statistically fewer days per year than respondents from all other sampled fisheries (Table 25). A third pairwise test revealed that charter fishers operated the most frequently in the nearshore, while salmon fishers operated the least frequently in the nearshore (Table 26).

Table 25. Pairwise comparisons of annual days fished, between fishery affiliations.

Fishery Pair	Dungeness crab	Groundfish	Salmon
Charter	p=0.827	p=0.021	p=0.827
Dungeness crab	-	p=0.038	p=0.827
Groundfish	-	-	p=0.017
Holm pairwise test assumes no difference in effort measurement between fisheries A p-value <0.05 indicates a significant differences in measurement between the fisheries			

Table 26. Pairwise comparisons of annual nearshore days fished, between fishery affiliations.

Fishery Pair	Dungeness crab	Groundfish	Salmon
Charter	p=0.012	p=0.006	p=4.8e-07
Dungeness crab	-	p=0.358	p=0.0004
Groundfish	-	-	p=0.033
Holm pairwise test assumes no difference in effort measurement between fisheries A p-value <0.05 indicates a significant differences in measurement between the fisheries			

A fourth pairwise test revealed that Dungeness crab fishers fished the most total daily hours, while charter fishers fished the fewest hours per day (Table 27). A fifth pairwise test indicated that Dungeness crab fisheries reported the most nearshore daily hours (Table 28). A sixth pairwise test revealed that Dungeness crab fishers previously fished significantly more days in areas that are now marine reserves (Table 29).

Table 27. Pairwise comparisons of daily hours fished, between fishery affiliations.

Fishery Pair	Dungeness crab	Groundfish	Salmon
Charter	p=< 2.0e-16	p=0.0009	p=4.4e-07
Dungeness crab	-	p=< 2.0e-16	p=< 2.0e-16
Groundfish	-	-	p=0.060

Holm pairwise test assumes no difference in effort measurement between fisheries
A p-value <0.05 indicates a significant differences in measurement between the fisheries

Table 28. Pairwise comparisons of daily nearshore hours fished, between fishery affiliations.

Fishery Pair	Dungeness crab	Groundfish	Salmon
Charter	p=< 2.0e-16	p=0.61	p=0.61
Dungeness crab	-	p=< 2.0e-16	p=< 2.0e-16
Groundfish	-	-	p=0.91

Holm pairwise test assumes no difference in effort measurement between fisheries
A p-value <0.05 indicates a significant differences in measurement between the fisheries

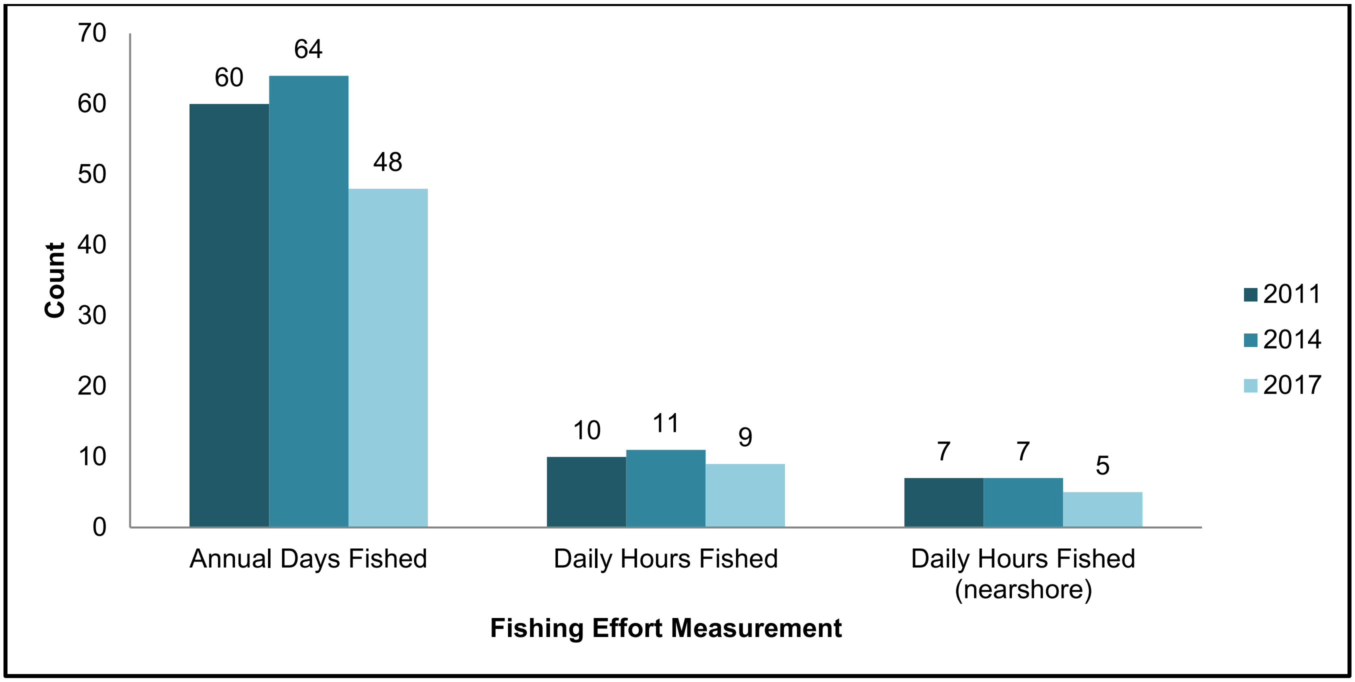
Table 29. Pairwise comparisons of annual days fished in areas that are now marine reserves, between fishery affiliations.

Fishery Pair	Dungeness crab	Groundfish	Salmon
Charter	p=0.007	p=1.00	p=1.00
Dungeness crab	-	p=0.002	p=6.6e-05
Groundfish	-	-	p=1.00

Holm pairwise test assumes no difference in effort measurement between fisheries
A p-value <0.05 indicates a significant differences in measurement between the fisheries

The final three pairwise tests indicated that respondents from the salmon fishery reported significantly fewer annual days fished total and in the nearshore, and fewer daily hours fished in the year 2017 (Figure 15).

Figure 15. Significant differences in fishing effort measurements between sampling year, for the salmon fishery.

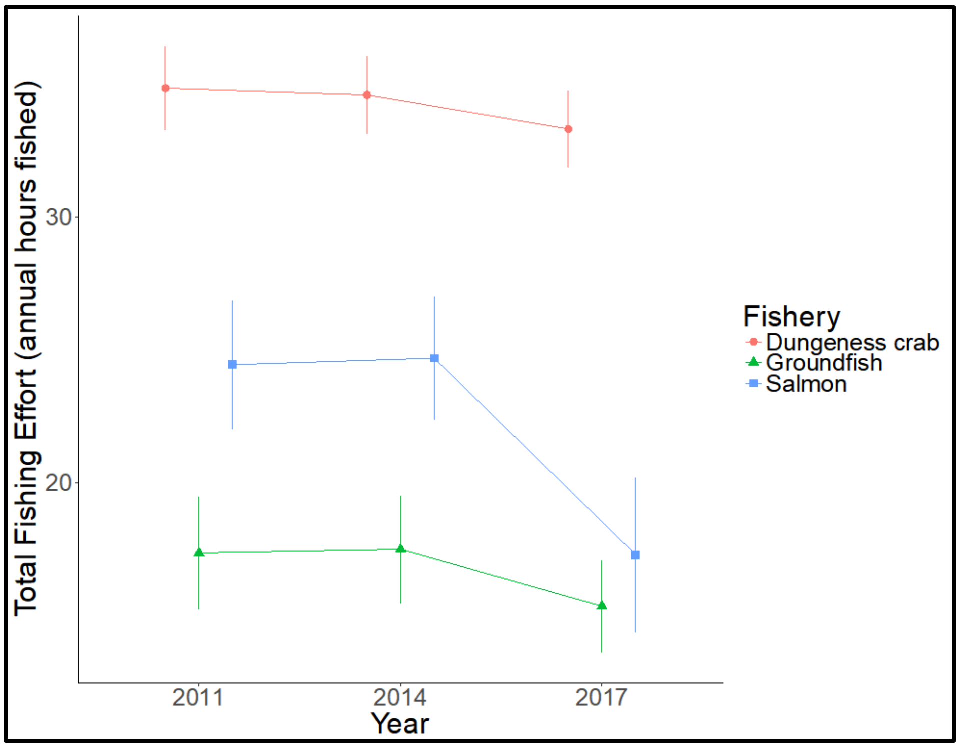


Significantly fewer: annual days fishing in 2017 (2011 p=0.003; 2014 p=0.003), daily hours fished in 2017 (2011 p=0.050; 2014 p=0.023), and daily hours fished in the nearshore in 2017 (2011 p=0.001; 2014 p=0.004)

Another series of analyses[44] were conducted to evaluate how total reported fishing effort differed between fisheries, port groups, and sampling years. Total fishing effort[45] was calculated by multiplying the total annual days fished by the number of daily hours fished to give the total annual hours fished, for years 2011, 2014, and 2017[46]. Results indicated that there were significant differences in fishing effort between fisheries, and between sampling years in the salmon fishery. There were no statistical differences in reported fished effort between port groups.

Dungeness crab fishers exhibited the significantly more effort for each of the years sampled, followed by the salmon and then groundfish fishers[47]. Fishing effort was also significantly lower during the year 2017 within the salmon fishery[48] (Figure 16). Due to the vast differences in business operations and lack of catch per unit effort and vessel feature data for subsequent multivariate analyses, respondents from the charter fishery were excluded from this analysis.

Figure 16. Average total fishing effort, by fishery, 2011, 2014, and 2017.



Dungeness crab N=45; Groundfish N=22; Salmon N=24

Significant differences in fishing effort between fisheries: F=18.7, p=2.83e-07

Effort in Dungeness crab significantly higher than: Groundfish p=<2e-16; Salmon p=3e-13

Effort in Groundfish significantly higher than: Salmon p=0.0032

Significant differences in fishing effort between sampling years in salmon fishery: F=7.35, p=0.01

Effort in 2017 significantly lower than: 2011 p=0.012; 2014 p=0.008

[44] Repeated measures ANOVA test used to evaluate if fishing effort differed between fisheries, port groups, and sampling years.

[45] Fishing effort values were raised to the ½ power to achieve normal distribution.

[46] Total days and hours fished selected to represent total effort based on results from a Principle Component Analysis (Appendix B, Figure B.1)

[47] Bonferroni-Holm pair-wise. comparison test.

[48] Bonferroni-Holm pair-wise comparison test.

Key Findings

- Fishers in the groundfish fishery were newer to fishing, when compared to respondents from the charter and Dungeness crab fisheries. While most respondents participated fulltime in their respective fishery, groundfish fishers participated in that fishery primarily as part-time fishers. Charter and Dungeness crab fishers were more financially dependent on their respective fisheries than groundfish and salmon fishers were on their respective fisheries.
- First generation fishers made up the largest proportion of respondents and the proportions of second, third and fourth-or-greater generation fishers tapered off as generational involvement increased.
- Almost half of fishers did not anticipate that his/her child would continue on in the family fishing business. A respondents' generational standing within the commercial fishing industry was almost always indicative of expectations of familial succession. Less than fourth generation fishers did not expect their children to persist in the family fishing business, whereas fourth-or-greater generation fishers had significantly higher expectations of familial succession.
- In the Dungeness crab and salmon fisheries the fourth-or-greater generational class is expected to grow, while the second and third-generational classes are expected to shrink. In the charter fishery, the second-generational class is expected to grow and the third-generational class is expected to shrink.
- In Tillamook County, the second and third-generational classes are expected to shrink, while in Lincoln County the second and fourth-or-greater generational proportions are expected to grow.
- Responses regarding perceptions of fishery management were more neutral for fishers that did not operate in Oregon. Fishers operating out of the Brookings port group reported more negative views regarding agency advocacy for personal interests than fishers from the Tillamook, Lincoln, and Curry counties.
- Over the time frame identified in the study, respondents from the salmon fishery reported the largest decreases in catch rates, followed by respondents from the charter fishery.
- The specific drivers of personal catch rates were fishery dependent, suggesting that different fisheries are subject to a unique suite impacts: Charter - regulations, ocean conditions, and catch limits; Dungeness crab - weather conditions, ocean conditions, and market prices; Groundfish - catch limits, ocean conditions, and operating expenses; Salmon - regulations, ocean conditions, and catch limits.
- Respondents from salmon and charter fisheries reported the largest decreases in fishery related profits.
- The specific drivers of personal profits were fishery dependent, suggesting that different fisheries are subject to a unique suite impacts: Charter - regulations, ocean conditions, and catch limits; Dungeness crab - ocean conditions, market prices, and operating expenses; Groundfish - Catch limits, ocean conditions, and operating expenses; Salmon - regulations, operating expenses, and catch limits.
- Selections for drivers of personal fishing effort were fishery dependent, suggesting that different fisheries are subject to a unique suite impacts: Charter - weather conditions, regulations, and ocean conditions; Dungeness crab - weather conditions, market prices, and ocean conditions; Groundfish - catch limits, ocean conditions, and weather conditions; Salmon - regulations, ocean conditions, and operating expenses.
- Respondents from the Dungeness crab fishery derived a significantly higher percentage (60%) of their household income from that fishery. In addition, respondents from the salmon fishery derived significantly more household income from that fishery (36%) than respondents from the groundfish fishery derived from their fishery (28%).

- Respondents from the groundfish fishery fished fewer days annually (43 days) than respondents from the other sampled fisheries. Charter fishers operated the most frequently in the nearshore (72 days), while salmon fishers operated the least frequently in the nearshore (22 days).
- Dungeness crab fishers fished the most total daily hours (23 hours), while charter fishers fished the fewest hours per day (6 hours). Dungeness crab fisheries reported the most nearshore daily hours (21 hours). Dungeness crab fishers previously fished significantly more days in areas that are now marine reserves (13 days).
- Salmon fishers reported significantly fewer annual days fished in their fishery and more days fished in the nearshore in comparison to the other fisheries. They also reported fewer daily hours fished in the year 2017 within that fishery.
- Dungeness crab fishers exhibited the significantly more fishing effort for each of the years sampled, followed by the salmon and then groundfish fishers. Fishing effort was also significantly lower during the year 2017 within the salmon fishery.
- Dungeness crab fishers reported marginal declines in effort from 2014 to 2017, likely corresponding with 2016 and 2017 season delays due to high levels of domoic acid.
- Salmon fishers reported significant declines in fishing effort from 2014 to 2017, corresponding with the fishery closures south of Florence for the 2016-2017 season due to low stock returns.
- Fishers from the Dungeness crab fishery reported significantly lower proportional costs associated with fuel expenditures (16%) and reported significantly higher proportional costs associated with crew expenditures (33%) than the other sampled fisheries. Fishers from the groundfish fishery report significantly higher proportional costs associated with crew expenditures (20%) when compared the salmon fishers (13%).
- In aggregate, a substantial majority of fishers (63%) reported that marine reserve implementation has not had any clear perceived impacts on fishery participation.
- When aggregated, a plurality of fishers (42%) indicated than none of the specific marine reserves have had any impact on fishing operation. When disaggregated for comparisons across fisheries, respondents still typically indicated that none of the reserves have had an impact on fishing operations. When disaggregated for comparisons across port groups, selections of the marine reserve that has had the greatest impact on fishing operations were typically representative of a port group’s general proximity to each marine reserve.
- Fishing vessels were the largest among Dungeness crab fishers (43 feet) and smallest among groundfish fishers (28 feet). The Clatsop and Lincoln County port groups had the largest average vessels (44 feet and 42 feet), while Tillamook and Curry County vessels were the smallest (24 feet and 27 feet).

Results Section 2- Multivariate Analyses

Socioeconomic Drivers of Fishing Effort

To evaluate which socioeconomic and operational variables drive overall fishing behavior, a series of linear models were generated for each fishery.[49] The dependent variable for each model was a measurement of catch per unit effort (CPUE), which was calculated by dividing a fisher's total annual landings (in pounds)[50] by their reported total annual effort (hours fished).[51] The model for each fishery selected relevant variables[52] from a list of 9: 1) a fisher's financial dependence on their respective fishery, 2) total nearshore fishing effort (the number of annual days fished in the nearshore multiplied by the number of daily hours fished in the nearshore), 3) miles traveled in order to fish, 4) the number of annual days previously fished in areas that are now marine reserves, 5) the percentage of income previously derived from fishing in areas that are now a marine reserve, 6) the proportion of operating expenditures spent of fuel costs, 7) a fisher's vessel size, 8) the number of vessels owned by a fisher, and 9) seasonal delays.

Respondents within the Dungeness crab fishery reported higher CPUE values than all other sampled fisheries. For respondents in the Dungeness crab fishery, increased vessel length (in feet) was typically indicative of high CPUE, while increased nearshore fishing effort, marine reserve revenue, and fuel expenditure ratios were typically indicative of low CPUE[53]. The final regression model, resulted in an Adjusted R^2 value=0.409, indicating that the variables included in the model explained 41% of the variability observed in CPUE measurements. The addition of survey respondent port group as a random effect resulted in an intra-class correlation coefficient (ICC)=0.990 ICC, indicating that 99% of the unexplained variability in CPUE can be explained by unquantifiable differences between port groups (Table 30). The ICC value enhances the explanatory power of the model and indicates that other variables contribute to variability in fishing success. Respondents from the Clatsop County port group had the highest CPUE measurement (74 lbs/hour; Figure 17).

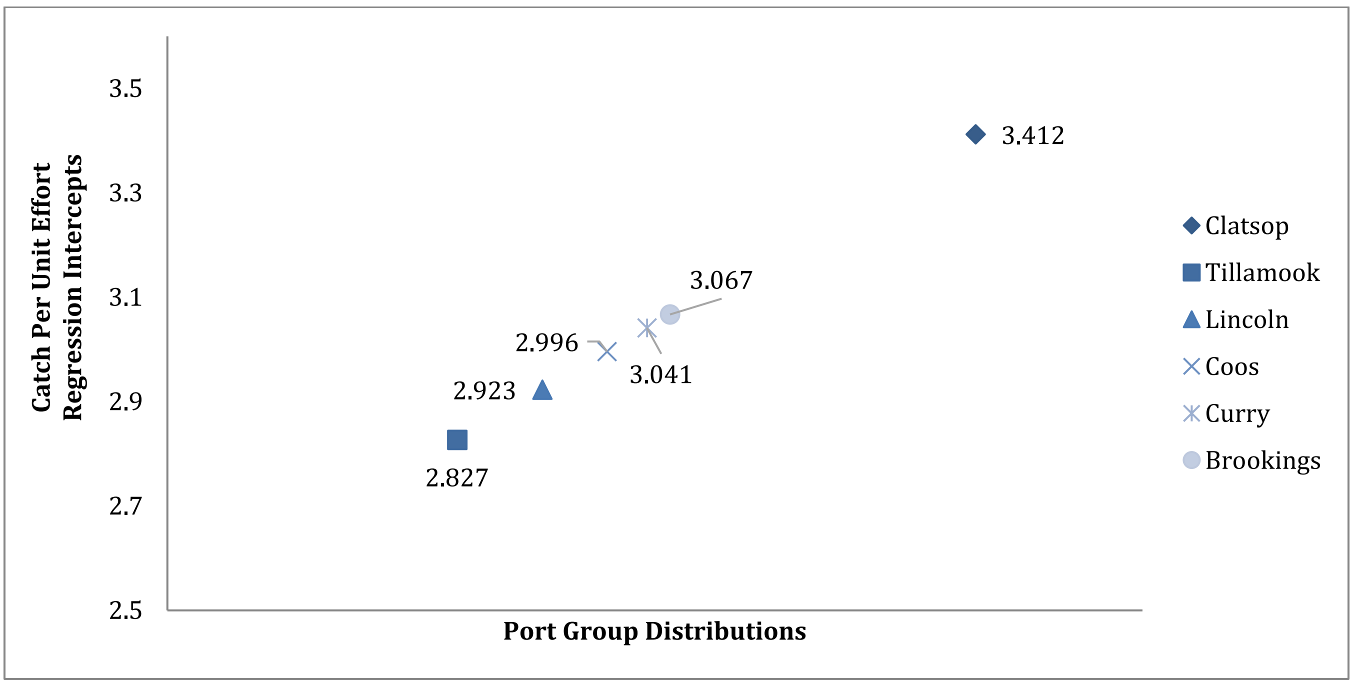
[49] A linear mixed effects model, comprised of fixed and random effects, was produced for the Dungeness crab, groundfish and salmon fisheries.
[50] Data gathered by The Research group from PACFIN. See footnote 1.
[51] CPUE measurements from 2011, 2014, and 2017 were averaged to create a single CPUE value for each survey respondent.
[52] Backward-stepwise AIC selection and VIF analyses eliminated variables that did not contribute to observed variability in CPUE.
[53] Because the Dungeness crab season was partially delayed in 2016 and 2017 for all fishers, the seasonal delay variable did not have any variability (1 for all fishers) and did not have a final intercept or p-value.

Table 30. Predictors of catch per unit effort for the Dungeness crab fishery.

Fixed Effects	Estimate[1]	SE	P[2]	Random Effects (ICC)
Intercept	2.92	0.260	1.22E-14	Port Group ICC= 0.990
2 Vessels Owned	0.579	0.537	0.288	
Vessel length	**0.323**	**0.145**	**0.031**	
Financial Dependence	0.111	0.224	0.622	
Nearshore Effort	**-0.368**	**0.14**	**0.013**	
Miles Traveled	-0.129	0.122	0.298	
Reserve Effort	0.487	0.445	0.282	
Reserve Revenue	**-0.693**	**0.24**	**0.007**	
Fuel Expenditure	**-0.641**	**0.32**	**0.052**	
Seasonal Delay	-	-	-	
Adjusted R^2=0.409				

N=44
[1] CPUE values are log-transformed and coefficients are standardized
[2] P-value indicates that slope of line differs from zero
Fixed effects contributing to observed variability in CPUE are indicated in bold
ANOVA revealed that all final models were significantly different when compared to null models and that there were no significant differences between the full and reduced models

Figure 17. Catch per unit effort regression intercepts display CPUE measurements for each port group in the Dungeness crab fishery.



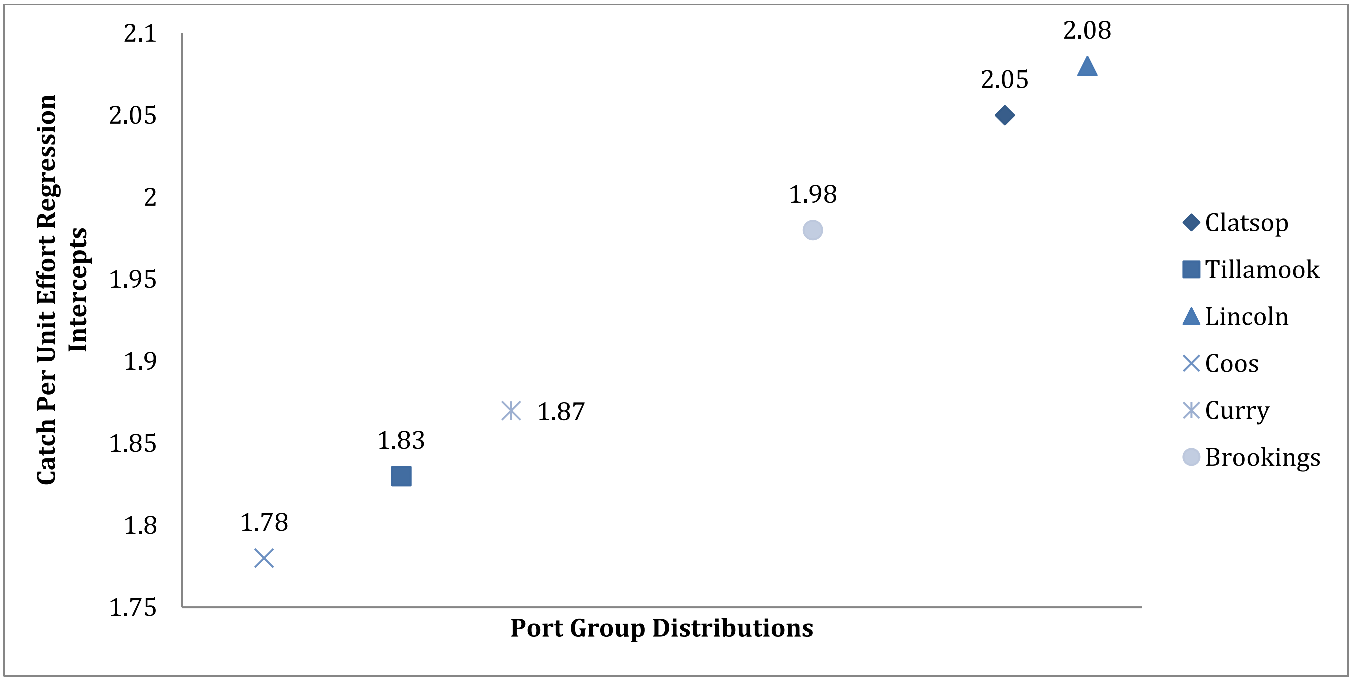
For fishers in the salmon fishery, more vessels owned by the fisher, and more miles traveled before launching fishing gear were indicative of high CPUE, while higher fuel expenditure ratios were indicative of lower CPUE. While increased ability to travel farther to fish indicates a higher travel capacity and a potentially larger fishing operation, higher fuel expenditure ratios indicate that a fishing operation spends lower proportions of operating expenditures on crew and other costs, suggesting that the operation may be relatively small. A fisher owning one vessel, rather than two vessels, was predicted to exhibit lower CPUE. The final regression model, resulted in an Adjusted R^2 value=0.319, indicating that the variables included in the model explained 32% of the variability observed in CPUE measurements. The addition of survey respondent port group as a random effect resulted in an ICC value=0.990, indicating that 99% of the unexplained variability in CPUE can be explained by unquantifiable differences between port groups (Table 31). Respondents from Lincoln and Clatsop County port groups had the highest CPUE measurements (17 lbs/hour and 16.5 lbs/hour) while respondents from Coos County group had the lowest (5 lbs/hour; Figure 18).

Table 31. Predictors of catch per unit effort for the salmon fishery.

Fixed Effects	Estimate[1]	SE	P[2]	Random Effects (ICC)
Intercept	0.41	0.131	1.40E-15	Port Group ICC= 0.990
2 Vessels Owned	**1.84**	**0.375**	**0.0004**	
Vessel Length	0.193	0.234	0.414	
Financial Dependence	-0.033	0.155	0.833	
Nearshore Effort	0.152	0.706	0.830	
Miles Traveled	**0.400**	**0.196**	**0.04**	
Reserve Effort	0.264	0.261	0.318	
Reserve Revenue	-0.133	0.171	0.443	
Fuel Expenditure	**-0.232**	**0.112**	**0.045**	
Seasonal Delays	-0.350	0.27	0.205	
Adjusted R^2=0.319				

N=47
[1] CPUE values are log-transformed and coefficients are standardized
[2] P-value indicates that slope of line differs from zero
Fixed effects contributing to observed variability in CPUE are indicated in bold
ANOVA revealed that all final models were significantly different when compared to null models and that there were no significant differences between the full and reduced models

Figure 18. Catch per unit effort regression intercepts display CPUE measurements for each port group in the salmon fishery.



For fishers in the groundfish fishery, none of the variables were selected as drivers of CPUE.[54] All variables were eliminated during the model selection process and for that reason no Adjusted R^2 value was produced, indicating that the variables included in the model explained 0% of the variability observed in CPUE measurements. The addition of survey respondent port group as a random effect resulted in an ICC value=0.681, indicating that 68% of the unexplained variability in CPUE can be explained by unquantifiable differences between respondents from the various port groups (Table 32). Respondents from the Clatsop and Curry County port groups had the highest CPUE measurements (149 lbs/hour and 52 lbs/hour) while respondents from Lincoln and Coos counties had the lowest measurements (5 lbs/hour and 8 lbs/hour; Figure 19).[55]

[54] Because there were no unexpected seasonal delays or closures in the groundfish fishery, the seasonal delay variable did not have any variability and did not have a final intercept or p-value.

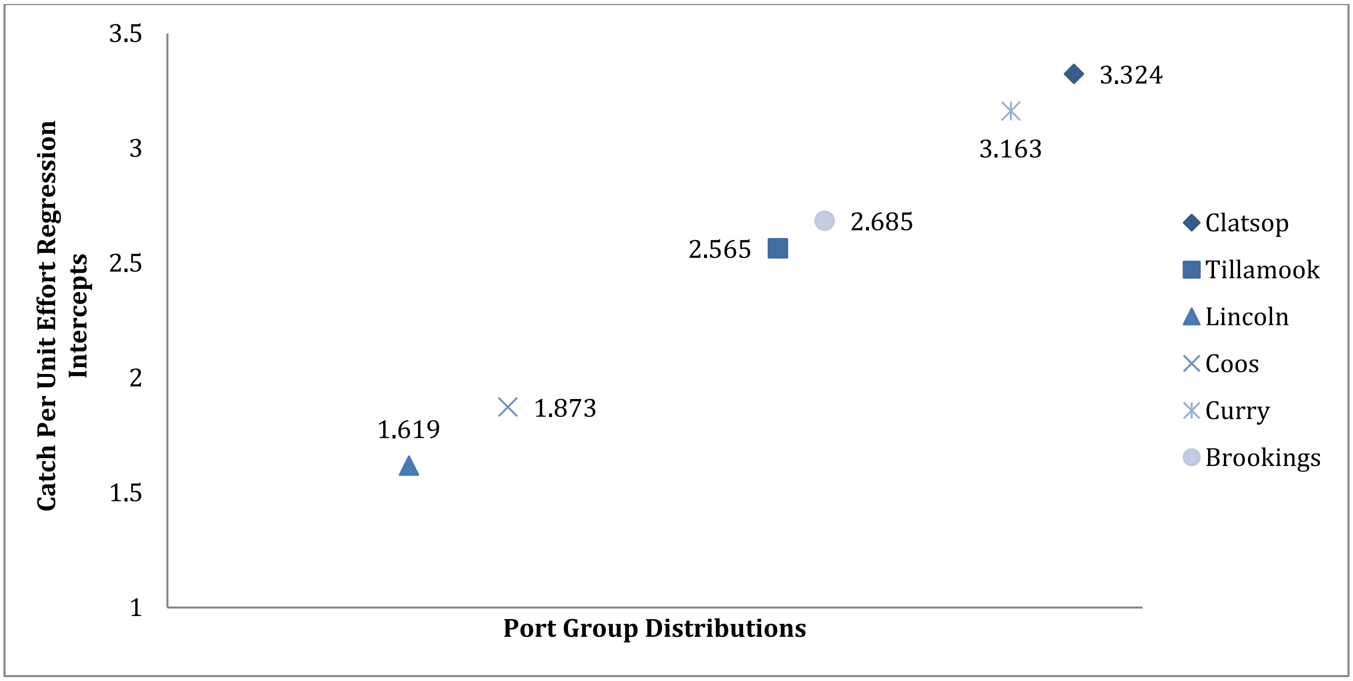
[55] The groundfish fishery had the lowest number of respondents among the fisheries included in the multivariate analyses. Some of the variability in reported CPUE and the magnitude of the port group ICC value may be related to the low number of groundfish respondents and/or the number of respondents by port group. There were only three respondents, for instance, from the groundfish fishery in Clatsop County.

Table 32. Predictors of catch per unit effort for the groundfish fishery.

Fixed Effects	Estimate[1]	SE	P[2]	Random Effects (ICC)
Intercept	2.41	1.07	0.039	Port Group ICC= 0.681
2 Vessels Owned	-0.854	1.20	0.486	
Vessel Length	-0.146	0.663	0.828	
Financial Dependence	0.722	0.683	0.305	
Nearshore Effort	-2.03	1.45	0.180	
Miles Traveled	-0.136	1.54	0.931	
Reserve Effort	2.39	1.65	0.164	
Reserve Revenue	-1.87	2.02	0.367	
Fuel Expenditure	-0.172	0.33	0.613	
Seasonal Delays	-	-	-	

N=26
[1] CPUE values are log-transformed and coefficients are standardized
[2] P-value indicates that slope of line differs from zero
Fixed effects contributing to observed variability in CPUE are indicated in bold
ANOVA revealed that all final models were significantly different when compared to null models and that there were no significant differences between the full and reduced models

Figure 19. Catch per unit effort regression intercepts display CPUE measurements for each port group in the groundfish fishery.



Socioeconomic Drivers of Revenue

To evaluate which socioeconomic and operational variables drive overall fishing revenue, a series of linear models were generated for each fishery.[56] The dependent variable for each model was a measurement of revenue, which was the average of revenue from the years 2011, 2014, and 2016. The model for each fishery selected relevant variables[57] from a list of 9: 1) a fisher's financial dependence on their respective fishery, 2) total nearshore fishing effort (the number of annual days fished in the nearshore multiplied by the number of daily hours fished in the nearshore), 3) miles traveled in order to fish, 4) the number of annual days previously fished in areas that are now marine reserves, 5) the percentage of income previously derived from fishing in areas that are now a marine reserve, 6) the proportion of operating expenditures spent of fuel costs, 7) a fisher's vessel size, 8) the number of vessels owned by a fisher, and 9) seasonal delays.

Respondents within the Dungeness crab fishery reported higher revenue values than all other sampled fisheries. For respondents in the Dungeness crab fishery, increased vessel length (in feet) and a fisher's increased financial dependence were typically indicative of high revenue values, while miles traveled to fish and marine reserve revenue were typically indicative of low revenue measurements[58]. The final regression model resulting in an Adjusted R^2 values=0.334, indicating that the variables included in the model explained 33% of the variability observed in revenue measurements. The

[56] A linear mixed effects model, comprised of fixed and random effects, was produced for the Dungeness crab, groundfish and salmon fisheries.

[57] Backward-stepwise AIC selection and VIF analyses eliminated variables that did not contribute to observed variability in revenue.

[58] Because the Dungeness crab season was partially delayed in 2016 and 2017 for all fishers, the seasonal delay variable did not have any variability (1 for all fishers) and did not have a final intercept or p-value.

addition of individual survey respondent as a random effect resulted in an intra-class correlation coefficient (ICC)=0.876 ICC, indicating that 87% of the unexplained variability in revenue can be explained by unquantifiable differences between respondents who participate in the Dungeness crab fishery (Table 33). The ICC value enhances the explanatory power of the model and indicates that other variables contribute to variability in fishing revenue.

Table 33. Predictors of revenue for the Dungeness crab fishery.

Fixed Effects	Estimate[1]	SE	P[2]	Random Effects (ICC)
Intercept	10.6	0.33	<2e-16	ID ICC=0.876
2 Vessels Owned	0.819	0.94	0.39	
Vessel length	**0.31**	**0.24**	**0.202**	
Financial Dependence	**0.679**	**0.33**	**0.047**	
Nearshore Effort	0.152	0.25	0.558	
Miles Traveled	**-0.27**	**0.19**	**0.166**	
Reserve Effort	0.98	0.78	0.218	
Reserve Revenue	**-1.55**	**0.42**	**0.0006**	
Fuel Expenditure	-0.075	0.67	0.912	
Seasonal Delay	-	-	-	
Adjusted R^2=0.334				

[1] Revenue values are log-transformed and coefficients are standardized
[2] P-value indicates that slope of line differs from zero
Fixed effects contributing to observed variability in Revenue are indicated in bold
ANOVA revealed that all final models were significantly different when compared to null models and that there were no significant differences between the full and reduced models

For fishers in the salmon fishery, more vessels owned by the fisher and increased financial dependence on that fishery was typically indicative of high revenue values. The final regression model resulting in an Adjusted R^2 values=0.118, indicating that the variables included in the model explained 12% of the variability observed in revenue measurements. The addition of individual survey respondent as a random effect resulted in an intra-class correlation coefficient (ICC)=0.875 ICC, indicating that 87% of the unexplained variability in revenue can be explained by unquantifiable differences between respondents who participate in the salmon fishery (Table 34).

Table 34. Predictors of revenue for the salmon fishery.

Fixed Effects	Estimate[1]	SE	P[2]	Random Effects (ICC)
Intercept	6.99	1.28	2.09E-06	ID ICC=0.875
2 Vessels Owned	**1.72**	**1.13**	**0.13**	
Vessel length	0.465	1.28	0.26	
Financial Dependence	**0.923**	**0.344**	**0.01**	
Nearshore Effort	1.98	1.93	0.31	
Miles Traveled	0.63	0.64	0.33	
Reserve Effort	0.622	0.694	0.37	
Reserve Revenue	-0.49	0.45	0.29	
Fuel Expenditure	-0.07	0.36	0.84	
Seasonal Delay	-	-	-	
Adjusted R2=0.118				

[1] Revenue values are log-transformed and coefficients are standardized
[2] P-value indicates that slope of line differs from zero
Fixed effects contributing to observed variability in Revenue are indicated in bold
ANOVA revealed that all final models were significantly different when compared to null models and that there were no significant differences between the full and reduced models

For fishers in the groundfish fishery, a fisher's increased financial dependence on that fishery was typically indicative of high revenue values[59]. The final regression model resulting in an Adjusted R^2 values=0.057, indicating that the variables included in the model explained 6% of the variability observed in revenue measurements. The addition of individual survey respondent as a random effect resulted in an intra-class correlation coefficient (ICC)=0.877 ICC, indicating that 88% of the unexplained variability in revenue can be explained by unquantifiable differences between respondents who participate in the groundfish fishery (Table 35)[60].

[59] Because there were no unexpected seasonal delays or closures in the groundfish fishery, the seasonal delay variable did not have any variability and did not have a final intercept or p-value.

[60] The groundfish fishery had the lowest number of respondents among the fisheries included in the multivariate analyses. Some of the variability in reported revenue and the magnitude of the port group ICC value may be related to the low number of groundfish respondents and/or the number of respondents by port group. There were only three respondents, for instance, from the groundfish fishery in Clatsop County.

Table 35. Predictors of revenue for the groundfish fishery.

Fixed Effects	Estimate[1]	SE	P[2]	Random Effects (ICC)
Intercept	8.85	0.58	4.72E-14	ID ICC=0.877
2 Vessels Owned	-1.26	2.02	0.54	
Vessel length	-0.39	1.12	0.73	
Financial Dependence	**1.05**	**0.53**	**0.05**	
Nearshore Effort	-1.72	2.44	0.49	
Miles Traveled	-0.15	2.59	0.95	
Reserve Effort	2.65	2.77	0.35	
Reserve Revenue	-2.08	3.5	0.54	
Fuel Expenditure	-0.06	0.56	0.91	
Seasonal Delay	-	-	-	
Adjusted R^2=0.057				

[1] Revenue values are log-transformed and coefficients are standardized
[2] P-value indicates that slope of line differs from zero
Fixed effects contributing to observed variability in Revenue are indicated in bold
ANOVA revealed that all final models were significantly different when compared to null models and that there were no significant differences between the full and reduced models

Socioeconomic Drivers of Familial Succession

Respondents were asked about their expectations for their children to continue in the family fishing operation (Q4). A multivariate analysis was performed to ascertain which factors were most likely to influence the respondents' expectations for continued familial involvement. [61] The regression model[62] was run with six predictor variables: 1) vessel length, 2) number of vessels owned, 3) generational involvement in fishing, 4) calculated CPUE, 5) financial dependence on fishing, and 6) fishery affiliation. The results were that the vessel length and number of vessels owned were the main determinates of expectations. When considering vessel length, for each unit (1 foot) that a fisher's vessel increases, the probability[63] of familial succession increases by a factor 1.61. If a fisher owns two fishing vessels, the probability of familial succession increases by a factor of 2.77 (Table 36; Figure 18).

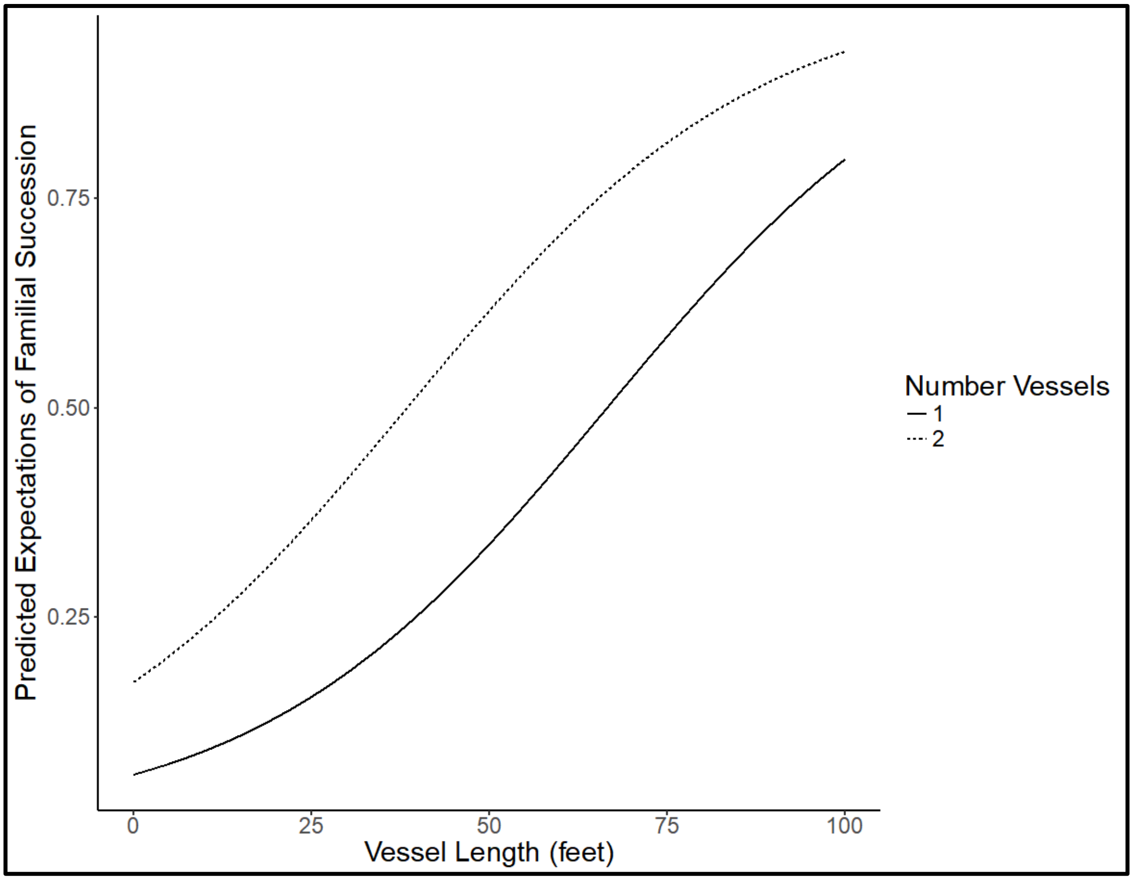
Table 36. Variables influencing expectations of familial succession probability.

Variable	β	SE	P	Odds	2.50%	97.50%
Intercept	-1.20	0.25	0.0003	0.30	0.18	0.48
Vessel Length	**0.48**	**0.22**	**0.031**	**1.61**	**1.05**	**2.55**
2 Vessels Owned	**1.02**	**0.61**	**0.097**	**2.77**	**0.805**	**9.29**
Generation	0.055	0.274	0.840	-	-	-
CPUE	-0.17	0.30	0.568	-	-	-
Financial Dependence	-0.148	0.287	0.607	-	-	-

N=126; No succession or unsure=92; Succession=34
β= Estimate, SE= ± standard error of the mean, 2.5% and 97.5%=confidence intervals
McFadden R^2= 0.062, Nagelkerke R^2= 0.101, Chi^2 p=0.17
Final model was significantly different when compared to the null model and ANOVA revealed no significant differences between the full and final models

[61] Binomial logistic regression model with the probability expectations of familial succession as the dependent variable (1=familial succession, 0=no succession).
[62] Backward-stepwise AIC selection and VIF analyses eliminated variables that did not contribute to expectations of familial succession.
[63] More specifically, the probability that the respondent expected their children to continue in the family fishing business.

Figure 20. Regression curves relating vessel length and number of vessels owned to familial successional expectations.



N=126; No succession or unsure=92; Succession=34
Binomial logistic curves illustrating that vessel length (1.61 x more likely) and number of vessels owned (2.77 x more likely) significantly increase probability of expectations for familial succession

Key Findings

- For respondents in the Dungeness crab fishery, vessel length was positively correlated with high CPUE while nearshore effort, prior revenue from areas that are now marine reserves, and fuel expenditure ratios were negatively correlated with high CPUE. These variables explained 41% of the observed variance in CPUE. Fishers from Clatsop County had the highest CPUE among the respondents in the Dungeness crab fishery. Revenue was positively correlated vessel length and financial dependence on that fishery and negatively correlated with increased traveling distances to fish and marine reserve revenue dependence. These variables explained 33% of the observed variance in fisher revenue.
- For respondents in the salmon fishery, the number of owned fishing vessels and increased travelling capacity were positively correlated with high CPUE, and fuel expenditure ratios were negatively correlated with high CPUE. These variables explained 32% of the observed variance in CPUE. Fishers from Lincoln and Clatsop County had the highest CPUE among the respondents in the salmon fishery. Revenue was positively correlated with the number of

vessels owned and financial dependence on that fishery. These variables explained 12% of the observed variance in fisher revenue.

- For respondents in the groundfish fishery, none of the observed socioeconomic variables in the multivariate analysis were selected as predictors of CPUE. An unexplained variance measurement of 68% indicates that there are suites of alternative factors that influence CPUE. Fishers from Clatsop and Curry County had the highest CPUE among the respondents in the groundfish fishery. Revenue was positively correlated with a fisher's financial dependence on the fishery. These variables explained 6% of the observed variance in fisher revenue.
- Probability of expectations for continuation of familial involvement in fishing increases by a factor 1.64 for each unit (1 foot) that a fisher's vessel length increases, and increases by a factor of 2.77 if a fisher owns two fishing vessels.

Management Implications

Climatic and oceanic variability impacts fishery dynamics. Shifts in fishing effort were moderately correlated with periods of low fish stocks and changing ocean conditions, such as warming or hypoxia that often resulted in fishery closures as well as market price fluctuations. Large-scale warming events have resulted in domoic acid-producing algal blooms that have led to delays in 2016 and 2017 Dungeness crab fishing season (McCabe et al., 2016; McKibben et al, 2017). In the words of one fisher:

"My effort has been impacted greatly by changing ocean conditions. Climate change has led to warmer oceans that produce more algal blooms that ultimately cause seasonal delays."

Furthermore, over the last century, salmon populations in the Northwestern United States and Canada have experienced declines, mainly linked to habitat loss and climatic variability (Lawson 1993; Gavin et al. 2017). Decadal scale oceanic fluctuations, such as the Pacific Decadal and El Nino Southern Oscillations, characterized by wide variability in sea surface temperatures, have been cited as major influences on these population declines (Mantua et al. 1997; Drake and Naiman 2007). Since 2006, low stock assessments have resulted in five spatial closures for Oregon's commercial salmon troll fishery that have led to millions of dollars in lost revenue (Richardson et al. 2018). Warming and climate related events led to reduced Chinook stocks and a partial closure of the 2017 salmon fishery in Oregon and California.[64] The most recent spatial closure (the first since 2010) occurred south of the city of Florence, which corresponded to the decrease in effort reported by respondents between 2014 and 2017.

Reduced expectations around familial continuation in fishing were present in fisheries that have been directly impacted by closures, while fisheries that have not experienced closures were projected to experience less variability in familial retention. As these analyses suggest, climatic fluctuations must be considered when evaluating natural resource industry dynamics.

Larger fishing operations may be more resilient to oceanic, regulatory, economic, and market variability. Large vessel size and increased travel capacity (measured in miles traveled to fish) were slightly indication of high catch per unit effort. Larger fishing operations allow for more gear storage than smaller vessels and are typically able fish for longer periods of time in highly variable weather conditions, due to increased fuel capacity and durability (Le Pape and Vigneau 2001; Smith et al. 2010; Davis et al. 2017). These fishers generate more revenue per trip and may be less vulnerable to

[64] Warming events also led to temporal and spatial closures of inland freshwater salmon fishing in 2017.

changing ocean and weather conditions. One respondent reflected on the difficulties of reduced fishing capacity:

"I have a smaller boat (36 feet) that made it hard to travel and fish successfully. For that reason, I lost interest and sold my salmon permit."

Salmon fishers that have diversified business operations may be more able to effectively cope with oceanic, regulatory, economic, and market fluctuation. Due to the volatile nature of salmon populations, fishing operations that are able travel farther to fish, with more vessels are correlated with higher catch per unit effort. One fisher reflected on the importance of business diversification:

"I have three boats and multiple permits and multiple fisheries. Any opportunity a fisherman has is vital to financial survival. Whether used or not they are important due to fishery fluctuation. [Other permits] could be needed when other fisheries are in a down cycle."

In the future, commercial fleets may be dominated by large, intergenerational fishing operations. Fishers with smaller, first generation fishing operations and increased activity in the nearshore may be particularly vulnerable to climatic, economic, regulatory, and ecological variability. These individuals are less likely to anticipate continued familial involvement in fishing. Barriers to maintain profitability in an industry dominated by larger scale operations may ultimately drive smaller operations to scale-up, shift to new markets, or exit the commercial fishing industry.

Local economies may drive familial succession and catch per unit effort. Patterns in familial succession and CPUE often modestly mirrored shifts in local industry, as well as location-specific fleet characteristics. In the Tillamook County port group, reduced familial succession might correlate with the industry shift from the commercial to recreational (charter) fishing sector (Package and Conway 2010a). Furthermore, dory fishers, who utilize small, wooden vessels that launch from the beach, historically characterized the Pacific City fleet (Hall and Murphy 2012). Small vessel size may reduce economic viability, resulting in a decline in youth participation in commercial fishing. There may be an opposite trend for large, deep-water commercial ports that more consistently prove profitable, such as Lincoln County, which encompass the largest fleets on the Oregon coast. Perhaps the ability to establish a fishing operation in a large, competitive geographic location means that a business is already scaled-up to a size that is profitable and resilient (Package and Conway 2010b). For this reason, fishery dynamics should continue to be studied with consideration of microeconomics and site-specificity.

Trends in the charter fleet are difficult to predict. Due to the nature of the business (primarily shorter day trips with tourists), climatic and ecological variability makes this fleet particularly susceptible to volatility. Rough weather, ocean conditions, and area closures may disproportionately impact this specific fishery. Profits from this fishery, however, are primarily driven by tourism, rather than weight of catch, which may lead fishers to shift from commercial fishing to recreational charter fishing; this may be observed to some degree in Tillamook County. Because the charter fleet displays vastly different business operations and behaviors, responses from that fishery did not receive advanced statistical analyses. For that reason, drawing conclusions about charter fishing effort from this study is difficult.

Fishers may be shifting between fisheries. Interactions with other fisheries should be taken into account when internal patterns are not apparent. Increases and decreases in effort may be indicative of fishers shifting from one fishery to another due to internal volatility or stability. Because neither groundfish nor salmon fisheries appear to provide a majority amount of household income, fishers may participate in both and switch between the two (and/or other fisheries) based on fishery stock health.

Furthermore, high CPUE measurements may indicate stability in fish stocks, which may explain consistent patterns in anticipated familial succession within the groundfish fishery.

A shift may be occurring from commercial to recreational fishing. Higher anticipation of familial succession among second-generation charter fishers in comparison to other sampled fisheries may reinforce a shift from commercial to recreational fishing. However, the low number of charter respondents limits the certainty of such interpretations.

There is no support that marine reserve designation has significantly reduced fishing effort. Data from this study revealed a diverse array of opinions regarding marine reserves. Overall, fishers appeared to hold relatively neutral opinions regarding the impacts of reserve implementation. Nearshore variability, whether climatic, economic or regulatory, is likely to disproportionately impact small-scale fishing operations. While economic losses may appear marginal, as climate variability increases, preservation and sustainable extraction from productive fishing grounds are becoming more important:

"The 3% of profit from marine reserves would come on days too windy to participate elsewhere. Redfish Rocks Marine Reserve is in a protected bay. The wind is unpredictable in some seasons and my family still needs food and shoes. My point, it's an incredibly important 3%, don't undervalue it."

Together, socio-ecological and economic patterns paint a picture of social and economic resilience. However, natural ecosystems shift and respond to environmental pressures that inevitably drive and limit the ways in which humans interact with them. In order to holistically quantify and assess fishing effort shifts, social, ecological, climatic, and economic factors should be considered as researchers attempt to explain human behavior.

References

Ackerman, R., R. Neuenfeldt, T. Eggermont, M. Burbridge, J. Lehrman, N. Wells, and X. Chen. 2016. Resilience of Oregon Coastal Communities in Response to External Stressors. M.S. Project Report. University of Michigan, School of Natural Resources and Environment.

Branch, T. A., Hilborn, R., Haynie, A. C., Fay, G., Flynn, L., Griffiths, J., and Young, M. (2006). Fleet dynamics and fishermen behavior: lessons for fisheries managers. Canadian Journal of Fisheries and Aquatic Sciences 63(7):1647-1668.

Caracciolo, D. (2017). Youth Recruitment and an Aging Workforce: A Pilot Study of Intergenerational Family Business in Oregon's Commercial Fishing Industry.

Carothers, C. (2011). Equity and access to fishing rights: exploring the community quota program in the Gulf of Alaska. Human Organization 70(3): 213-223.

Carothers, C., and Chambers, C. (2012). Fisheries privatization and the remaking of fishery systems. Environment and Society 3(1): 39-59.

Cross, J. E. (2001). What is Sense of Place? Paper presented at the Headwaters Conference, Western State Colorado University, CO.

Dalton, T. M. (2004). An approach for integrating economic impact analysis into the evaluation of potential marine protected area sites. Journal of Environmental Management 70(4): 333-349. doi:https://doi.org/10.1016/j.jenvman.003.12.012.

Davis, S., Sylvia, G., Yochum, N., and Cusack, C. (2017). Oregon Dungeness crab Fishery Bioeconomic Model: A Fishery Interactive Simulator Learning ToolFinal Report . Corvallis, Oregon: OSU Coastal Oregon Marine ExperimentStation and The Research Group, LLC . Retrieved from http://oregondungeness.org.

Demsetz, H. (1982). Barriers to Entry. The American Economic Review 72(1):47-57.

Del Valle, I., Astorkiza, I., and Astorkiza, K. (2003). Fishing effort validation and substitution possibilities among components: the case study of the VIII division European anchovy fishery. Applied Economics, 35(1):63-77.

Dillman, D. A. (2011). Mail and Internet surveys: The tailored design method--2007 Update with new Internet, visual, and mixed-mode guide. John Wiley and Sons.

Donkersloot, R. (2011). What keeps me here: gendered and generational perspectives on rural life and leaving in an Irish fishing locale (Doctoral dissertation, University of British Columbia).

Duncan, W. J. (1979). Mail questionnaires in survey research: A review of response inducement techniques. Journal of Management 5(1):39-55.

Eardley, C., and Murphy, M. (2013). Long Form Recreational Fishing Community Profile: Cascade Head and the Coastal Salmon River Area, Oregon. Prepared for Oregon Department of Fish and Wildlife. Retrieved from http://oregonmarinereserves.com/.

Epperly, H., Swearingen, T., and Polis, H. (2017). 2010, 2011, 2014, and 2015 Business Surveys: Redfish Rocks, Cape Perpetua, Otter Rock, Cascade Head and Cape Falcon Marine Reserves. Oregon Department of Fish and Wildlife. Retrieved from http://oregonmarinereserves.com/.

Executive Order 08-07. (2008). Directing State Agencies To Protect Coast Communities In Siting Marine Reserve and Wave Energy Projects, 08-07 C.F.R.

Fox, R. J., Crask, M. R., and Kim, J. (1988). Mail survey response rate: A meta-analysis of selected techniques for inducing response. Public Opinion Quarterly 52(4):467-491.

Gale, H. F. (2003). Age-Specific Patterns of Exit and Entry in U.S. Farming, 1978-1997. Review of Agricultural Economics, 25(1):168-186.

Gell, F. R., and Roberts, C. M. (2003). Benefits beyond boundaries: the fishery effects of marine reserves. Trends in Ecology and Evolution 18(9):448-455. doi:10.1016/S0169-5347(03)00189-7

Goyder, J. C. (1982). Further evidence on factors affecting response rates to mailed questionnaires. American Sociological Review 550-553.

Hall, E. and Murphy, M. (2013). Long Form Fishing Community Profile: Pacific City, Oregon. Oregon Department of Fish and Wildlife, Marine Resources Program. Newport, Oregon. Retrieved from http://oregonmarinereserves.com/.

Halpern, B. S. (2003). The Impact of Marine Reserves: Do Reserves Work and Does Reserve Size Matter? Ecological Applications 3(1):21.

Heberle, R. (1938). The causes of rural-urban migration a survey of German theories. American Journal of Sociology 43(6):932-950.

Heberlein, T. A., and Baumgartner, R. (1978). Factors affecting response rates to mailed questionnaires: A quantitative analysis of the published literature. American sociological review 447-462.

Himes-Cornell, A., and Kent, K. (2014). Involving fishing communities in data collection: a summary and description of the Alaska Community Survey, 2011. U.S. Dep. Commerce. NOAA Tech. Memo. NMFSAFSC-284, 171 pp. Retrieved at https//:www.afsc.noaa.gov.

House Bill 3013, Oregon House 3 (2009).

Kirkley, J. E., Färe, R., Grosskopf, S., McConnell, K., Squires, D. E., and Strand, I. (2001). Assessing capacity and capacity utilization in fisheries when data are limited. North American Journal of Fisheries Management 21(3): 482-497.

Kanuk, L., and Berenson, C. (1975). Mail surveys and response rates: A literature review. Journal of Marketing Research 440-453.

Klein, C., Chan, A., Kircher, L., Cundiff, A., Gardner, N., Hrovat, Y., and Airame, S. (2008a). Striking a balance between biodiversity conservation and socioeconomic viability in the design of marine protected areas. Conservation Biology 22(3): 691-700.

Klein, C. J., Steinback, C., Scholz, A. J., and Possingham, H. P. (2008b). Effectiveness of marine reserve networks in representing biodiversity and minimizing impact to fishermen: a comparison of two approaches used in California. Conservation letters 1(1):44-51.

Lawson, P. W. (1993). Cycles in Ocean Productivity, Trends in Habitat Quality, and the Restoration of Salmon Runs in Oregon. Fisheries, 18(8):6-10. doi:10.1577/15488446(1993)018<0006:CIOPTI>2.0.CO;2

Le Pape, O., and Vigneau, J. (2001). The influence of vessel size and fishing strategy on the fishing effort for multispecies fisheries in northwestern France. ICES Journal of Marine Science 58(6):1232-1242.

Linsky, A. S. (1975). Stimulating responses to mailed questionnaires: A review. Public Opinion Quarterly 39(1):82-101.

Low, S. M. (1992). Symbolic Ties That Bind. In I. Altman and S. M. Low (Eds.), Place Attachment (pp. 165-185). Boston, MA: Springer US.

Mabogunje, A. L. (1970). Systems approach to a theory of rural-urban migration. Geographical analysis 2(1):1-18.

Marino, E. (2015). Cape Falcon Marine Reserve: A Pilot Study of Impacts, Outcome and Effort Shifts of Commercial and Charter Fishers. Oregon State University-Cascades. Retrieved from http://oregonmarinereserves.com/.

McCabe, R.M., Hickey, B.M., Kudela, R.M., Lefebvre, K.A., Adams, N.G., Bill, B.D., Gulland, F., Thomson, R.E., Cochlan, W.P. and Trainer, V.L. (2016). An unprecedented coastwide toxic algal bloom linked to anomalous ocean conditions. Geophysical research letters 43(19).

McCluskey, S. M., and Lewison, R. L. (2008). Quantifying fishing effort: a synthesis of current methods and their applications. Fish and fisheries 9(2): 188-200.

McKibben, S. M., Peterson, W., Wood, A. M., Trainer, V. L., Hunter, M., and White, A. E. (2017). Climatic regulation of the neurotoxin domoic acid. Proceedings of the National Academy of Sciences 114(2): 239-244.

Murphy, M., and Hall, E. (2013). Long Form Fishing Community Profile: Depoe Bay, Oregon. Prepared for Oregon Department of Fish and Wildlife. Retrieved from http://oregonmarinereserves.com/

Nederhof, A. J. (1988). Effects of a final telephone reminder and questionnaire cover design in mail surveys. Social Science Research 17(4):353-361.

Needham, M. D., Cramer, L. A., and Johnston, J. R. (2016). Resident perceptions of the Oregon Marine Reserve System. Prepared for Oregon Department of Fish and Wildlife. Retrieved from http://oregonmarinereserves.com/

Oregon Department of Fish and Wildlife. (2016). Pounds and Values of Commercially Caught Fish and Shellfish Landed In Oregon: Years 2007-2016. [Data Set]

Oregon Department of Fish and Wildlife. (2017a). Marine Reserves: Human Dimensions Monitoring Plan. Retrieved from http://oregonmarinereserves.com/

Oregon Department of Fish and Wildlife (2017b). ODFW fisheries permit files for 2015-2017. [Data Set].

Ocean Policy Advisory Committee. (2008). Oregon Marine Reserve Policy Recommendations. Department of Land Development and Conservation. Retrieved from www.oregon.gov/LDC

Pacific Fisheries Information Network. (2017). Annual vessel summary data, April 2009, March 2010, July 2011, April 2013, March 2014, April 2015, November 2016, and March 2017 extractions. [Data Set].

Package, C., and Conway, F. (2010a). Long Form Fishing Community Profile: Garibaldi, Oregon. Oregon Department of Fish and Wildlife. Retrieved from http://oregonmarinereserves.com/

Package, C., and Conway, F. (2010b). Long Form Fishing Community Profile: Newport, Oregon. Oregon Department of Fish and Wildlife. Retrieved from http://oregonmarinereserves.com/

Package, C., and Conway, F. (2010c). Long Form Fishing Community Profile: Port Orford, Oregon. Oregon Department of Fish and Wildlife. Retrieved from http://oregonmarinereserves.com/

Pascoe, S., and Robinson, C. (1996). Measuring changes in technical efficiency over time using catch and stock information. Fisheries Research 28(3):305-319.

Pollnac, R., Christie, P., Cinner, J.E., Dalton, T., Daw, T.M., Forrester, G.E., Graham, N.A. and McClanahan, T.R. (2010). Marine reserves as linked social–ecological systems. Proceedings of the National Academy of Sciences 107(43):18262-18265.

Power, N. G., Norman, M. E., and Dupré, K. (2014). "The fishery went away": The impacts of long-term fishery closures on young people's experience and perception of fisheries employment in Newfoundland coastal communities. Ecology and Society, 19(3). doi:10.5751/ES-06693-190306

Rodomsky, B. T. and Calavan T.R. (2015). The Oregon Commercial Nearshore Fishery Summary: 2014. Oregon Department of Fish and Wildlife Marine Resources Program. 43 pp. Retrieved from http://www.dfw.state.or.us/MRP.

Rodomsky, B. T., Calavan, T. R., and Carpenter, A. L. (2016). The Oregon Commercial Nearshore Fishery Summary. Oregon Department of Fish and Wildlife Marine Resources Program. 51pp. Retrieved from http://www.dfw.state.or.us/MRP.

Rodomsky, B. T. and Calavan, T. R. (2017). The Oregon Commercial Nearshore Fishery Summary: 2016. Oregon Department of Fish and Wildlife Marine Resources Program. 63 pp. Retrieved from http://www.dfw.state.or.us/MRP.

Richardson, K., Leonard, J., and Holland, D. S. (2018). Predicting the economic impacts of the 2017 West Coast salmon troll ocean fishery closure. Marine Policy. doi:https://doi.org/10.1016/j.marpol.2018.03.005

Rumelt, R. P. (1982). Diversification strategy and profitability. Strategic management journal 3(4):359-369.

Ruttan, L. M. (2003). Finding fish: grouping and catch-per-unit-effort in the Pacific hake (Merluccius productus) fishery. Canadian Journal of Fisheries and Aquatic Sciences 60(9):1068-1077.

Sade, R. M. (2012). The graying of America: challenges and controversies. In: SAGE Publications Sage CA: Los Angeles, CA.

Scott, C. (1961). Research on mail surveys. Journal of the Royal Statistical Society. Series A (General):143-205.

Senate Bill 1510, Oregon Senate 2 (2012).

Smith, M. D., Lynham, J., Sanchirico, J. N., and Wilson, J. A. (2010). Political economy of marine reserves: Understanding the role of opportunity costs. Proceedings of the National Academy of Sciences 107(43):18300-18305.

Swearingen, T., and Epperly, H. (2016). 2015 Visitor Intercept Survey: Cape Falcon Marine Reserve. Oregon Department of Fish and Wildlife. Retrieved from http://oregonmarinereserves.com/

Swearingen, T., Epperly, H., and Kazloff, L. (2016). 2014 Visitor Intercept Survey: Cape Perpetua, Otter Rock, and Cascade Head Marine. Oregon Department of Fish and Wildlife. Retrieved from http://oregonmarinereserves.com/

Swearingen, T., H. Epperly, and S. Davis. 2017. 2010 Fishers Interviews: Anticipated Marine Reserves Impacts on Fishing Effort Shift. Oregon Department of Fish and Wildlife, Marine Resources Program. Newport, Oregon. Retrieved from http://oregonmarinereserves.com/

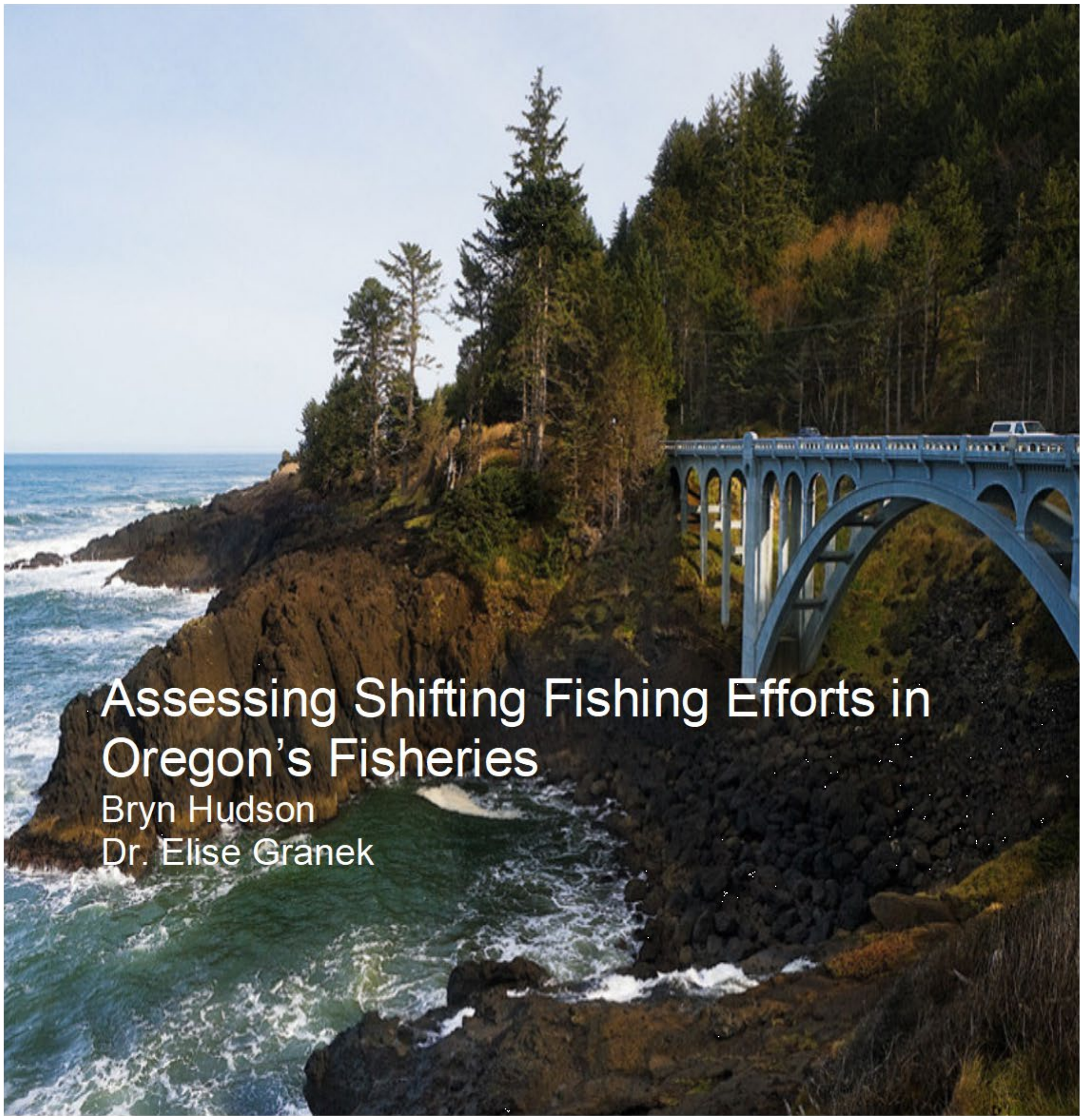
The Research Group, LLC. and Golden Marine Consulting. (2012). Using Spatial Analysis of Fisheries and Habitat Data to Evaluate Economic Effects of Oregon Marine Reserve Sites. Prepared for Oregon Department of Fish and Wildlife. Retrieved from http://oregonmarinereserves.com/

The Research Group, LLC. (2013a). Oregon's Commercial Fishing Industry, Year 2011 and 2012 Review. Prepared for Oregon Department of Fish and Wildlife. Retrieved from http://oregonmarinereserves.com/

The Research Group, LLC. (2013b). Economic Impact of Marine Recreational Fishing: Oregon Pilot Survey. Prepared for Oregon Department of Fish and Wildlife. Retrieved from http://oregonmarinereserves.com/

The Research Group, LLC. (2018). Oregon Nearshore Fisheries Effort Shift Survey Commercial Fishing Representativeness Report. Prepared for Marine Resources Program, Oregon Department of Fish and Wildlife.

Appendix A. Survey Instrument



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Oregon'Fishery'Effort'Survey'
Department'of'Environmental'Science'&'Management'
Portland'State'University'
'
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Portland,'Oregon'97207G0751'
www.pdx.edu/esm'

Portland State UNIVERSITY

Hello! We are contacting you to ask for your help in a study on changes in Oregon fisheries over time. We are conducting this study as part of my graduate research at Portland State University with Drs. Elise Granek and Max Nielsen-Pincus, and in partnership with the Oregon Department of Fish and Wildlife.

As part of this study, we request that you complete the enclosed questionnaire about your experiences with Oregon fisheries. We will be evaluating shifting conditions in Oregon's nearshore commercial ground fish, Dungeness crab, nearshore salmon troll, urchin, charter and nearshore trawl fisheries. Participation in this study is an opportunity for you to voice your perspective and experience in Oregon's fisheries, which will contribute to a growing body of work regarding marine resource policy and management. Your responses will help develop more effective communication between management agencies and fishers.

Participation in this study will take 20-40 minutes and there is no more than minimal risk associated in your participation. Your personal information will only be used to mail and return your survey. Your responses are completely confidential, and your name will never be connected to your answers or included in any reporting. A final report will be published by Portland State University; a copy will be provided to the Oregon Department of Fish and Wildlife. If requested, we will send you a copy as well.

There is a separate postcard enclosed in this packet. On that postcard, you can enter into a raffle to win one of five $50 gift cards and you may also opt to sign up for an in-depth interview for a related study. This interview is an opportunity to speak with another researcher about any additional information you feel is critical in understanding changes in fisheries or fisheries management over time. You will be compensated with a $25 gift card if you choose to participate in the interview. Please include the postcard with your return mailing.

Your decision to participate in this study is completely voluntary, you may skip any questions you do not want to answer, and you have the right to end your participation at any time. When you complete and return the attached questionnaire, it means that you have read and understood this information, you agree to take part in this study, and you are over 18 years old. Thank you very much for your time and support of this study.

Sincerely,

Bryn Hudson (Graduate Student)
503-686-5407
bryn@pdx.edu!

PS. The Portland State University Institutional Review Board overseeing human research has reviewed and approved this study. If you have any questions before or after the survey, you can contact me, or my advisor Elise Granek at graneke@pdx.edu. If you have questions regarding your rights as a research participant, you may call the Portland State University Office for Research Integrity at (503) 725-2227 or 1(877) 480-4400. The Office for Research Integrity is the office that supports the PSU Institutional Review Board. For more information, you may also access the Institutional Review Board website at https://sites.google.com/a/pdx.edu/research/integrity

2017 Oregon Fishing Effort Survey

Please answer the following questions to the best of your ability. Feel free to write your thoughts and comments anywhere on the survey.

1. **Currently, what is your primary operating port?** ***(Circle one or write one in)***
   a. Astoria, Warrenton, Hammond area
   b. Garibaldi, Pacific City area
   c. Newport, Depoe Bay, Florence area
   d. Coos Bay, Bandon, Charleston, Winchester Bay area
   e. Port Orford, Gold Beach area
   f. Brookings
   g. Other port in Oregon: ________________
   h. Port not in the State of Oregon: ________________

2. **For each commercial fishery in Oregon that you participated in since at least 2011, fill in the table below.**

Fishery *(Circle all that apply)*	**Years Fished** *(From-to)*	**Fulltime fishery participant** (*Write in* ***yes*** *or* ***no***)	**Percentage of household income derived from fishery** (Column must add to *100%* fishing income)
Nearshore ground fish			
Dungeness crab			
Salmon troll			
Sea Urchin			
Charter			
Nearshore trawl (Beach dragging)			
Other: ____________			

If you have discontinued your activity in any of the above fisheries since 2011, please state the name of the fishery(ies) and the reason for your discontinuation in the box below.

3. How many generations has your family participated in Oregon's fisheries? *(Circle one)*

   a. 1 (I am a first generation fisher)
   b. 2
   c. 3
   d. 4 or more

4. Do you anticipate that your children will participate in your family's fishing operation? *(Circle one)*

   Yes No Maybe I Don't Have Children

5. To what degree do you agree/disagree with each statement below? (*Check one box for each statement)*

Statement	Strongly disagree	Moderately disagree	Neutral	Moderately agree	Strongly agree
Public agencies have done a good job advocating for my personal interests	☐	☐	☐	☐	☐
Public agencies have done a good job advocating for the interests of the fisheries in which I participate	☐	☐	☐	☐	☐
Public agencies adequately communicate issues regarding Oregon fishery management to my local fishing community	☐	☐	☐	☐	☐
I am satisfied with the amount of contact I have with agency representatives	☐	☐	☐	☐	☐
I feel comfortable voicing my opinions about Oregon ocean management and policy to public agencies	☐	☐	☐	☐	☐
I know where to obtain information about policy changes regarding Oregon ocean issues	☐	☐	☐	☐	☐
I know where to obtain information about scientific research regarding Oregon ocean issues	☐	☐	☐	☐	☐

For questions 6-14, please write in each fishery that you participate in. If you participate in more than two, pick the two fisheries that contribute most to your net household income. If you are a participant in the Charter fishery, please select the two most lucrative species for which you fish: example= Charter: Dungeness crab, Charter: Salmon.

6. Since 2011, which best describes the extent to which your catch rates have been generally increasing or decreasing? (*Check one box for each statement)*

Fishery	Large decreases	Moderate decreases	Some increases and decreases	Moderate increases	Large increases	No clear trend
____________	☐	☐	☐	☐	☐	☐
____________	☐	☐	☐	☐	☐	☐

7. What do you see to be the main factors influencing the trends in your catch rates? *(**Circle up to 3 factors that influence catch rates and rank them 1-3, with 1 being the largest influence**)*

Fishery: ____________________

RANK

a. ___ Operating expenses
b. ___ Catch limits
c. ___ Catch per unit efforts
d. ___ Ocean conditions
e. ___ Weather conditions
f. ___ Market prices
g. ___ Regulations (specify): ____________________
h. ___ Regulations (specify): ____________________
i. ___ Other: ______________

Fishery: ____________________

RANK

a. ___ Operating expenses
b. ___ Catch limits
c. ___ Catch per unit efforts
d. ___ Ocean conditions
e. ___ Weather conditions
f. ___ Market prices
g. ___ Regulations (specify): ____________________
h. ___ Regulations (specify): ____________________
i. ___ Other: ______________

8. Since 2011, which best describes the extent to which your fishery related profits have been generally increasing or decreasing? (*Check one box for each statement)*

Fishery	Large decreases	Moderate decreases	Some increases and decreases	Moderate increases	Large increases	No clear trend
____________	☐	☐	☐	☐	☐	☐
____________	☐	☐	☐	☐	☐	☐

!
!

9. What do you see as the main factors influencing the trends of your fishery related profits?!(**Circle up to 3 factors that influence profits and rank them 1-3, <u>with 1 being the largest influence</u>**)

Fishery: ______________________

RANK

a. ___ Operating expenses
b. ___ Catch limits
c. ___ Catch per unit efforts
d. ___ Ocean conditions
e. ___ Weather conditions
f. ___ Market prices
g. ___ Regulations (specify): ___________________
h. ___ Regulations (specify): ___________________
i. ___ Other: ______________

Fishery: ______________________

RANK

a. ___ Operating expenses
b. ___ Catch limits
c. ___ Catch per unit efforts
d. ___ Ocean conditions
e. ___ Weather conditions
f. ___ Market prices
g. ___ Regulations (specify): ___________________
h. ___ Regulations (specify): ___________________
i. ___ Other: ______________

10. Since 2011, what are the main factors that explain the variability in your <u>fishing effort</u>?!(**Circle up to 3 factors that influence fishing effort and rank them 1-3, with 1 being the largest influence**)

Fishery: ______________________

RANK

a. ___ Operating expenses
b. ___ Catch limits
c. ___ Catch per unit efforts
d. ___ Ocean conditions
e. ___ Weather conditions
f. ___ Market prices
g. ___ Regulations (specify): ___________________
h. ___ Regulations (specify): ___________________
i. ___ Other: ______________

Fishery: ______________________

RANK

a. ___ Operating expenses
b. ___ Catch limits
c. ___ Catch per unit efforts
d. ___ Ocean conditions
e. ___ Weather conditions
f. ___ Market prices
g. ___ Regulations (specify): ___________________
h. ___ Regulations (specify): ___________________
i. ___ Other: ______________

11. Please fill the table in below explaining how the percentage of each cost has contributed to your total operating costs in the years 2011, 2014 and 2017. **(Ensure each box adds to 100% for each year)**

Fishery	2011	2014	2017
__________________	___% fuel ___ % crew ___ % other	___% fuel ___ % crew ___ % other	___% fuel ___ % crew ___ % other
__________________	___% fuel ___ % crew ___ % other	___% fuel ___ % crew ___ % other	___% fuel ___ % crew ___ % other

!

12. **To the best of your memory, fill in the table below that describes your fishing effort of each fishery in which you participate over the last seven years (2011-2017). We acknowledge that the 2017 season is not over for some fisheries, answer for that year to the best of your ability. Please note that 3 nautical miles falls within state territorial waters and is typically less than 40 fathoms deep.**

Fishery: ____________ Year	**2011**	**2014**	**2017**
Define your fishing season (Circle the **months fished**)	Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.	Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.	Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.
What **percentage** of your net **household income** was derived from this fishery? (0-100%)			
About how many **days** did you fish during the season, **total**? *(0-365)*			
About how many **days** did you fish during the season, **within 3 nautical miles**? *(0-365)*			
About how many **hours** was your fishing gear deployed each day during the season? *(0-24)*			
About how many **hours** was your fishing gear deployed each day during the season, **within 3 nautical miles**? *(0-24)*			
About how many **miles** did you travel before deploying fishing gear?			
About how many **days** did you fish within what is now marine reserve limits? (0-365)			
What **percentage** of your annual revenue was caught within what is now marine reserve limits? (0-100%)			

Fishery: ___________ Year	**2011**	**2014**	**2017**
Define your fishing season (Circle the **months fished**)	Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.	Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.	Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.
What **percentage** of your net **household income** was derived from this fishery? (0-100%)			
About how many **days** did you fish during the season, **total**? *(0-365)*			
About how many **days** did you fish during the season, **within 3 nautical miles**? *(0-365)*			
About how many **hours** was your fishing gear deployed each day during the season? *(0-24)*			
About how many **hours** was your fishing gear deployed each day during the season, **within 3 nautical miles**? *(0-24)*			
About how many **miles** did you travel before launching fishing gear?			
About how many **days** did you fish within what is now marine reserve limits? (0-365)			
What **percentage** of your annual revenue was caught within what is now marine reserve limits? (0-100%)			

13. Which best describes the type of impact that the establishment of no-take marine reserves has had on your ability to partake in at least one Oregon fishery in which you participate? If reserves have had NO CLEAR IMPACT on your fishing efforts, skip to the end of the survey. (*Check one box for each statement)*

Fishery	**Largely negative**	**Moderately negative**	**No clear impact**	**Moderately positive**	**Largely positive**
______________	☐	☐	☐	☐	☐
______________	☐	☐	☐	☐	☐

14. How has marine reserve establishment impacted your ability to partake in any of the Oregon fisheries in which you participate? (**Circle up to 3 outcomes and rank them 1-3, <u>with 1 being the greatest impact</u>**)

Fishery*:* ___________________________

RANK

a. ___ Fishing ground displacement
b. ___ Increased spatial competition
c. ___ Longer travel distances
d. ___ Other: _______________
e. ___ Other: _______________
f. ___ Other: _______________

Fishery*:* ___________________________

RANK

a. ___ Fishing ground displacement
b. ___ Increased spatial competition
c. ___ Longer travel distances
d. ___ Other: _______________
e. ___ Other: _______________
f. ___ Other: _______________

15. Identify which marine reserve (if any) has had the greatest impact on your fishing operations. (*Circle one)*

GREATEST IMPACT

a. Marine reserve implementation has not impacted my fishing operation
b. Cape Falcon
c. Cascade Head
d. Otter Rock
e. Cape Perpetua
f. Redfish Rocks

SECOND GREATEST IMPACT

a. Marine reserve implementation has not impacted my fishing operation
b. Cape Falcon
c. Cascade Head
d. Otter Rock
e. Cape Perpetua
f. Redfish Rocks

-This is the end of the survey-

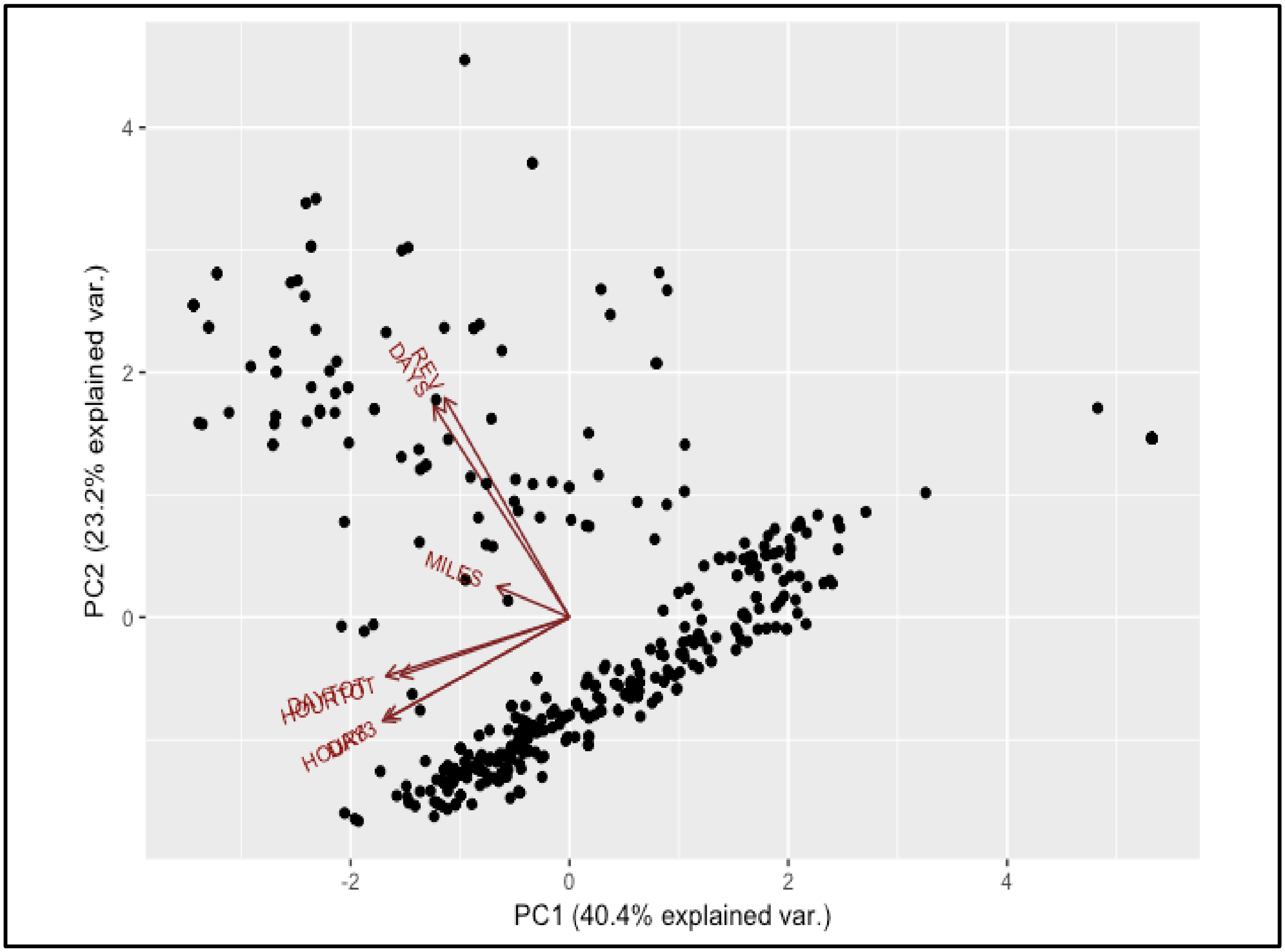
Thank you for your time. We greatly value your answers and opinions. Please return your survey and the raffle ticket in the self-addressed stamped envelop within <u>two weeks</u>.

Please remove and keep the cover letter for your records. If you have any questions or concerns, please contact the number given on the cover letter. If you would like to be entered in a raffle to win one of five $50 gift cards, please fill out and send back the enclosed postcard in your return envelope.

Feel free to write any other thoughts you have about Oregon Fisheries in the space below or on the next page:

Appendix B. Tables and Figures.

Figure B.1. Principle Component Analysis displaying observed variability in overall effort based on seven logistics of effort.



DAYTOT= total days fished per year, HOUR TOT=hours fished per day, DAY3=total days fished per year, inside three miles, HOUR3=hours fished per day, inside three miles, MILES=miles traveled to fish, DAYS=total days fished inside area that is now marine reserve, REV=percent annual revenue from catch from areas that is now a marine reserve.