The Pacific Halibut, *Hippoglossus stenolepis,* and Sablefish, *Anoplopoma fimbria,* Individual Fishing Quota Program: A Twenty-year Retrospective

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ABSTRACT—Although catch shares may be an effective tool to address overcapitalization in fisheries, there is increasing evidence that the costs and benefits of these programs may not be equitably allocated geographically or across generations. This paper examines the spatial and temporal distributional outcomes of 20 years of the Pacific halibut, Hippoglossus stenolepis*, and sablefish,* Anoplopoma fimbria, *Individual Fishing Quota (IFQ) Program, which was implemented with many provisions explicitly intended to mitigate adverse effects on coastal communities, crewmembers, small vessels, and new entrants. Utilizing performance metrics to track distributional objectives over time, we show that, similarly to other catch share programs, the IFQ Program created winners and losers with inter-generational and inter-community inequities in access and opportunities, an effect that may have been exacerbated by regulatory exemptions and loopholes as well as differentiated transportation access in rural Alaska. Nevertheless, some programmatic provisions may have effectively curtailed a complete redistribution of QS (quota shares) within the fleet. Furthermore, consolidation coupled with prolonged fishing seasons and product changes have provided for improvements in some conditions of employment for remaining crew members. We also provide lessons learned for the development and review of catch share programs in the future with respect to defining measureable objectives and establishing mechanisms for data acquisition at the outset. Data collections implemented at the start of a program can provide information to track performance against meaningful baselines. Although potentially time intensive in the development and implementation periods, long-standing data collections may ultimately be easier from the standpoint of the respondents and administrators than ones implemented after a program is in place.*

Introduction

Catch shares are a management tool that have been applied across the world to address overcapitalization in fisheries (Squires et al., 1995; Arnason, 1996; Wilen, 2000). However, there is growing concern that these programs can have adverse and disproportionate impacts on some participants due to the resultant consolidation and loss of access opportunities from high entry costs (Copes and Charles, 2004; Olson, 2011; Grimm et al., 2012). These distributional effects have been shown at the community level as well, with geographic redistributions of fishing privileges and access rights that can lead to losses of employment, income diversification opportunities, tax revenues, and shoreside support businesses and infrastructure (McCay, 1995; Campbell et al., 2000; Copes and Charles, 2004; McCay, 2004; Kasperski and Holland, 2013; Holland and Kasperski, 2016; Holland et al., 2017). Initial distributions, consolidation, and individual fishing quota (IFQ) leasing (of annual pounds), among other factors, may also lead to inter-generational inequities in access and opportunities within and across communities (McCay, 1995; Palsson and Helgason, 1995; McCay, 2004; Pinkerton and Edwards, 2009; Carothers et al., 2010; Carothers, 2015; Carothers[1]).

Recent research indicates that the privatization paradigm of fisheries access in Alaska has created social conflict in communities, transformed the way in which young people perceive participation opportunities, and potentially undermined the sustainability of cultural fishing traditions and economies (Lowe, 2012, 2015; Carothers, 2013; Ringer et al., 2018). This study contributes to the growing body of literature on catch share program effects on the distribution of benefits by examining 20 years of performance of the Pacific halibut and sablefish Individual Fishing Quota Program with respect to its varied spatial and temporal distributional objectives.

The Pacific halibut, *Hippoglossus stenolepis,* and sablefish, *Anoplopoma fimbria,* IFQ Program was implemented in 1995 to address issues associated with the "race for fish" that had resulted from the previous open-access management regime (NPFMC/NMFS, 1992). For the halibut fishery, in the years leading up to the IFQ Program, seasons lasted only a few days in which the commercial sector would harvest their annual catch limits (Pautzke and Oliver[2]). Due to challenges of in-season management in

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[1]Carothers, C. 2008. Privatizing the right to fish: challenges to livelihood and community in Kodiak, Alaska. Univ. Wash. Dissert., 262 p. (avail. at https://anthropology.washington.edu/research/graduate/privatizing-right-fish-challenges-livelihood-and-community-kodiak-alaska).

[2]Pautzke, C., and C. Oliver. 1997. Development of the Individual Fishing Quota Program for sablefish and halibut longline fisheries off Alaska. Natl. Res. Council Committee to Rev. Ind. Fish. Quotas, 4 Sept. 1997, Anchorage, Alaska (avail. at https://www.npfmc.org/ifqpaper/)

such a short, competitive season, this sometimes resulted in harvests that exceeded the annual catch limits. Congestion on the grounds led to gear conflicts, lost gear, resource waste, and an incentive to operate with less regard to safety at sea. Short fishing seasons also led to gluts at processing plants and, coupled with what was often hurriedly handled fish, resulted in a mostly frozen product and lower exvessel prices for fishermen (NPFMC/NMFS, 2016).

The sablefish fishery had been predominately comprised of foreign vessels until the passage of the Magnuson Fishery Conservation and Management Act in 1976. As domestic operators began to hone their skills in capitalizing on this valuable fishery, it began to look similar to the derby-style conditions of the halibut fishery. For instance, in 1988 the number of active vessels over 50 ft was 10 times greater than in 1982 and the number of smaller active vessels was 14 times greater (Pautzke and Oliver[2]). Similar to the halibut fishery, sablefish season lengths decreased from nearly yearround to only a few weeks in some areas (Oliver, 1997).

Prior to the IFQ Program, the halibut and sablefish fisheries were managed under an open access licensing system (Pautzke and Oliver[2]). As capacity grew rapidly in the halibut fishery in late 1970's and 1980's, and in the sablefish fishery in the late 1980's, the North Pacific Fishery Management Council (NPFMC), which manages Federal fisheries off Alaska (i.e., those from 3 to 200 miles offshore), grappled with limited entry concepts. By the late 1980's, the NPFMC adopted a Statement of Commitment declaring its intent to pursue development of a license limitation or IFQ Program for the sablefish fishery. In 1990, halibut was added to the discussion of alternatives for implementing a license limitation or IFQ Program for the sablefish fishery (NPFMC/NMFS, 2016). In December of 1991, the NPFMC chose an IFQ Program as the preferred management alternative for both halibut and sablefish fixed-gear fisheries. The IFQ Program was approved as a regulatory amendment by the Secretary of Commerce in 1993 and implemented by NMFS in 1995.

In developing the IFQ Program, the NPFMC expressed a desire to end the race for fish and control harvests while balancing a variety of other social and economic objectives, some of which were inherently at odds (NPFMC/NMFS, 1992). The NPFMC wanted to ensure continued access to these fisheries for small vessels and new entrants and to moderate consolidation and the impacts on coastal communities from potential redistributions of quota shares (QS). However, in providing for broad participation, the NPFMC curtailed the harvest capacity reductions and efficiency gains that could have occurred with a less restricted market for QS (Kroetz et al., 2015).

The IFQ Program fundamentally altered prosecution of the North Pacific halibut and sablefish fisheries, starting with the issuance of harvesting privileges. Quota shares are the basic longterm use privilege in the IFQ Program and were issued to participants on the basis of recent pre-IFQ fishing history as a percentage of the QS pool for a species-specific IFQ regulatory area. For both fisheries, these QS are translated into annual IFQ allocations in the form of fishable pounds based on the annual total allowable catches (TAC's) established for each IFQ area. The IFQ's are also vessel class-specific; limiting the length of the vessel upon which they can be fished.

Throughout the lifetime of the IFQ Program, over 70 amendments have modified the management of the halibut and sablefish fisheries. Many of these amendments were in response to distributional impacts that resulted from the program or to better align the benefits of this management regime with the original goals and objectives of the program. These relevant amendments are discussed within the related sections in order to contextualize the results of this study.

After 20 years, the IFQ Program was comprehensively reviewed for the first time by the authors of this study (NPFMC/NMFS, 2016). This paper presents and extends the results of that review with respect to spatial and temporal distributional issues to better understand the changes in the allocations of benefits and costs of the IFQ Program among stakeholder groups (e.g., vessel owners, crewmembers, communities, and the next generation of participants). We focus on these issues because concerns about programmatic inequities informed much of the regulatory structure of the IFQ Program (NPFMC/NMFS, 1992), as well as amendments that were subsequently made to the IFQ Program, and the distributional impacts of catch share programs are an ongoing area of debate in the literature (Ringer et al., 2018; Young et al., 2018).

Specifically, this study examines a number of related distributional issues. How did the IFQ Program perform with respect to reducing capacity while maintaining fleet diversity? Have programmatic provisions intended to provide operational flexibility to IFQ participants affected the owner-operator characteristic of the fleet? How did the shift to IFQ management affect crew employment and fishing opportunities for Alaska coastal communities and new entrants?

This paper is organized as follows: the following section presents the data and methods used in this assessment, including the performance metrics developed to examine the IFQ Program's objectives, as specified by the NPFMC at the time of implementation, and their inherent limitations. This is followed by an in-depth discussion of the study results and the overall conclusions and recommendations for future catch share programs and reviews.

Data and Methods

This study is similar to other retrospective analyses of catch share or limited-access programs, which examine changes in the fishery with respect to the expected or intended impacts of the change in management (Gauvin et al., 1994; Casey et al., 1995; Squires et al., 1995, 1998; Wang, 1995; NRC, 1999; Sutinen, 1999; Hamon et al.,

Table 1.—Performance metrics for IFQ Program distributional objectives.[1]

Objective	Performance metric[2]
Address economic stability in the fisheries and communities	• Fish landing distributions by state
Address rural coastal community development of a small boat fleet	• Fish landing distributions within Alaska, by rural and urban communities
Limit the adjustment cost to current participants including Alaska coastal communities	• Fish landing distributions within rural Alaska communities by transportation access
Maintain the diversity in the fleet with respect to vessel categories	• QS distributions by vessel class • Fleet distribution by vessel class • IFQ landings across vessel classes
Maintain the existing business relationships among vessel owners, crews, and processors	• Crew impacts: N/A (There was no data available to inform a metric; we hosted a focus group workshop with crewmembers to gather qualitative information).
Assure that those directly involved in the fishery benefit from the IFQ Program by assuring that these two fisheries are dominated by owner/operator operations	• Harvest distributions by hired masters and QS holders • Total IFQ leasing
Limit the concentration of QS ownership and IFQ usage that will occur over time	• Gini coefficient and Herfindahl-Hirschman Index of revenues at the vessel level
Provide entry opportunities	• QS distribution by generation (initial recipient vs. new entrant) • Average QS holdings by generation • Rate of new entry

[1]NPFMC established 10 programmatic objectives during the development of the IFQ Program (NPFMC/NMFS, 1992). This study focuses on the programmatic objectives related to distributional impacts of the program, as well as entry opportunities, which was an additional area of concern for the NPFMC during the 20-year review.
[2]All metrics are over time and for both species unless otherwise noted.

2009; Van Putten and Gardner, 2010; Agar et al., 2014; Brinson and Thunberg, 2016). We developed performance metrics (Table 1) around the programmatic objectives that focus on distributional outcomes of the program and examined trends in these metrics to evaluate whether there is indication that the objective is being realized in the IFQ fisheries. Similar to Agar et al. (2014) and Brinson and Thunberg (2016), these performance metrics rely on descriptive statistics such as vessel and QS holder counts, average QS holdings, as well as indices including the Herfindahl-Hirschman index (HHI) and Gini coefficient (Gini, 1936; Herfindahl, 1955; Hirschman, 1964).

We also incorporate locally weighted scatterplot smoothing (LOWESS) in this study, which is a regression technique that places the greatest weight on the nearest neighbor in the data, to expand upon trends observed in the fisheries post-IFQ implementation (Cleveland, 1981). Several data sources were used to construct these performance metrics, including the NMFS harvest and administrative data, Alaska Fisheries Information Network's fisheries landings and community profile data, and Alaska Department of Fish and Game's Commercial Operator's Annual Report processing data.

Information about the number of crewmembers or their earnings has historically not been tracked in the IFQ fisheries. To provide information on IFQ impacts on crewmembers for the review, a focus group workshop was held with IFQ crewmembers. Eighteen key informants (Tremblay, 1957; Krueger and Casey, 2000) attended the focus group, representing various geographic segments of the IFQ fishing fleet, past and present crewmembers, vessel owners, initial QS issuees, and new entrants.

Researchers used process agendas and interview guides to conduct the focus group (Krueger and Casey, 2000), which focused on several key topics including participants' experiences with respect to crew earnings, other conditions of crew jobs (duration of the IFQ fishing season, safety, and overall sense of welfare), and entry opportunities and how these experiences have evolved since the implementation of the IFQ Program. Major themes[3] were developed based on notes taken during the focus group and provided to participants for additional feedback afterwards. Given that no additional information was provided for each topic during or at the end of the focus group or in the follow-up review of the major focus group themes, we were able to determine data saturation, the point at which no new information is being discovered (Corbin and Strauss, 1990; Guest et al., 2006).

The baseline period used throughout this study is the three years preceding the implementation of the IFQ Program, 1992 through 1994, which is presented as an average. Although baseline years could have been defined in a number of different ways and no years would have been completely representative of pre-IFQ Program fisheries, the chosen baseline years were intended to eliminate years with rent-seeking behavior (i.e., irrational increases in participation in the short-run with the long-term goal of establishing a fishing history) and consistent with other analyses of catch share programs undertaken by the National Marine Fisheries Service (Brinson and Thunberg, 2016; Fissel et al., 2017). Since history was determined from activity between 1988 and 1990 and the IFQ Program was identified as the preferred management alternative by the NPFMC in 1991, it is likely there was less strategic fishing behavior in the baseline years chosen. Furthermore, there are concerns about the reliability of the data further back in time.

The performance metrics presented here are only used to examine trends

[3]These major themes are included in the supplementary materials.

in the data related to the distributional policy objectives of the IFQ Program; we do not attempt to make conclusive statements about the progress of the program with respect to these objectives. In addition to data limitations for developing metrics, the objectives themselves are broad, without specified and measurable targets, and sometimes even self-contradictory (e.g., addressing excess harvesting capacity and limiting consolidation).

In addition, the purpose of this study is not to identify causal links between the program and the metric. Causal analysis would necessitate complex, systematic modeling with the ability to control for numerous exogenous influences on the harvesters, processors, markets, and associated communities. It would be inappropriate to assert that changes are uniquely attributable to the program without a counterfactual with which to measure changes against. Instead, this study is focused on describing the tangible changes in the IFQ fisheries with respect to programmatic objectives and provisions, understanding that in addition to the shift in management, there have been other influences on those involved with these fisheries. Throughout this study, we identify these exogenous influences qualitatively when possible.

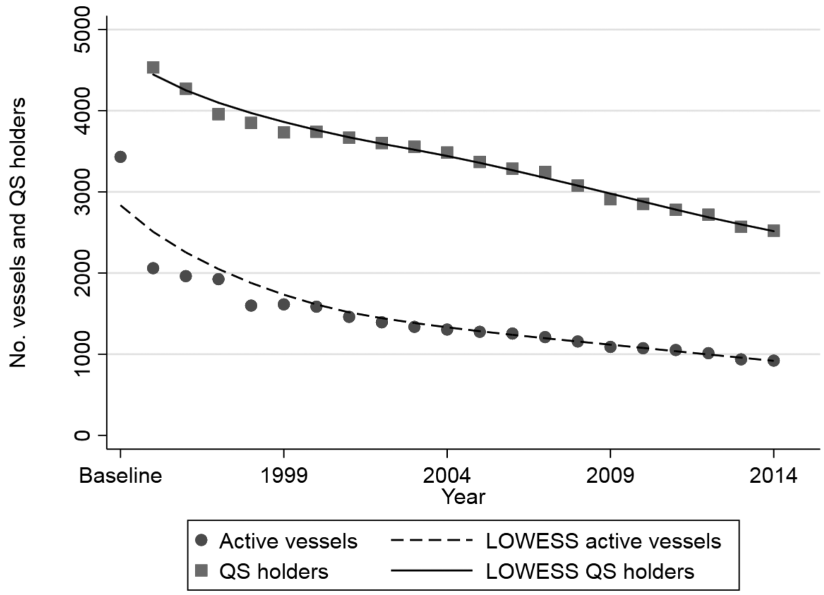

Figure 1.—Annual active vessels and total QS holders in the halibut IFQ fishery from 1992 to 2014 with locally weighted scatterplot smoothing curves.

Results and Discussion

The following section presents the findings organized by groupings of programmatic provisions and objectives around topic areas associated with temporal and spatial distributional issues, examining key facets of IFQ outcomes related to the NPFMC's concerns about potential inequities.

Harvesting Capacity, Revenue Distribution, and Market Concentration

Many of the benefits of the IFQ Program were expected to arise from resulting reductions in harvesting capacity and longer fishing seasons (NPFMC/NMFS, 1992). Under the program, fishing seasons extended from just a few days in some cases to over 8 months. Researchers have shown that catch share programs can be an effective tool for reducing capacity in fisheries and prolonging fishing seasons (Hilborn et al., 2001; Dupont et al., 2002, 2005; Brinson and Thunberg, 2016; Birkenbach et al., 2017). For example, fewer participating vessels and longer seasons could reduce competition on fishing grounds and gear conflicts, improve safety, reduce bycatch and discarding, etc. Given that capacity can be directly related to fleet size, the number of active vessels (those making landings of IFQ fish) was used as a proxy for capacity (Brinson and Thunberg, 2016). The number of QS holders (calculated at the beginning of each fishing year) over time is also included to provide information on consolidation of ownership.

Examination of the LOWESS curves in Figures 1 and 2 indicates that there was substantial consolidation in the IFQ fisheries at both the QS holder and vessel level immediately following the implementation of the IFQ Program with consolidation continuing over the course of the program, although generally at a slower rate. From IFQ implementation to 2014, there was a 73% reduction in vessels in the halibut fishery and a 67% reduction in sablefish vessels; concurrently, there was a 44% reduction in halibut QS holders and a 21% reduction in sablefish QS holders. Differentiated attrition rates by fishery may be attributed to distinct amounts of consolidation at the start of the program as well as differing incentives (TAC's, ex-vessel prices, opportunity costs, etc.), with indication that many of these vessels were displaced into other fisheries (Kroetz et al., 2019). These trends, along with data on the number of quota shareholders per vessel over time (NPFMC/NMFS, 2016), indicate that since IFQ implementation quota shareholders have increasingly been coordinating the harvest of their IFQ on fewer vessels. Reductions in available IFQ due to decreasing TAC's, especially over the last 10 years, may also be incentivizing shareholders to pool their quota to make economically worthwhile fishing trips.

The NPFMC sought to balance a decrease in harvesting capacity with continued opportunities for a diverse fleet, which in turn was intended to limit programmatic impacts on fisheries participants and Alaska coastal com-

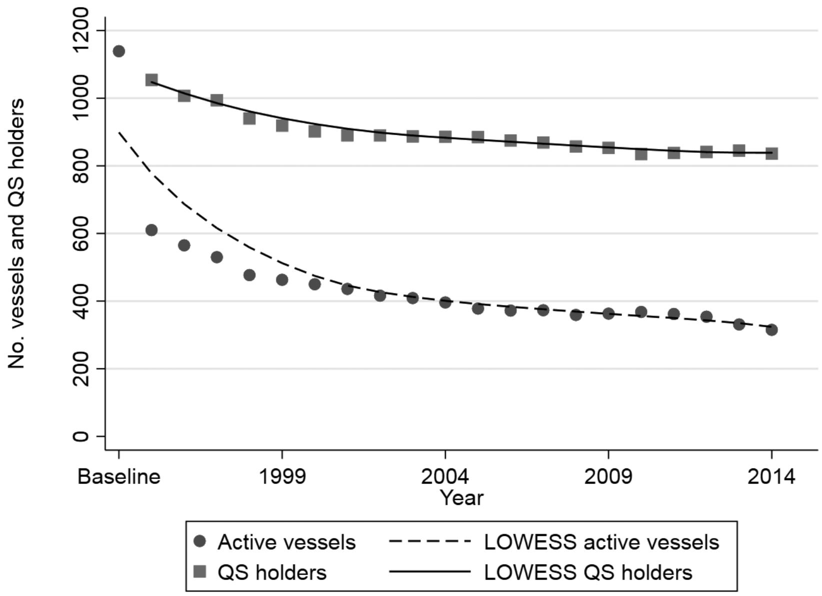

Figure 2.—Annual active vessels and total QS holders in the sablefish IFQ fishery from 1992 to 2014 with locally weighted scatterplot smoothing curves.

munities (NPFMC/NMFS, 1992). To prevent excessive consolidation, QS holders have a cap on the percent of the QS pool they can hold (QS ownership cap) and vessels are capped at the amount they can harvest each year (vessel IFQ cap). Similar to other catch share program evaluations, we used the Gini coefficient (Gini, 1936) and the Herfindahl-Hirschman Indices (HHI) (Herfindahl, 1955; Hirschman, 1964) to examine changes in the distribution of annual IFQ revenue across all active vessels within both IFQ fisheries (Agar et al., 2014; Brinson and Thunberg, 2016).

The Gini coefficient varies between 0 and 1, where a value of 0 indicates that all vessels earn exactly the same gross revenue, while a value of 1 indicates that a single vessel earns 100% of the gross revenues. The absolute value of the Gini coefficient is less important than its trend over time, with a decreasing trend indicating greater evenness of revenue across vessels and an increasing trend indicating a less even distribution of revenues. The Gini coefficients in the pre- and post-IFQ periods imply different patterns for the two fisheries (Fig. 3, 4).

In the halibut fishery there has been an increase in revenue concentration since IFQ implementation, which started below 0.60, and has been above that level for the duration of the program, even while declining from 2011 to 2014. In the sablefish fishery there has been a more even revenue distribution since IFQ's following the first several years wherein inequality increased. The sablefish fishery includes both catcher-processors (those vessels which both catch and process that catch onboard) and catcher vessels that catch and deliver to shoreside processors. While the Gini coefficient for sablefish catcher-processor vessels only shows a lot more variation throughout the years (partially due to the smaller number of participating vessels in this group), it has also been below the pre-IFQ baseline value throughout the course of the IFQ Program indicating a more even distribution.

HHI scores approach zero when a market is composed of a large number of vessels of similar size and reaches a maximum of 10,000 when a single vessel controls the entire market. Federal merger guidelines indicate that HHI scores of less than 1,500 indicate a lack of market concentration and an unlikely presence of adverse competitive effects while scores above 2,500 indicate highly concentrated markets (USDOJ and FTC, 2010).

For both IFQ fisheries, the HHI indicates increasing revenue concentration following IFQ implementation (Fig. 5, 6), likely in part due to the decrease in the number of participating vessels following IFQ implementation. In the sablefish IFQ fishery, the HHI for catcher vessels only and for all vessels combined (inclusive of both catcher vessels and catcher-processors) indicates a steep increase in revenue concentration the year following implementation of the program and a gradual increase for several years afterwards, followed by general stability since the early 2000's.

The HHI for sablefish catcher-processors operates on a vastly different scale than the HHI for catcher vessels due to the higher concentration of revenues over a smaller number of vessels amongst catcher-processors. However, this sector also experienced an increase in concentration of sablefish IFQ revenues throughout the course of the program, reaching a high of nearly 1,400 in 2014. The catcher processor sablefish revenues in Alaska only represent a segment of the whole sablefish market, which also includes sablefish that are supplied by Canada and the U.S. west coast as well as catcher vessels in Alaska, which would be considered in any formal review of market concentration.

Variation in the trends demonstrated by the HHI and Gini coefficient can be attributed to them measuring slightly different things. Whereas the Gini coefficient is a metric of inequality measuring the evenness of revenue distribution per vessel, the HHI is a metric of market power evaluating revenue concentration over the total number of vessels.

One of the primary intentions of the IFQ Program was to address overcapacity in the fisheries; thus, consolidation was a desired programmatic outcome. However, the extent of that intended capacity reduction was not

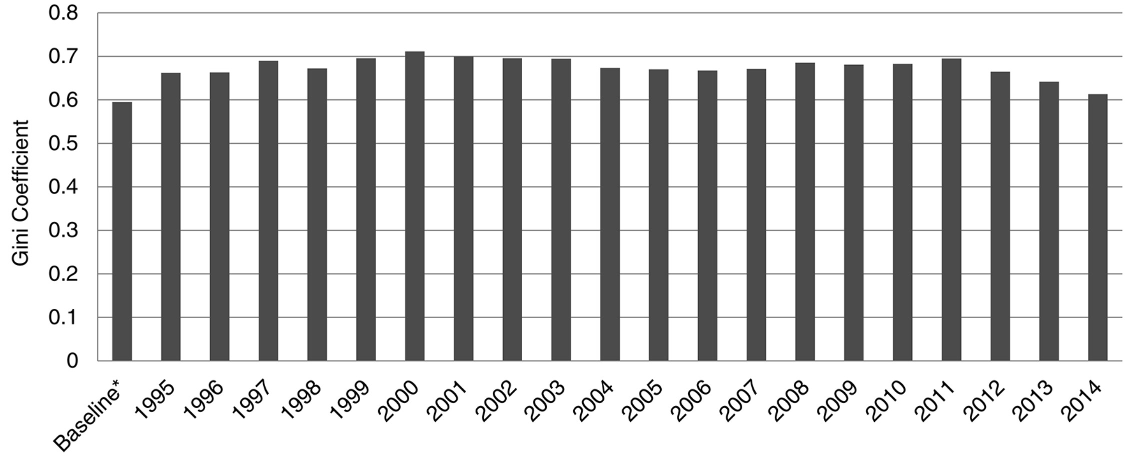

Figure 3.—Halibut IFQ fishery Gini coefficient for vessel revenue distributions from the baseline period (the average for 1992 through 1994) to 2014.

articulated and the exit of a substantial segment of the fleet and QS holders has invariably changed who benefits from these fisheries and by how much.

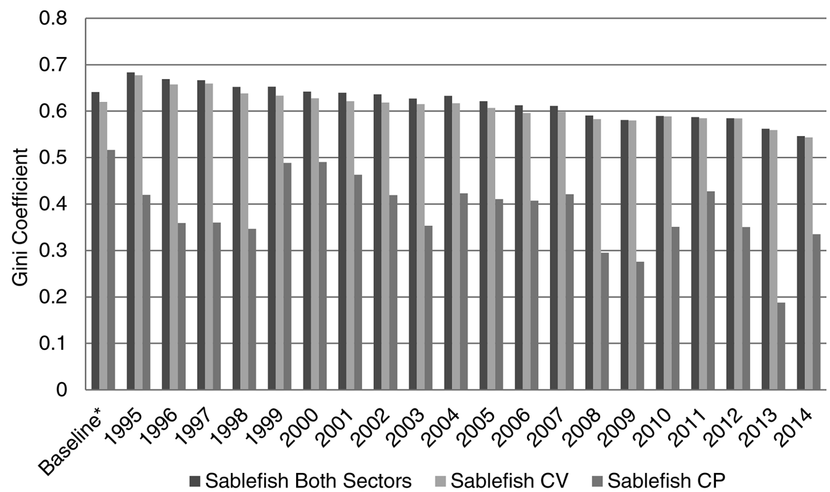

Figure 4.—Sablefish IFQ fishery Gini coefficients for vessel revenue distributions by catcher vessel and catcher processor sector and for both sectors combined from the baseline period (the average for 1992 through 1994) to 2014.

Fleet Diversity

One of the areas of concern with increasing consolidation following IFQ implementation was the potential redistribution of QS towards the owners and operators of larger vessels, many of which were presumed to operate more efficiently than the smaller vessels and could thereby have a greater willingness to pay for QS (Casey et al., 1995). The NPFMC, however, wanted to maintain fleet diversity under the IFQ Program, providing for continued participation of larger vessels while ensuring access for small vessels which were disproportionately owned by Alaskans and assumed to be the entry point for new participants (NPFMC/NMFS, 1992).

Therefore, since implementation, the program has included QS vessel class designations by vessel length and prohibitions on QS trading between the vessel-classes (Holland et al., 2015; Sanchirico et al.[4]). While consolidation has occurred in all vessel length categories, the proportion of active vessels participating in the halibut IFQ fleet that falls into the smallest length category (<35 ft length overall (LOA)) has slightly decreased from 38% during the baseline period to an average of 35% over the course of the program. The proportional composition of the fleet in the largest length category (>60 ft LOA) has remained stable at an average of 8% while the mid-size class (35–60 ft LOA) has increased from 56% to an average of 57% since IFQ. Overall, a diverse fleet has continued to operate in the halibut IFQ fishery as was intended by these provisions. The sablefish IFQ fleet was composed of generally mid-size vessels (35–60 ft LOA) and vessels in the largest length category (>60 ft LOA) pre-IFQ program. The proportional composition of active vessels has remained relatively stable throughout the program for the sablefish IFQ fishery.

After program implementation, it was determined the QS class categories were not needed in order to pre-

[4]Sanchirico, J. N., K. Kroetz, and D. K. Lew. 2011. Memorandum: preliminary analysis of the Alaskan halibut and sablefish ITQ markets. Final report to NMFS.

serve participation from the larger vessel categories (NPFMC[5]; NMFS[6]); thus, subsequent amendments created allowances for "fishing down" (landing larger vessel class QS on smaller vessels). Additional amendments allowed for "fishing up" halibut IFQ in portions of the Bering Sea, using smaller vessel class QS on larger vessels, to address safety concerns about mandating small vessels fish in these waters. In response to the flexibility afforded by these fishing up and down provisions, there have been some changes in the length of vessels landing each category of QS class.

Due to the ability for QS to be fished down, an increasing portion of the largest vessel class (>60 ft LOA) QS is landed on the mid-size vessels (35–60 ft LOA), accounting for on average 33% and 32% of the halibut and sablefish largest class QS, respectively, over the course of the program. In the halibut IFQ fishery, the implementation of the "fishing up" amendments (in 2007 and 2014) were also followed by a redistribution of IFQ landings towards the mid-size vessels. Thus, despite substantial consolidation and increasing revenue concentration following IFQ, programmatic provisions curtailed QS redistributions across vessel length categories, evidenced by changes in fleet landing patterns following a lift in inter-class IFQ harvest restrictions.

Absenteeism and Changing Operational Paradigms

One of NPFMC's key objectives for the IFQ Program was to ensure that the benefits of the IFQ fisheries flowed to those actively participating, including Alaska coastal communities (NPFMC/NMFS, 1992). Researchers have shown that leasing of harvesting privileges can provide greater flexibility and economic efficiency gains above what can be expected with permanent transferability alone (Palsson and Helgason, 1995; LeGallic and Mongruel, 2006; van Putten and Gardner, 2010; Moxnes, 2012; Sanchirico et al.[7]; Wilen and Brown[8]). However, leasing can be associated with prohibitively high QS prices for new entrants and a migration of fishing privileges away from historically dependent fishing communities (LeGallic and Mongruel, 2006; Pinkerton and Edwards, 2009; Stewart and Callagher, 2011).

To curtail leasing in the IFQ fisheries, the NPFMC included an owner-on-board mandate for individual catcher vessel QS holders and an overall prohibition on leasing of catcher vessel IFQ (NPFMC/NMFS, 1992). In general, initial recipients including both individuals and non-individual entities were exempted from the owner-on-board mandate and may use hired masters (anyone designated by the shareholder) to land their catcher vessel IFQ. Because some catcher vessel QS recipients had used hired masters in the halibut and sablefish fisheries prior to the IFQ Program, the NPFMC intended the exemption to provide initial recipients with the latitude to continue in these business practices (NPFMC/NMFS, 2016).

Hired master use for catcher vessel IFQ has increased since program implementation despite a continued transfer of QS to individuals from non-individual entities; and, programmatic amendments intended to reduce reliance on hired masters have only begun to show any evidence of success over the last several years (Szymkowiak and Himes-Cornell, 2015; Szymkowiak and Felthoven, 2016). The IFQ Program tied the hired master use privilege to the initial QS holder and not the initially allocated QS. Thus, it allowed initial recipients to build business models on the basis of utilizing hired masters to land their IFQ and created the opportunity for hired master use to increase in the fisheries. In 1995 hired masters harvested 13% of the total weight of IFQ halibut. This proportion peaked at 46% of the total weight of IFQ halibut in 2010 and decreased to 38% in 2014. For the sablefish fishery, the percent of the total weight of sablefish harvested by hired masters increased from 12% in 1995 to 55% in 2014 (NPFMC/NMFS, 2016).[9]

Although hired master-shareholder relationships can be de facto leasing arrangements (Szymkowiak and Himes-Cornell, 2015), they are not considered as such in the IFQ Program and the only allowable mechanisms for catcher vessel IFQ leasing are under emergency conditions or rare circumstances (military, survivorship, and medical leasing, as well as leasing to the recreational sector, and leasing to community development groups in times of low abundance). Total leasing of catcher vessel IFQ comprises a small percentage of the TAC's in both IFQ fisheries (about 4.25% and 2% in 2015 in the halibut and sablefish fisheries, respectively), although these percentages have also been increasing over the last 15 years (NPFMC/NMFS, 2016). Furthermore, there is indication of repeated use of the medical lease provision for catcher vessel IFQ by a limited number of QS holders in the fisheries, which may be indicative of them using the provision to bypass the owner-on-board requirement or for chronic conditions from which shareholders may not recover (NPFMC/NMFS, 2016).

[5]NPFMC. 1996. Draft for secretarial review: Environmental assessment and regulatory impact review/initial regulatory flexibility analysis for categories (class D & D). N. Pac. Fish. Manage. Counc., Anchorage, Alaska (avail. at https://alaskafisheries.noaa.gov/sites/default/files/analyses/bsai42goa42ea.pdf).

[6]National Marine Fisheries Service (NMFS). 2005. Draft for NOAA Fisheries Service Review: Regulatory impact review and initial regulatory flexibility analysis for seven proposed amendments to regulations that implement the halibut and sablefish IFQ Program. Juneau, AK. 9 November, 2005 (avail. at: https://alaskafisheries.noaa.gov/sites/default/files/analyses/rir_irfa_61506.pdf).

[7]Sanchirico, J., R. Newell, and K. Papps. 2005. Asset pricing in created markets for fishing quotas. Discuss. Pap. dp-05-46, Resour. for the Future.

[8]Wilen, J., and G. Brown. 2000. Implications of various transfer and cap policies in the halibut charter fishery. U.S. Dep. Commer., NOAA, Natl. Mar. Fish. Serv., AFSC Rep., 33 p. (avail. at https://www.st.nmfs.noaa.gov/st5/RecEcon/Publications/Halibut_1st_with_graphs.pdf).

[9]The hired master harvest numbers for halibut are slightly different here than what is presented in the IFQ review (NPFMC/NMFS, 2016) due to the incorrect inclusion of harvests for the Community Development Quota groups in the review in Areas 4B, 4C, and 4D in the IFQ review.

The IFQ Program does not include a systematic collection of lease rates (the percent of the ex-vessel revenue that goes to the QS holder) or the distribution of revenues within arrangements between hired masters and quota shareholders. However, lease rates are self-reported by some participants on the forms required by NMFS for medical and beneficiary leases in the IFQ Program, accounting for about 10% of all lease transactions.[10] Based on these transactions, over the course of the program, average lease rates reported have been between 51% and 56% of ex-vessel revenues. Previous research on revenue distributions between shareholders and hired masters also indicates about 50–60% of revenues go to the shareholder for the harvest of their IFQ (Szymkowiak and Himes-Cornell, 2015). This means that lessees or hired masters earn 40–50% of the gross ex-vessel revenues, from which they will deduct operating costs, crew shares, etc. Although lease rates should reflect annual earnings expectations in the IFQ fisheries (Holland et al., 2015), in situations where fishermen's profits are squeezed by rising lease rates, there is evidence that this can contribute to poor safety decisions and high-grading (van Putten and Gardner, 2010; Emery et al., 2014a, b; Szymkowiak and Felthoven, 2016).

[10]The lease rates are noted as a source of financing for the transfer and written in as a percentage of the gross revenue, and many of these reported lease rates are not independent observations.

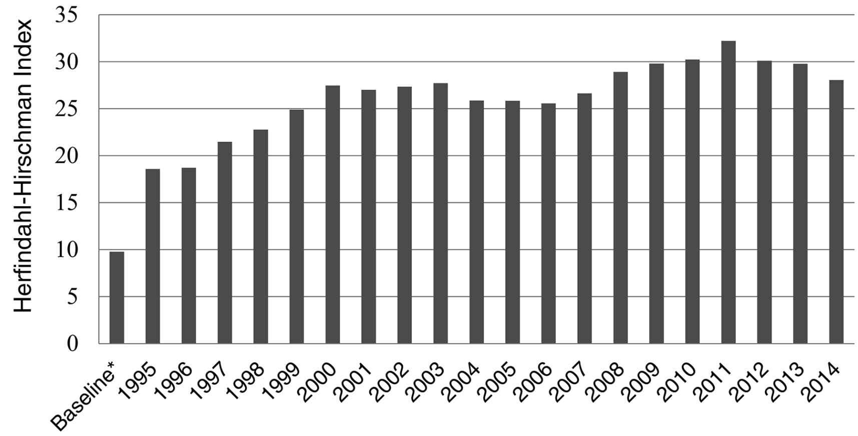

Figure 5.—Halibut IFQ fishery HHI scores for vessel revenue distributions from the baseline period (the average for 1992 through 1994) to 2014.

Even as QS is transferred to second-generation shareholders who are mandated to be on board during the harvest of their IFQ, there is anecdotal information that some of these second-generation shareholders are coming on-board as "walk-ons" or "ride-ons" who do not participate in the actual fishing activity but fulfill the letter of the law by being on board during the harvesting of their IFQ (Van der Voo, 2013; Szymkowiak and Himes-Cornell, 2015). As these are de facto leasing relationships, the flow of benefits from the halibut and sablefish fisheries may not strictly be to those actively participating even with the exit of initial recipients (Szymkowiak and Himes-Cornell, 2015).

Intergenerational Equity and Entry Opportunities

In an overcapitalized fishery, the transition to catch shares is expected

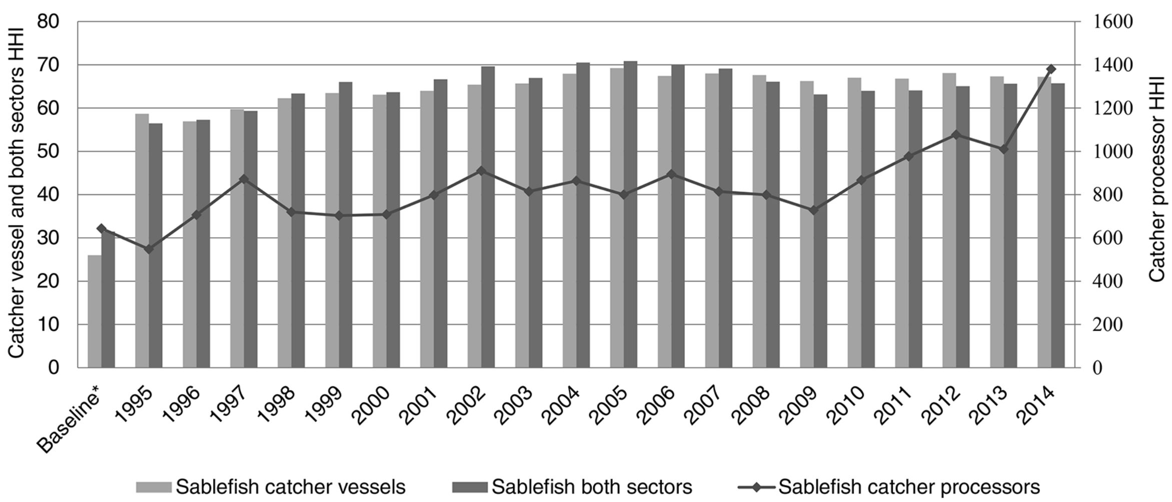

Figure 6.—Sablefish IFQ fishery HHI scores for catcher vessels, catcher-processor, and both sectors combined vessel revenue distributions from the baseline period (the average for 1992 through 1994) to 2014.

to reduce employment opportunities and create other adjustment costs, especially for crew (OECD, 2000). Since the implementation of the IFQ Program, the transition of QS to inactive shareholders, consolidation, and QS pooling have altered crew employment opportunities despite an IFQ programmatic objective to minimize these impacts (NPFMC/NMFS, 1992). The total number of crew jobs in the IFQ fisheries has likely decreased by several thousand (Hartley and Fina, 2001), due to overall consolidation as well as QS pooling and a reduced number of crew positions per boat resulting from the slower fishery (Casey et al., 1995).

With a decline in the number of available crew jobs, IFQ crew workshop participants also noted that the bargaining strength of crewmembers relative to vessel owners has decreased and, in turn, so have crew shares—the percentage of gross ex-vessel revenues that crewmembers receive. However, focus group participants also reported that, similarly to other catch share fisheries (Abbott et al., 2010), average seasonal crew earnings became more predictable and generally increased under IFQ's as average vessel revenues increased. Participants noted a perception of safety improvement in the fisheries as well because of the flexibility to choose fishing days and avoid bad weather, developing relatively consistent work schedules, and sleeping more while at sea, as well as reduced congestion on fishing grounds and the reduced need to haul gear as quickly as possible (Knapp, 1997; Carothers, 2013).[11]

Unless otherwise addressed, inequities in the generational distribution of catch share benefits may be inherent to this type of management regime. When an IFQ system gives rise to resource rents and QS are freely allocated to initial recipients with no mechanism for collecting some of this rent by resource managers, most of the resource rent may be captured by the first generation of quota shareholders when they exit and sell their shares and that value is paid by the incoming shareholders (Whitmarsh, 1998). Furthermore, the acquisition of QS is fundamentally different for initial recipients and new entrant QS holders. Initial recipients may utilize their initially allocated QS as collateral for loans or subsidize the purchase of additional QS through revenues generated from harvest of IFQ derived from initially allocated QS; opportunities that do not exist for new entrants.

In developing the IFQ Program, the NPFMC wanted to ensure that future participants in these fisheries were active fishermen. Therefore, it restricted QS acquisition to those who were initial recipients and those individuals that can demonstrate 150 days of crewing experience in any U.S. commercial fishery. Nevertheless, many of the trends already discussed for these fisheries that stemmed from other programmatic objectives or provisions would be associated with adverse effects on the availability of opportunities for new entrants including the transition of QS to inactive shareholders, consolidation, the (slightly) increasing proportion of larger class vessels, and the decreasing numbers of crew employment opportunities (NPFMC/NMFS, 2016).

We examine entry opportunities with respect to QS distribution by generation (initial recipient or new entrant—defined as any person who purchased QS in a given year and did not hold any QS in any previous year in either of the IFQ fisheries), average QS holdings by generation, and the rate of new entry (examined as the number of new entrants relative to all other QS holders in the fishery). Whereas the first two metrics provide information on how the fisheries have been transitioning to ownership by a new generation of participants, the third metric indicates perceptions of opportunities in the fisheries for new participants.

New entrants' QS holdings have been incrementally increasing since the start of the IFQ Program. Since 2009 and 2010 for the halibut and sablefish IFQ fisheries, respectively, new entrants hold the majority of QS, with 56% and 53% of the respective holdings (NPFMC/NMFS, 2016). However, there continues to be a large disparity in the amount of QS held by generation; in 2015, an individual initial recipients' average QS holdings were 21% and 55% greater than new entrant's QS holdings in the halibut and sablefish fisheries, respectively (NPFMC/NMFS, 2016).

There is indication that barriers to entry into the IFQ fisheries have changed over the 20 years of the IFQ Program. According to IFQ crew focus group participants, over the last decade decreasing TAC's, increasing QS prices, and rising operating costs associated with regulatory requirements have made entry more difficult. This is aligned with theoretical expectations and previous research indicating that as catch share programs reduce overcapacity and increase efficiency, the costs of QS rise and may become cost prohibitive for new entrants who often lack sufficient access to capital (Huppert et al., 1996; Dewees et al., 1998; Copes and Charles, 2004; Pinkerton and Edwards, 2009; Cardwell and Gear, 2013; Carothers[1]). Figure 7 shows that average QS prices (in 2014 dollars per pound of associated IFQ) in both IFQ fisheries have increased substantially since the early to mid-2000's.

The NMFS Fisheries Finance Program was established in 1996 in part to provide financing for QS in the halibut and sablefish IFQ fisheries. According to IFQ participants and QS loan agents interviewed for the IFQ Program Review, fisheries income diversification and collateral has become increasingly important as a means for new entrants to build up capital to buy QS and for lenders concerned about the health of the IFQ stocks. At the same time participation in alternative fisheries has become increasingly constrained by other limited entry programs (Kasperski and Holland, 2013; Holland and Kasperski, 2016), making it difficult for participants to meet requirements

[11]As part of the IFQ Review, NIOSH conducted a safety assessment of the IFQ fleets and concluded that although there has likely been some decrease in hazards as a result of IFQ's, fatalities have continued in the fisheries (NPFMC/NMFS, 2016).

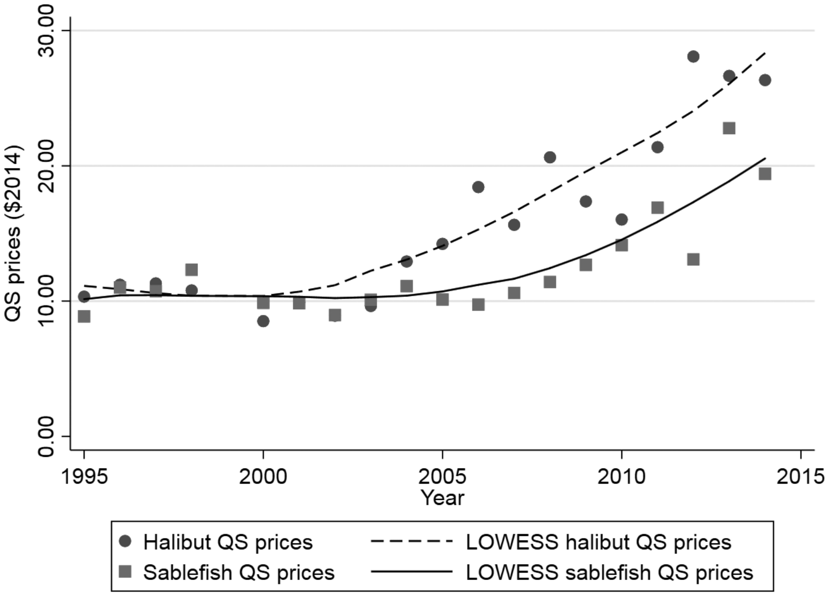

Figure 7.—Average halibut and sablefish QS prices from 1995 to 2014 with locally weighted scatterplot smoothing curves.

to qualify for loans. Holland et al. (2017) find that species diversification decreased after the implementation of the IFQ Program across all halibut and sablefish vessels (although they found no statistically significant difference in the coefficient of variations in vessel revenues before and after IFQ Program implementation for those that still participate in the fishery or for those that exited the IFQ fishery and fished other species). Consistent with expectations about these impacts from the literature and previous experience with catch share programs, the trend in the rate of new entrants (the number of new entrants as a percent of total quota shareholders) over the course of the IFQ Program (Fig. 8) demonstrates a considerable decrease in entry trends over the last 20 years.

Fishing Communities

One of the consequences of the derby-style halibut and sablefish fisheries prior to IFQ's, was over-capitalization in the processing sector (Matulich and Clark, 2003; Fell and Haynie, 2011). The switch to IFQ management was expected to slow the pace of the fisheries and gradually change the product form for halibut, as had happened following individual vessel quotas (IVQ's) in the British Columbia halibut fishery several years prior (Casey et al., 1995; Herrmann, 1996; Grafton et al., 2000).

These anticipated changes were expected to result in some geographic redistributions of IFQ landings from outside of Alaska into Alaska and among Alaska coastal communities to those with access to transportation, which would be critical in moving fresh product to markets (NPFMC/NMFS, 1992). There was also concern that the program could lead to a redistribution of QS ownership within Alaska away from rural Alaska communities.

As previously noted, to address these concerns, the NPFMC included several provisions to ensure the continued participation of Alaska coastal communities in the IFQ Program, including QS allocations by vessel class, limits on who can acquire and use QS, limits on leasing and hired master use, QS acquisition and IFQ use caps, and also through allocating a portion of the Bering Sea and Aleutian Islands (BSAI) halibut and sablefish TAC's to communities in the Bering Sea as part of the Community Development Quota (CDQ) Program.[12]

Since IFQ implementation, Alaska halibut has gradually increased in fresh production, averaging 48% fresh product from 1995 to 2014 (and 60% in 2013 and 2014) compared to 20% during the 1992 to 1994 baseline period (NPFMC/NMFS, 2016). Whereas the primary market for halibut is North America, sablefish is primarily processed for export to Japan (AFSC, 2016) and sablefish product forms largely did not change following IFQ implementation (NPFMC/NMFS, 2016). However, there is considerable overlap between the vessels that prosecute these fisheries, so changes in landing patterns for halibut affected sablefish landings as well. The IFQ Program in essence released some of the previous constraints and operational requirements associated with processing in the IFQ fisheries and allowed new processors without the capital investment in frozen processing capacity to enter the market. However, this also diminished the competitive advantage of some that had been processing these fisheries prior to IFQ and had previously invested in capital that was no longer necessary for the new market (Matulich and Clark, 2003; Fell and Haynie, 2011, 2013).

The decline of processors in these fisheries has been substantial, with 90% of the processors that had been processing halibut or sablefish pre-IFQ no longer participating in these fisheries (NMPFC/NMFS, 2016).[13] As other researchers have noted, pro-

[12]The CDQ Program was created by the NPFMC in 1992 to provide Western Alaskan communities with the opportunity to participate in federally-managed BSAI fisheries through harvest allocations. Given the highly capitalized nature of these fisheries direct harvesting opportunities for residents in these communities have been largely constrained to halibut due to its proximity to shore (Szymkowiak and Himes-Cornell, 2018).

[13]There are some general limitations to the underlying data used to examine processor entry and exit. The data is self-reported and any new buyer, including a previous processor that opened a plant in a different port or those that bought fish strictly for the purpose of transporting the fish to market, would qualify as a processor in this dataset.

cessor exit from the IFQ fisheries was also a function of trends in other fisheries in which the processor operated, poor business administration, and other personal circumstances (Dawson, 2006). The absence of a fish buyer in a community can contribute to QS selling decisions and thus adversely affect the capacity of a community to sustain participation (Szymkowiak et al., 2019).

Previous research on community impacts from the IFQ Program has explored the out-migration of QS from communities on the Alaska Peninsula subgroup (Tingley et al., 1998), participation in the QS market as explained by QS holder residency (Carothers et al., 2010), and impacts on traditional cultures and the social fabric of communities, crewmember empowerment, and entry opportunities (Carothers 2008, 2015; Carothers et al., 2010). In general, rural residents received relatively small initial QS allocations, likely had lower profit margins, were more susceptible to inter-annual variability in income due to limited employment opportunities, and had less access to capital to purchase additional QS (Carothers et al., 2010; Sethi et al., 2012; Sethi et al., 2014a,b; McDowell Group[14]).

Evidence of a decrease in participation in the halibut and sablefish fisheries by small and remote Gulf of Alaska communities following IFQ implementation precipitated the development of the Community Quota Entity Program in 2004, which allows for QS purchase by non-profit entities in these communities as a way to increase their participation (NPFMC, 2010). However, the program has had limited success in terms of inducing participation because the high costs of entry remain prohibitive for many communities (Carothers, 2011; NPFMC, 2010).

We examine changes in QS holdings and IFQ landings at the aggregated state level (Alaska, Washington, Oregon, and all other states) and

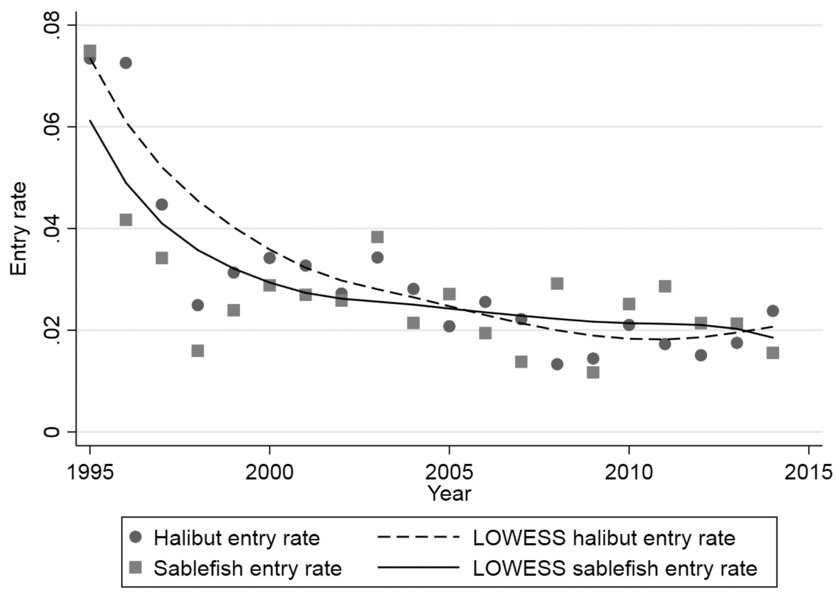

Figure 8.—Halibut and sablefish IFQ entry rates from 1995 to 2014 with locally weighted scatterplot smoothing curves.

the aggregated Alaska community level (rural and urban). Here, rural is defined as a community with fewer than 2,500 people, based on the U.S. Census Bureau definition. Rural communities are further decomposed on the basis of transportation access (road and airport access).

From IFQ implementation to 2014, the percentage of total IFQ landed pounds at Alaska shoreside processors has increased from 92% to 97% for halibut and from 99% to 100% for sablefish (NPFMC/NMFS, 2016). Concomitantly, there has been a shift of halibut and sablefish IFQ landings from remote communities (without airports or access to the road system) to those with airport access. Since the late 2000's, those communities without connections to the road system or commercial flights have had nearly no halibut or sablefish landings, decreasing from about 25% for halibut and 45% for sablefish during the baseline years (NPFMC/NMFS, 2016).

Since IFQ implementation, the proportion of QS held by Alaskans has been stable, decreased slightly for QS holders from Washington, remained stable for QS holders from Oregon, and increased slightly for QS holders in other states. Of the total QS held by Alaskans, the percentage held by those in rural Alaska has remained relatively stable since initial QS allocations, increasing by 3% for halibut QS and decreasing by 2% for sablefish QS from 1995 to 2015. Similarly to the changes in IFQ landings among rural Alaska communities, there has been a general movement of QS for both IFQ fisheries away from the more remote communities (without airport and road access) to those with transportation access (Fig. 9, 10). Because we did not hold the communities constant in the time series, the divergence in these figures in the trends in 2013 is due to a community being designated as rural due to a population decrease for a single year below the 2,500 cutoff. Expanding upon these findings, research also indicates that residency in a remote Alaska community is a significant contributor to the probability of selling halibut QS, even when accounting for various other community, individual, and QS characteristics (Szymkowiak et al., 2019). In addition to overall consolidation trends, the movement of processing capacity out

[14]McDowell Group. 2005. Community quota entity financial analysis, prepared for Southeast Alaska Inter-tribal Fish and Wildlife Commission.

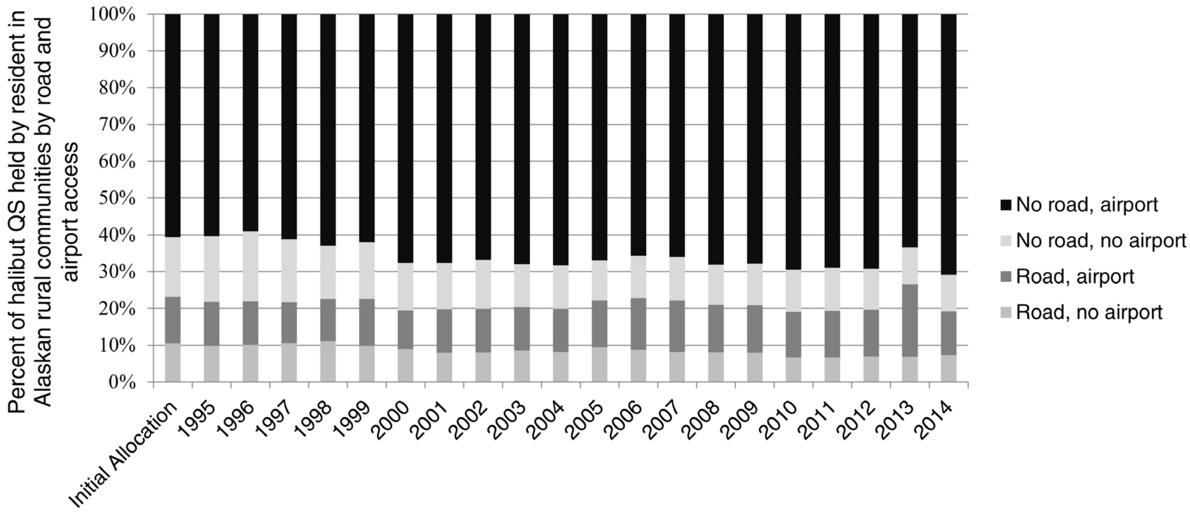

Figure 9.—Percent of halibut QS held by rural Alaska residents by community transportation access.

of some remote rural Alaska communities potentially created spillover impacts on availability of support services and on fuel prices, impacting operating costs for IFQ fishermen in these communities and how competitive they could be in the market for QS.

Conclusions

As intended at its outset, the Pacific halibut and sablefish IFQ Program provided for decreased harvesting and processing capacity in the IFQ fisheries and the elimination of the previous derby fishing conditions. However, similar to other catch share programs, the IFQ Program created winners and losers in terms of the temporal and spatial distribution of outcomes. This occurred despite many and varied provisions intended to limit adverse impacts on participants, which may not demonstrate the flaws of the provisions themselves but the difficulty of balancing objectives, such as harvesting and processing capacity reductions while also providing fleet, stakeholder, and community protections. Our ability to understand the effects of the program across these various distributional layers was constrained by the use of secondary data sources some of which were highly limited in temporal scope and representativeness. Future extensions of this research could reasonably warrant a primary data collection effort for each of these distributional effects and a mixed-methods approach that integrates ethnographic research to understand how impacts reverberate throughout communities.

Nevertheless the IFQ Program does offer a number of lessons specific to how programmatic provisions have related to policy outcomes for some distributional objectives. As previously noted by Szymkowiak and Himes-Cornell (2017), regulatory exemptions for initial recipients with respect to the owner-on-board mandate created a decades-long lag in the transition to an owner-operator IFQ fleet while regulatory loopholes in leasing provisions may allow for continued absenteeism. If lessees are stretched in their capacity to make a profit harvesting others' IFQ's, there may be long-term negative implications for the sustainability of the resource and safety of the fleet.

Despite limits on consolidation, QS trading and leasing, and who can participate in the IFQ fisheries, QS prices have risen considerably over the two decades of the IFQ Program and entry has decreased considerably. Although this was not systematically examined in this study, high QS prices may be tied to the continued exploitation of some IFQ regulatory exemptions and loopholes, but may also be associated with diminishing diversification opportunities for Alaska fishermen more broadly. Coupled with decreasing crew employment opportunities in the IFQ fisheries due to consolidation and increases in lease rates, high QS prices have made entry into the IFQ fisheries prohibitive for many individuals. However, some conditions of crew employment have also likely improved, including perceptions of safety, average earnings, and predictability of the latter. Thus the availability of crew jobs and upward mobility may have been adversely affected while the type of job that IFQ crew have may have improved.

There is also indication that some of the provisions of the IFQ Program were effective at curtailing a complete redistribution of QS within the fleet, but less so when examining QS transfer patterns at the community level in Alaska. Quota share allocations by vessel class and trading prohibitions provided for fixed QS distributions, but changes in the fleet composition over time do indicate that the diversity of the fleet would have likely changed

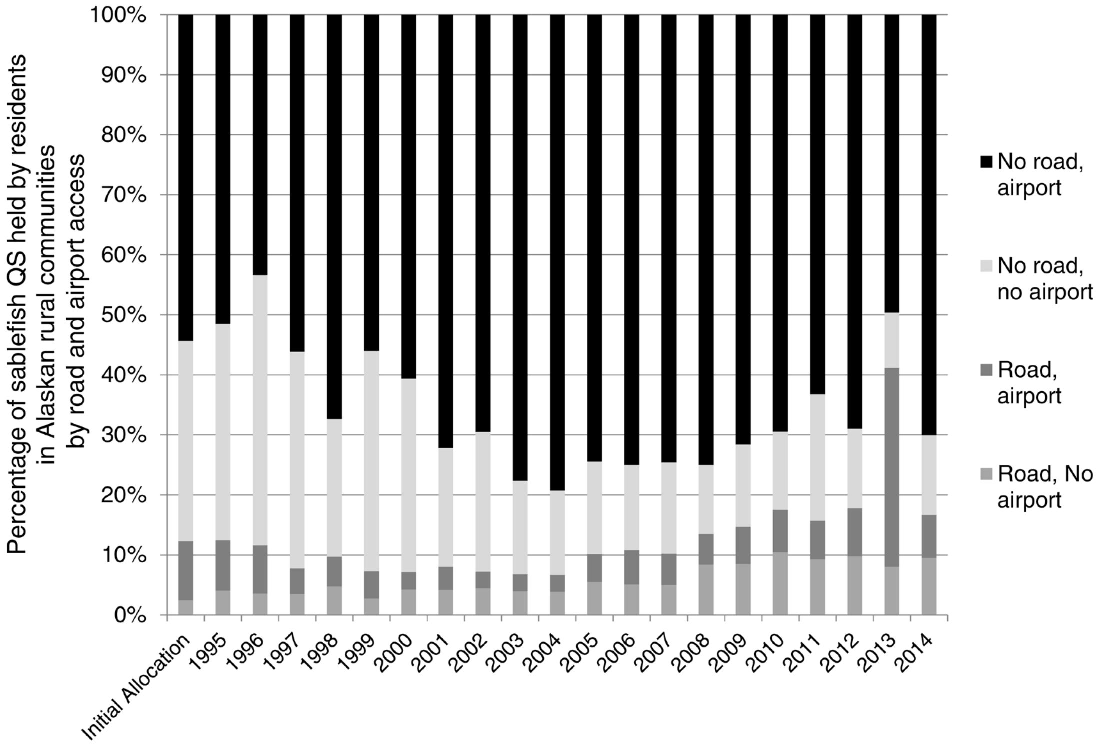

Figure 10.—Percent of sablefish QS held by rural Alaska residents by community transportation access.

given further regulatory flexibility. At the community level, however, there are demonstrable losses of QS from remote Alaska communities, many of which were likely associated with product form changes which necessitated transportation access, as shown in this study and that of Szymkowiak et al. (2019). Thus, although maintaining opportunities for the smallest vessel class in the IFQ fisheries was envisioned as a mechanism of protecting Alaska coastal communities, it did not effectively curtail QS transfers out of the most remote communities, which may have been associated with product form changes and the loss of buyers, as well as broader social dynamics and changes in other fisheries that would not have been easily addressed with regulatory provisions simply in the IFQ Program.

The IFQ Program also offers a number of lessons for catch share program design and review. Clear, measurable targets or objectives should be determined at the outset of a new management program so that the program may be evaluated in a meaningful way. For example, the NPFMC wanted to address excess harvesting capacity in the fixed gear halibut and sablefish fisheries, but it did not define excess or a level of desired capacity in the IFQ fisheries. As others have also noted, baselines and methodologies for programmatic evaluations should also be pre-determined, and readily understood metrics should be supplemented with rigorous analytical methods (Agar et al., 2014). Measurable targets would also facilitate evaluating a program that has contradictory objectives, like addressing excess harvesting capacity while limiting consolidation and maintaining fleet diversity. Progress toward addressing excess harvesting capacity would inherently result in consolidation, potential reductions in fleet diversity, and challenges for entry. Determining metrics and targets for these objectives at program development would have made the concurrent attainment of these objectives feasible rather than inherently contradictory.

Finally, complementary to measurable targets is the necessity for regulatory agencies to have the mechanisms to gather, validate, and store the appropriate data to track performance metrics. Some of the IFQ programmatic objectives related to distributional impacts lacked the data to design an appropriate metric to evaluate performance. For example, lack of any data on crew members in the IFQ fisheries precluded a systematic examination of IFQ impacts on crew employment in terms of number of jobs, duration/seasonality, earnings, upward mobility, etc. The fisheries also lack any cost and effort data for examining net returns or rent or data on lease rates to determine net benefits to participants or the nation. Data collections implemented prior to the development of a program can provide information to systematically track performance against stated objectives using relevant baseline periods. Furthermore, although such initial data collection programs may be time intensive at the beginning, there is likely to be less work associated with maintaining long-standing data collections from both the respondents' and an administrative standpoint, which has been demonstrated in the Economic Data Collection Program implemented as part of the west coast groundfish trawl rationalization program (Steiner[15]).

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