

Learning to Share the Fish:
A Multiple Case Study on the Use of Market-Based Mechanisms in U.S. Federal Fisheries Management

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Abstract

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The problems of subtractability and low excludability often lead to overexploitation of common pool resources such as fisheries. Market-based mechanisms, or catch shares, are a collection of policy innovations increasingly employed in fisheries management to address a variety of policy problems including overfishing and overcapitalization. Catch shares have been successful domestically and internationally in protecting the productivity and sustainability of the resource, the industry, and the culture built around it. Yet, this policy instrument remains controversial for both its intended and unintended consequences and the trade-off between economic efficiency and social equity that is often at the heart of these issues. This thesis traces the innovation in the design and use of catch shares by the Regional Fishery Management Councils to more effectively reach policy objectives over time. I used a multiple case analysis framework based on the existing theory of policy and instrumental learning and policy diffusion to examine how new information, knowledge, and experience was or was not incorporated into a Council's development process of a catch share program.

Additionally, I analyzed the learning outcome of each case based on the original design of the management program. Four distinct programs were analyzed that vary temporally from the first catch share implementation in the U.S. to one of the most recent. I found that significant learning occurred overall, however the process and outcome manifested in considerably different ways between the cases. The learning process incorporated the experience of other Councils in employing catch share management and prior experience of a Council had an important influence on later developments by

the same Council for other fisheries. The program development in each case was inextricably linked with the unique contextual characteristics of the fishery; this finding emphasizes the importance of reinventing the development process for each new catch share program. The analysis of the four cases showed that Councils have continued to innovate in the development of catch shares, but continue to struggle with preventing unintended consequences such as consolidation. Therefore, learning must continue for catch shares to be an effective and successful tool for the long-term management of fisheries.

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1.1 | The problem of common pool resources

Aristotle asserted “That which is owned by everyone is taken care of by no one” (Allen 2005). This conceptualization of the problem of common pool resources (CPR) has been advanced through the years in the works of many great scholars. A seminal piece by H.S. Gordon in 1954 conceptualized fisheries as CPRs with the argument that fishery overexploitation problems stemmed from the lack of individual property rights (Copes 1986). Garrett Hardin was also an early pioneer who analyzed why common ownership of natural resources often leads to overexploitation, which he described as the ‘tragedy of the commons’ (Hardin 1968). Hardin argued that effectively managing CPRs required privatization of the resource or government intervention via public policy to prevent economically inefficient consumption (Hardin 1968). Hardin’s work was very influential and natural resource management often still draws on his promotion of mutual coercion through public policy regulation (Ostrom et al. 1999).

Elinor Ostrom has also been a very prominent figure and leader in advancing the study of CPRs. Ostrom’s work has challenged the focus on privatization and rigid central governance as the best solutions by focusing on how user groups can effectively manage commons by developing sustainable institutions for governance (Ostrom et al. 1999). Ostrom was awarded the Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel in 2009 for her work in economic governance and on the commons in particular. Regardless of the solutions proposed, many scholars agree that the problem of CPRs stems from the tendency towards overexploitation of these resources because the benefits of exploitation are borne individually while the costs are borne collectively (Hardin 1968; Ostrom et al. 1999; Stavins 2001). Ultimately, CPRs are resources that have characteristic subtractability, or rivalry in consumption, and difficulties of exclusion that create trade-offs between short-term and long-term benefits and between individual users and user groups (Ostrom et al. 1999). These characteristics also often contribute to a market failure (Dolšak 2007). This occurs when the market does not allocate a good efficiently and therefore does not promote efficient consumption (Weimer and Vining 2011). Both privatization and government intervention have been designed to manage the underinvestment in preservation of the resource and overinvestment in production capital for resource extraction and use (Weimer and Vining 2011). Many natural resources exhibit CPR characteristics and fisheries are a prominent example.

Before the advent of dedicated research and study, the oceans were viewed as limitless. This was especially true for fish. It often seemed unfathomable that there would ever be a day when there were not enough fish in the sea to feed the masses (NRC 1999). However, that day did come as humans

became more and more successful at harvesting even the furthest reaches of the ocean (Alcock 2002). New technologies allowed, and made profitable, fishing farther and farther offshore and into areas previously inhospitable to fishing activity (Berkes et al. 2006). Catches skyrocketed and this likely served to entice more people to try their luck in the industry. The once preposterous concept of overfishing, when harvest rates exceed a stock's ability to replenish itself, became the norm in many of the world's most productive and iconic fisheries such as Atlantic cod (Berkes et al. 2006). Overfishing then often led to the collapse of fish stocks (Costello et al. 2008). As the ranks of fishermen swelled, the problem of CPRs was amplified in what became known as the 'race for fish' in which too many fishermen chased too few fish (Gordon 1954). Fisheries were often afflicted with overfishing and the overcapitalization problems that resulted from having too many fishermen targeting a specific stock. The race for fish was also frequently accompanied by serious safety issues for industry participants (Huppert 2005). The dual problems of overfishing and overcapitalization threaten the productivity and sustainability of the resource, the industry, and the culture built around fisheries. The value of the fishing industry¹ and the common pool nature of the resource have long required considerable management oversight to overcome the individual incentive towards overexploitation (Arnason et al. 2000).

1.2 | Fisheries management law and policy: 1976 - current

The market failure of harvesting activity in fisheries substantiates public policy intervention. The rationale behind the government as managers of this natural resource in the U.S. is rooted in the Public Trust Doctrine which charges the government with protecting the collective rights of the public to use and enjoy public land and water (Turnipseed et al. 2009). *Jus publicum*, or public law, specifically dictates that living marine resources such as fish are publically owned and are held in trust under the stewardship of the government. The activity of fishing itself is also a protected public trust right (Turnipseed et al. 2009). The modern era of government management intervention in the U.S. fishing industry began under the Fishery Conservation and Management Act (FCMA) of 1976 (P.L. 94-265). The Act extended National jurisdiction over the ocean out to 200 nautical miles from all U.S. held land (FCMA 1976). The FCMA created a unique regional management structure as the framework of federal fisheries management, which devolves significant authority to eight Regional Fishery Management Councils: the North Pacific, Pacific, Western Pacific, Gulf of Mexico, Caribbean, South Atlantic, Mid-

¹ The US commercial fishing industry harvested 8.3 billion pounds of finfish and shellfish in 2008, worth a valued USD 4.4 billion. Additionally, a 2008 estimate showed that 1.5 million people were employed (part-time or full-time) by the commercial seafood industry (including the commercial harvest sector, processors, dealers, wholesalers, distributors, and retailers in the US (NOAA Fisheries Service 2011).

Atlantic, and New England Fishery Management Councils. The Councils have the authority to develop Fishery Management Plans (FMP) tailored to the stocks targeted by commercial and recreational fisheries in its regional jurisdiction. This Regional Council framework for managing the nation's fisheries was developed to foster collaboration between federal and state bodies and participatory governance with fisheries scientists and industry members (NRC 1999).

The general policymaking process involves the Councils making management decisions after weighing input from the Science and Statistical Committee (SSC), the Advisory Panel (AP), any other relevant committees created by the Council, and members of the public. Following the Councils' decisions, the implementation of rules and regulations is put in the hands of the National Marine Fisheries Service (NMFS)² which must first determine if the Council actions satisfactorily meet the legal guidelines in the FCMA. Stocks that cross regional boundaries are managed jointly by the adjacent Councils and stocks crossing multiple boundaries are considered Highly Migratory Species and are managed by NMFS. In the FMPs, Councils may employ any number of management tools or policy instruments that each may choose, the instruments generally boil down into two categories, input and output controls. Input controls or effort controls include measures such as limits on the number of participants in the fishery (i.e. limited entry) or the gear type allowed for harvesting (NRC 1999). Output controls include Total Allowable Catch (TAC) and Annual Catch Limits (ACL) or specifications on the sex or individual size of fish allowed to be harvested. The decentralized structure of federal fisheries management gives significant deference to each Council to employ management tools tailored to an individual fishery's economic, ecological, and social characteristics as each sees fit (NRC 1999). The overarching federal role in management in approving the FMPs is limited to assessing how well the plan meets the FCMA policy objectives. Collectively, these objectives are the National Standards (see below). Seven of the National Standards were laid out in the original 1976 policy and three were added later in the 1996 Sustainable Fisheries Act (SFA) (P.L. 104-297), a reauthorization of the FCMA (NRC 1999).

Almost four decades of federal fisheries management after the original fisheries policy implementation has seen significant failures in the traditional policy approaches to meet the management objectives (Hilborn et al. 2004; Beddington et al. 2007). Chronic overfishing and overcapitalization problems have plagued fisheries and have been associated with significant economic hardship on the industry and vulnerable coastal communities due to the individually and collectively falling catches. Traditional regulatory output controls based on the TAC of a stock have been shown to

² NMFS falls under the authority of the National Oceanic and Atmospheric Administration (NOAA) in the Department of Commerce.

often lead to 'derby-style' fisheries that pit every fisherman against the others to individually harvest as many fish as possible before the collective TAC is hit, which triggers the closing of the fishery (Huppert 2005). This race for fish has been linked to ownership rights that only kick in when the fish is in the boat, so that each fisherman has to get as many fish in the boat as possible before the other fishermen can get them (NRC 1999). This effect is the characteristic subtractability and nonexcludability of the resource. Fisheries managed with output regulations and few input regulations frequently overshoot the TAC (Melnychuk et al. 2011). This is frequently because of limitations on monitoring catch while keeping up with derby fishery harvesting rates. Additionally, many derby-style fisheries have had serious safety issues, poor product quality, and high rates of gear loss³ which negatively impact both the profitability of fishermen and the ecosystem (NRC 1999). Traditional input controls such as total number of fishing days were limited to one or just a few measures of effort thus motivating capitalization in other effort measures. This often incited an arms race between resource users and resource managers (Marvin 1992). These traditional measures may not fully fit the definition of command-and-control resource management due to the decentralized structure of federal fisheries management. However FMPs that dictate when, where, how, and how much fishermen can harvest arguably have a similar negative effect on user behavior as command-and-control management of other resources.

The overwhelming failure of the traditional policy and instrument approaches to meet the objectives of fisheries management has demanded a course correction (NRC 1999). Substantive changes to the policy approach to effectively meet the National Standards necessitated changes in the management toolkit available for Councils to develop individual FMPs. The course change in policy instruments began at the Council level with experimentation in the design and use of market-based mechanisms in individual FMPs (Fina 2011). The policy changes vacillated first in the SFA in opposition to the instrument changes and then in support of them in the 2006 reauthorization of the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) (P.L. 109-479). This flip-flopping of the central guiding legislation for domestic fisheries characterized the controversy of shifting from the basic fisheries management paradigm of regulative approaches to the promotion of a more incentive-based system utilizing market-based mechanisms (Sullivan 2001).

³ The issue of derelict fishing gear often contributes to the problem of ghost fishing, where lost or abandoned gear continues to catch marine life incidentally and indiscriminately (NRC 1999).

1.3 | The MSFCMA National Standards (P.L. 109-479)

(1) Conservation and management measures shall prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery for the United States fishing industry.

(2) Conservation and management measures shall be based upon the best scientific information available.

(3) To the extent practicable, an individual stock of fish shall be managed as a unit throughout its range, and interrelated stocks of fish shall be managed as a unit or in close coordination.

(4) Conservation and management measures shall not discriminate between residents of different States. If it becomes necessary to allocate or assign fishing privileges among various United States fishermen, such allocation shall be (A) fair and equitable to all such fishermen; (B) reasonably calculated to promote conservation; and (C) carried out in such manner that no particular individual, corporation, or other entity acquires an excessive share of such privileges.

(5) Conservation and management measures shall, where practicable, consider efficiency in the utilization of fishery resources; except that no such measure shall have economic allocation as its sole purpose.

(6) Conservation and management measures shall take into account and allow for variations among, and contingencies in, fisheries, fishery resources, and catches.

(7) Conservation and management measures shall, where practicable, minimize costs and avoid unnecessary duplication.

(8) Conservation and management measures shall, consistent with the conservation requirements of this Act (including the prevention of overfishing and rebuilding of overfished stocks), take into account the importance of fishery resources to fishing communities by utilizing economic and social data that meet the requirements of paragraph (2), in order to (A) provide for the sustained participation of such communities, and (B) to the extent practicable, minimize adverse economic impacts on such communities.

(9) Conservation and management measures shall, to the extent practicable, (A) minimize bycatch and (B) to the extent bycatch cannot be avoided, minimize the mortality of such bycatch.

(10) Conservation and management measures shall, to the extent practicable, promote the safety of human life at sea.

1.4 | **Market-based mechanisms in fisheries management**

The growing use of market-based mechanisms as a fisheries management tool has mirrored efforts underway in management regimes of other CPRs⁴ that employ new strategies drawing on market tools to shape user behavior (Stavins 2001). The underpinning of most market-based mechanisms is the creation of property or quasi-property rights for a resource that is collectively owned (Huppert 2005). The creation of property rights then affords the right-holder a level of security in their allowed use of or access to the resource so that they may choose more cost-efficient ways to utilize it (Copes 1986). While the creation of property rights is central to the use of market-based mechanisms in natural resource management, the application to fisheries has been very unambiguous in that such programs do not confer full property rights (MSFMCA 2006). Instead quasi-property rights confer the privilege to holders to access the stock and at least attempt to harvest a certain percentage of the TAC. Market-based mechanisms in fisheries create quasi-property rights because the government retains ultimate control over the resource and its conservation (Marvin 1992). Thus, market-based mechanisms in fisheries are a middle ground between full privatization of the resource and government control. In creating a right to use or access the resource, a market-based mechanism creates a market value for it that then can be incorporated in decisions by resource users about how, when, and to what extent they will use the resource to achieve the maximum benefit. In CPRs like fisheries, the problem is then shifted from that of a CPR problem into that of a business efficiency issue (Ohashi 2010). The shift to market-based mechanisms has occurred in tandem with the redefinition of the policy problem from being too few fish to too many fishermen which then makes the race to fish the underlying issue. Framing the problem definition as too many fishermen further argues for the inefficacy of traditional management in fisheries because command-and-control regulation cannot address problems that are essentially economic and social in nature (Allen 2005).

⁴ i.e. air pollution controls (Dolšak and Sampson 2011)

Market-based mechanisms take on many different shapes in fisheries but are built off the same general principles in using economic logic to better achieve management objectives. These management strategies in fisheries are collectively referred to as catch shares. The term catch share is broadly defined as a management tool that allocates privileges to access and harvest a specific portion of fish to a group of participants (Fina 2011). Over time the catch-all term of catch shares has encompassed an ever growing litany of adapted management programs including Individual Transferable Quotas (ITQ), cooperatives, Community Development Quotas (CDQ), and others (Sullivan 2001). These adaptations differ in what entities can be initially allocated the privilege and which can more generally hold the privilege, among other differences. The U.S. Commission on Ocean Policy described catch shares as Dedicated Access Privileges (DAP) in their 2004 report and emphasized that what was being granted was access to the resource rather than ownership of the harvest (Anderson and Holliday 2007). The MSFCMA refers to catch share management strategies as Limited Access Privilege Programs (LAPP). It specifically states that a limited access system may not create or grant a right, title, or interest in the fish stock to the holder of a privilege and that no claims of compensation can be made if changes are made to the program under which the privilege was derived.

Even though the legal standing of what type of privileges a catch share program can create and allocate to resource users is limited, the privilege or access right in the form of a quota share (QS) still creates the security in allowed resource use to end the race to fish and allow for more rational⁵ harvesting (Holland and Ginter 2001). And often while the central policy goal of a market-based mechanism may be realizing efficiency, secondary goals may be facilitated in using this management tool as well. This is because ownership, even quasi-ownership, can extend the decision timeframe farther into the future and reduce discounting for that resource to encourage more conservative use of the resource in the present (NRC 1999). Secondary goals that may be achieved through the use of market-based mechanisms in fisheries include incentivized stewardship and the promotion of sustainable harvest decisions made by the resource users outside of regulatory requirements. This may help fishermen proactively achieve long-term sustainability in their livelihood. The implementation of rights-based fishery management systems has largely proven to be a successful policy innovation in fisheries worldwide when evaluated on the metrics of increased economic efficiency, realized incentives for conservation, and reduced fleet capacity (NRC 1999; Huppert 2005). Catch share programs have shown success in stopping overfishing by slowing the pace of harvest and allowing more careful

⁵ Many fisheries that undergo the transition into catch share management are often referred to as being 'rationalized' which refers to the perceived economic rationality of private property rights (Mansfield 2004).

monitoring of catch in relation to the TAC. Additionally, they can afford flexibility to fishermen to choose when and where to harvest based on preferable market and ocean conditions to optimize profitability and safety (NRC 1999). Catch shares have also been shown to increase employment stability for fishery participants (Bonzon et al. 2010).

Often catch share programs are collectively referred to as Individual Fishing Quotas (IFQ); however this may be a misnomer as many programs allow for more than just individuals to be holders of privileges. For this reason, terms such as DAPs and LAPPs are useful in recognizing that the privilege can be conferred to many different entities including corporations, cooperatives, and communities (Anderson and Holliday 2007). Catch share programs may also differ in how they approach the issue of transferability of the privilege, which is the prevailing difference between IFQs and ITQs. And some catch share programs combine multiple types of privileges such as in the Bering Sea King and Tanner Crab program that uses IFQs, Individual Processor Quotas (IPQ), CDQs, and cooperatives (Fina 2011). Catch share ideas have been implemented in a variety of fisheries that differ in their management setting as well, including state⁶ versus federal fisheries. The implementation of a catch share program can be catalyzed by a range of fishery issues and the design of a program depends on the unique social, ecological, and economic character of a fishery. This helps explain the numerous existing adaptations of the general market-based mechanism paradigm in fisheries (Huppert 2005).

1.5 | Federal law and policy for catch share programs

The momentum behind catch share program management in U.S. fisheries was largely initiated by a bottom-up movement of individual Councils (Schikler 2008). The new management direction was advanced at the individual Council level with the implementation of programs like the Atlantic Surf Clam and Ocean Quahog ITQ program in 1990 and the Alaska Halibut and Sablefish IFQ program in 1995. The increase in the use of market-based mechanisms in fisheries and the potential unintended consequences of these programs such as excess fleet consolidation was scrutinized by some involved in the industry and management (NRC 1999). The lack of federal experience with the catch share program management strategy and growing industry concern led to a federal moratorium on new IFQ program implementations in the 1996 SFA. The Act commissioned the National Research Council (NRC) to gather information and report on the potential use of this management tool in U.S. fisheries during the

⁶ Existing state level catch share programs include the Alaska weathervane scallop program (Kitts and Edwards 2003) and the Florida spiny lobster trap certificate program that is based on tradable effort permits (Larkin and Milon 2000).

moratorium (Schikler 2008). The SFA also required catch share program developments to take the NRC report into consideration after the moratorium was allowed to expire (SFA 1996).

The NRC delivered its report in 1999 which contained a comprehensive review of the theory behind catch share programs and individual case studies of extant programs in Sharing the Fish: Toward a National Policy on Individual Fishing Quotas. The report highlighted the positive effects catch share tools had been shown to have on problems such as overcapitalization and overfishing with evidence from several fisheries domestically and internationally (NRC 1999). The recommendations of the report were to allow flexibility in catch share program design and use on a fishery-by-fishery basis at the discretion of the Councils because of the positive potential impacts catch shares could have compared to other alternative management strategies. The NRC also pointed out that great care needed to be taken in design and implementation to prevent negative consequences such as excess consolidation (NRC 1999). The report ultimately recommended that Congress lift the moratorium on new catch share programs that was set to expire in 2000 and to amend the SFA to specifically allow Councils to have flexibility in the design and use of market-based management mechanisms (NRC 1999). However, Congress instead added a two year extension to the federal moratorium, which later expired in 2002 (Fina 2011). The moratorium expired without changes to the central policy or direct mandates on catch share program use based on the findings and recommendations of the NRC report. More detailed legislated mandates were limited until the reauthorization of the SFA in 2006.

In the interim between the 1996 SFA and the 2006 MSFCMA, the U.S. Commission on Ocean Policy delivered a report in 2004 also acknowledging the potential benefits catch share programs could offer fisheries and recommended there be federal guidelines to ensure the successful design and implementation of this management strategy (US Commission on Ocean Policy 2004). Catch share programs as a fisheries management tool were more explicitly addressed with the MSFCMA Reauthorization in 2006. Respecting the traditional decentralized framework of the policy, the MSFCMA does not require Councils to consider or employ catch share programs. The policy leaves market-based mechanisms as an option in the management toolkit should a Council feel it would effectively address the management objectives of a FMP (NOAA Catch Share Policy 2010). Under the MSFCMA, catch share programs are a potential management option that must effectively address the ten National Standards as any non-catch share FMP would as well as must assist in rebuilding overfished stocks, reduce capacity in overcapitalized fisheries, include detailed plans for monitoring and review, and promote social and economic benefits (MSFCMA 2006). The specifics of the program design incorporating these

requirements and other provisions to meet fishery-specific objectives are left to the discretion of the Councils.

Guidelines specific to catch share program design have been put forth in two National Oceanic and Atmospheric Administration (NOAA) Technical Memorandums (*Issues and Options in Designing and Implementing Limited Access Programs in Marine Fisheries*, 1998; and *The Design and Use of Limited Access Privilege Programs*, 2007) and the NOAA Catch Share Policy (2010). The 2007 NOAA Technical Memorandum is a highly detailed report that addresses program design decisions by assessing how various elements may be trade-offs in catch share program design like, for example, balancing transferability provisions with social concerns about maintaining the viability of smaller entities in the fishery. The Memorandum offers a framework for analyzing potential design elements of a catch share program based on already established federal programs (Anderson and Holliday 2007). This document best applies to Councils already seriously considering pursuing a catch share program alternative for a particular FMP, it offers a step-by-step process to flesh out a program design based on the intricacies of a specific fishery. NOAA's Technical Memorandum (2007) lists criteria it deems catch share programs should meet, including: compliance with the National Standards, with the MSFCMA in general, and with other applicable laws⁷; consistency with Council determined management objectives for the fishery; internal consistency; simplicity to the extent practicable; compatibility with other related FMPs; operational effectiveness; and lowest possible cost of implementation and operation.

The NOAA Catch Share Policy (2010) includes catch share guiding principles that it recommends be considered in the design process of catch share programs including advice on allocations, distinctions among sectors, and cost recovery. The Policy also states NOAA's commitment to helping Councils explore, design, and implement catch share programs in fisheries where it may be appropriate (NOAA Catch Share Policy 2010). In addition to federal guidance, guidance on the design and use of catch shares has been offered by various non-governmental organizations (NGO). The Pew Environment Group put out a report incorporating recommendations on the design and use of catch shares in 2009 titled "Design Matters: Making Catch Shares Work". This report recommends explicit conservation, social, and economic goals be laid out in each program with metrics and monitoring plans to determine the program's effectiveness in meeting these. The Pew document also recommends that the allocation process of privileges should be transparent and include opportunities for new fishermen to enter the fishery. The Environmental Defense Fund (EDF) and Ecotrust have also distributed reports on the

⁷ i.e. The American Fisheries Act (1998) (P.L. 105-277)

subject: EDF's 2010 "Catch Share Design Manual: A Guide for Managers and Fishermen" and Ecotrust's 2007 "Market Design for Limited Access Privileges Programs in U.S. Fisheries".

The above reports and detailed guidance on the design and use of catch share program mechanisms in management in the U.S. came after several of the federal programs were already in place. Thus the policy arena relevant to catch shares in fisheries management changed significantly between earlier and later implementations. And much of the official federal guidance: the 1999 NRC report, the 2007 NOAA Technical Memorandum, and the 2010 NOAA Catch Share Policy, drew upon experience gained from the early implementations. This reflects that the catch share program early adopter Councils led the charge towards operationalizing incentive-based management and played an important role in the policy experimentation of catch share programs (Schikler 2008). The early adopters were trailblazers in refining aspects of program design and interpretations of the language of the MSFCMA through trial and error. This contribution to the unofficial clearinghouse of catch share program information may subsequently have influenced later adoptions of programs across U.S. federal fisheries.

No two fisheries are exactly alike when considering the intertwining biological, economic, and social fabric of each; so it would logically follow that no two catch share programs should be alike (Anderson and Holliday 2007). In addition to design differences, the preemptive reasons Councils may or may not consider pursuing catch share programs are unique to each Council and stem from many sources. The most obvious reason is that catch share programs are not suited for all fisheries nor are they a panacea for all struggling fisheries (Anderson and Holliday 2007). There are certainly political pressures involved with catch share programs⁸ and regional differences in public and industry sentiment about the desirability of this management strategy. Overall, though, the role of catch share programs in U.S. federal fisheries management is continuing to increase. NMFS currently recognizes 528 individual stocks and stock complexes⁹ managed in 46 FMPs (NOAA Fisheries Service 2011). There are currently 15 federal fisheries managed as catch share programs that fall under the jurisdiction of six different Regional Fishery Management Councils. Many Councils have been proactive about exploring and developing catch share programs, while others have been less actively pursuant.

⁸ The Southerland-Grimm Amendment to the Commerce, Justice, Science, and Related Agencies Appropriations Act for 2013 (H.R. 5326) passed the House 220-191 on May 8th, 2012. If passed by the Senate, the Amendment would prohibit the use of federally-appropriated funds to develop or implement any new LAPPs by the South Atlantic, Mid-Atlantic, New England, and Gulf of Mexico Councils.

⁹ A fishery may be based on a single stock or geographic population of fish or on a stock complex that incorporates several fish populations that are caught together in the same gear. The MSFCMA recognizes a fishery as a stock or group of stocks managed as a unit (MSFCMA 2006).

1.6 | Catch share controversies

The use of catch share programs in fisheries is not without controversy. This policy instrument has been criticized for both its intended and unintended consequences that often iron out into controversies about the trade-offs between economic efficiency and social equity (Guyader and Thébaud 2001). Unintended consequences of catch share programs may include the shifting of excess capacity from that fishery into others with less restrictive management and high-grading practices where target fish are discarded to attempt to catch other fish of a potentially higher quality or of a particular size, etc (Black 1996). Intended consequences of catch share programs that are frequently criticized include the loss of employment opportunities that comes with the reduction in capacity of a fishery (Copes and Charles 2004). Additionally, reorganization of the harvesting-processing relationship may occur that favors some ports over others thereby impacting communities historically dependent on port or shoreside processor activity. Enduring social equity concerns in the design and use of catch share programs include unbalanced power relationships between owners of privileges and crew members, windfall gains in initial allocations, barriers to new entry, consolidation of privileges in the hands of a few participants, and privatization of a public good (Guyader and Thébaud 2001; Copes and Charles 2004). These equity problems may result from the embrace of free market ideals that promote the achievement of economic efficiency. Dealing with the social equity concerns often requires the curtailing of full free market characteristics like complete transferability of privileges. In general, arguments against catch share programs often stem from the controversy of economic allocation and social engineering in the choosing of 'winners and losers' by the Councils and NFMS (NRC 1999).

Catch share programs may also leave residual ecosystem externalities in fisheries such as bycatch (Criddle and Macinko 2000). There are also administrative issues such as the high cost burdens of designing, implementing, and administering catch share programs in comparison to other management tools (Huppert 2005). Additionally, concerns about how much input industry should have in deciding to transition a fishery to catch share management has resulted in referendum requirements for the New England and the Gulf of Mexico Councils (MSFCMA 2006). The implementation of a catch share program represents a significant management shift in many fisheries that often creates path dependence in policy rigidity. This is because transitioning to catch share systems is often accompanied by substantial business decisions made by industry participants in response to quota allocations or new management requirements (NRC 1999). And occasionally rumors of catch share development in particular fisheries create a 'fishing for history' effect in which fishermen prospectively overfish to increase their personal catch history because that is often a major determinate in quota allocations

(Macinko 2005). These enduring criticisms of catch shares have played out in numerous proposed Congressional bills¹⁰ to create substantive and procedural requirements for catch share program design and implementation (McCracken et al. 2005). The contention has resulted in a continued conversation between industry members and fishery managers as to the pros and cons of this management strategy and the nuances of program design.

1.7 | Learning and catch share management

The underlying rationale for this research is that catch shares have had both documented and perceived successes and failures in different fishery applications. The costs and benefits for fisheries transitioning to and being managed under market-based mechanisms are still being debated. Costs and benefits must be balanced out in the design of individual catch share programs and managers must better understand how to effectively adapt catch shares to the needs of specific fisheries to ultimately improve this track-record. Additionally, designing catch share programs must be done with great care to prevent continued controversy so that catch shares remain a viable tool for each Council to employ should it choose to do so. To contribute to the dialogue on catch shares as an effective management tool, this research project examined learning in the design and use of catch share programs as a federal fisheries management policy instrument. Ultimately, a comprehensive understanding of what has already been done in the design and use of catch share programs can help forecast what the future of this management tool will be.

Learning has two linked components, the process and the outcome (Busenberg 2001). Both were examined in this application. The process component focused on the pathways along which learning was or was not occurring in the use and application of this policy instrument. Processes were mechanisms that brought knowledge, information, and experience to the Council to evaluate in its decisions and may have been internal or external to individual Councils. The external process was identified as diffusion. The diffusion of catch share management strategies relates to the study of policy learning, which is especially relevant in natural resource management because of the great uncertainty inherent in these resource systems. This demands flexible and dynamic management approaches (Beem 2006). Effectively managing this uncertainty depends on learning from past mistakes and adapting to new changes. The outcome component of this research analyzed what the result of learning was, which may or may not have been change. The theoretical frameworks of learning and diffusion guided this analysis and are addressed in the next chapter. This work contributes to the more general literature of

¹⁰ i.e. S.1106 (National Standards for Fishing Quota Systems) and H.R.2621 (Fishing Quota Standards System bill)

policy and instrumental learning and policy diffusion with the added complexity of using a longitudinal study framework to assess these concepts.

Two management decision stages were considered in this analysis as well, the primary decision to pursue the development of a catch share program and the secondary design decision; though the two are often debated in tandem. An analysis of potential diffusion drivers as process variables was carried out for four individual catch share programs; the Atlantic Surf Clam and Ocean Quahog IFQ, Alaska Halibut and Sablefish ITQ, Bering Sea King and Tanner Crab Rationalization, and New England Multispecies Sectors programs. Additionally, an analysis of program design was completed for each. The linkage between the learning process and outcome was analyzed within each case. The four cases were then collectively analyzed for commonalities and differences in the role of different variables in the learning process and the relationship between the learning process and outcome. The theoretical progression of innovation in the development of catch share programs in U.S. federal fisheries over time was analyzed. This project aimed to assess whether learning specific to catch share program design and use has occurred, and if so, with what regional and temporal patterns. I sought to determine if learning has occurred so that over time catch shares are being more effectively adapted through design and use to achieve fisheries management goals. This ultimately situates this research as an examination of how federal fisheries management may be changing and hopefully improving with the guidance of a growing national dialogue on the practice of catch share management. Additionally, this work will be relevant to the identification of obstacles to learning and the diffusion of knowledge between Councils that should be addressed to allow catch share programs to be employed to the greatest national benefit.

Nearly four decades of federal experience with fisheries management since the implementation of the FCMA in 1976 has encompassed significant changes in the management strategies and tools used. The central policy of fisheries management has seen considerable shifts over the years with respect to the momentum behind market-based mechanisms. This has been driven by significant failures of the traditional tools of the policy to effectively address or prevent the severe and enduring effects of problems such as overharvesting and overcapitalization (Huppert 2005). The changes in the MSFCMA in relation to market-based mechanisms as a policy innovation can be analyzed from the perspective of the policy learning theory. The bulk of this work will concentrate on a more focused application of policy learning, instrumental learning. The progressive adaptation of market-based mechanisms to specific fisheries and specific fishery management problems through the development of catch share programs is a well-suited application of the theory of instrumental learning.

There are two interlocking components of learning that can be studied, the process of learning and the outcome. For the purposes here, the learning process was considered the sum of the steps in the Council decision to pursue transitioning a fishery to catch share management and then the actual development of the catch share program. This incorporated all the modes in which new information, knowledge, or experience reached the learning entity (the Council) to be evaluated in subsequent management decisions. It is important to note that this definition does not limit consideration to learning that resulted in change, learning was considered whether or not it resulted in a revised course of action. The learning process can be analyzed in both its internal and external contexts in reference to the entity that is learning. Internal processes of learning may include review and evaluation and adaptation of existing programs. External processes of learning are often referred to as diffusion. Both contexts of the learning process relate to how information or knowledge is gained and used. The outcome component of learning is what the result of those processes is. This examines what the impact of the new knowledge or information was on the entity and its activities. The learning outcome for this thesis was specifically the design of the catch share program as it was originally implemented. It is favorable to examine both the process and outcome of learning because limiting analysis to the outcome may assume that all policy change is due to learning and vice versa. This is often not the case (Beem 2005).

The work below presents a discussion of the theoretical groundings of learning (both policy and instrumental). Following this there is a discussion of the variables that were used to analyze instrumental learning in this research based on the processes and the outcomes of four catch share management cases considered. Case selection rationale follows the theoretical discussion and

operationalization of theoretical concepts for this research. Finally, there is a discussion of the analytic methodologies used. The four cases examined in this work are the:

- Atlantic Surf Clam and Ocean Quahog ITQ program
- Alaska Halibut and Sablefish IFQ program
- Bering Sea King and Tanner Crab Rationalization program
- New England Multispecies Sectors program

The process framework examined how catch share programs were developed across regions and Councils by analyzing specific drivers of individual program development and adaptation. By analyzing specific variable drivers in the development of individual catch share programs, the process framework facilitated the examination of the learning process each Council underwent in determining how to adapt the ideas of market-based mechanisms for each fishery's unique needs. The outcome framework analyzed the design of the four programs to determine the end product of learning in the development process of individual catch share programs. Then the correlation between the learning process and outcome was analyzed within each case. The purpose of this research project was to first understand the processes by which learning in the application of market-based mechanisms to meet management objectives may have occurred at the Council level, and then scaled that understanding up to the national level. The second focus was on the outcome question pertaining to what the result of learning has been on the use of catch shares as a policy instrument across the US. Each focus was examined separately in the four cases.

2.1 | Policy learning theory

The study of policy learning has proliferated through many academic disciplines such as policy (Sabatier 1988), international studies (Brooks 2005), and economics research (Kirman and Salmon 1995). It is often considered in tandem with theories of institutional, political, instrumental and social learning. Learning is an encapsulation of the processes through which new information and ideas are applied to decisions (Beem 2006). The learning process may be formal or informal. The broad definition of learning can be focused down to the specific elements of policy-making such as policy versus instrumental components. Sabatier (1988) defined policy learning as a change in thinking or behavior in the development of public policy due to new experience. May (1992) added to the definition of policy learning, describing it as judgments made on the preference of a current course of action, e.g. a policy,

relative to alternative courses of action. May (1992) also noted that learning may result in policy change or may maintain a given course of action based on a reaffirmed conceptualization of the policy problem and judgment on the appropriateness of the chosen policy solution approach.

Learning may facilitate the assimilation of a variety of types of new information, such as from general policy experience or from a methodical evaluation of a particular policy. May (1992) described that the mechanisms of learning generally fall into one of two categories: trial and error (ad hoc) or systematic policy evaluation or experimentation. Ad hoc learning may be referred to as policy evolution. Policy evolution defines policy learning that is the collective repetitious testing of the suitability of a particular course of action, not as a result of refined evaluation and experimentation (May 1992). The newly obtained information from the learning process may be relevant to the performance of a policy and how it does or does not achieve the objectives it was developed to meet (Busenberg 2000). Sabatier (1988) contends that policy learning may often be initiated due to dissatisfaction with the performance of a policy, which may then lead to reexamination. How that information is or is not incorporated into future decisions on the preference of a course of action to obtain specific policy objectives encapsulates the learning process. A resulting policy change or reinforcement of the existing policy direction is the policy learning outcome.

Evidence of policy learning is generally most attainable from the policy outcome stage. Bennett and Howlett (1992) as well as May (1992) reason that the most basic evidence of the occurrence of policy learning may be obtained through the documentation of fundamental changes in the basic policy concept or its objectives. As discussed above, though, this may not capture all policy learning processes. Policy learning may refer to the attainment of new knowledge that initiates policy changes or that reinforces the suitability of a current course of action for reaching specified policy objectives. In the later situation, there would not be evidence of policy change even if policy learning were occurring. And just as policy learning may occur without resulting in policy change, policy change may occur without policy learning (Sabatier 1988).

2.2 | Application of policy learning theory to fisheries management

The theory of policy learning applied to fisheries management references learning related to how the MSFCMA as a policy prescribes the tools available for Councils to design FMPs to appropriately meet the policy objectives, which are summarized in the National Standards. The structure of the MSFCMA devolves the management application of the federal policy to the eight Regional Fishery Management Councils and policy applications specifically are structured in the Council developed FMPs

(Ohasi 2010). The occurrence of learning in this situation relates to how the prescriptions for Council action laid out in the MSFCMA relative to catch share management may change in response to experience or new knowledge. And in regards to the changes in the MSFCMA provisions on catch shares, the 2006 Reauthorization was a major in-course correction likely due to the accumulation of experience, the 1999 NRC report, and changing regional fishery management conditions.

2.3 | Instrumental learning theory

Whereas policy is the general course of action to achieve a set of objectives, policy instruments are how policies are actually operationalized. Policy instruments are the suite of tools designed and employed to achieve policy objectives (Beem 2006). The collective instruments employed by a policy can be referred to as the policy toolkit. The study of learning can be applied to the design and use of policy instruments as well as to policy in general. May (1992) defines instrumental learning as lessons on the viability of a policy tool or instrument for effectively achieving the predetermined policy objectives. Learning may result in improved designs of tools to meet existing policy goals more effectively than previous instruments had done. Learning may also occur as the acknowledgment of any limitations of an instrument either in the feasibility of implementation or its viability in achieving policy objectives. The boundaries between policy learning and instrumental learning may not always be clear if in operation the line between the two is already difficult to discern. Policy failure may in fact be a function of the instruments chosen to achieve the objectives in following the chosen course of action rather than the course of action itself.

Similar to policy learning, instrumental learning may occur through an official evaluation or more of an unofficial ad hoc way based on policy experiences. However, similar to the caveats in the analysis of policy learning, May (1992) warns that not all policy toolkit changes should actually be considered instrumental learning. May argues that the label should only be assigned when redesign is a function of the assessment or evaluation of a policy instrument. Beem (2006) supports this argument, asserting that evidence that instrumental learning has occurred should depend on evaluations of the policy instruments in meeting the predetermined policy objectives. Brodey et al. (2009) argue for adaptive management as a mechanism to operationalize instrumental learning because it draws on the understanding that policies are designed as hypotheses that must be tested, and revised if necessary, specifically for how they meet policy objectives. Additionally, a change in the objectives may necessitate a revision of a tool through instrumental learning.

2.4 | **Application of instrumental learning theory to fisheries management**

The MSFCMA is the guiding policy for fisheries management. Catch shares are one tool in a suite of potential tools that Councils are legally allowed to employ in FMPs to assist with the attainment of the policy, management, and fishery-specific objectives. As a policy instrument, catch shares are a generalized market-based tool that may be specified in many unique ways to help an individual fishery meet the National Standards as well as individual goals for that FMP. Individual FMP goals may include objectives to protect vulnerable coastal communities with significant historical processing roles or to aid potential new entrants such as younger participants into the fishery (NRC 1999). Instrumental learning in catch shares examines how catch share programs are designed and used to meet these objectives. The specificity and unique development of individual catch share programs merits the analysis of instrumental learning on a case by case basis. The cases to be examined here have all implemented a catch share program and therefore have a documented instrument change relative to the pre-catch share implementation FMP toolkit.

Instrumental learning (hereafter referred to simply as learning) will be assessed based on an analysis of the process of the program development and the outcome in the design of individual programs. This will facilitate an examination of how catch shares as a management tool have been adapted to ameliorate fishery-specific problems as well as general fishery management issues. Individual programs can be studied along a temporal scale to determine if in more recent catch share implementations Councils employ new information, experience, and knowledge on program design. Analyzing how learning has occurred in each catch share program development can inform the understanding of the learning outcome such as why programs look as they do and if this reflects individual or collective learning on how to effectively tailor market-based mechanisms to fishery-specific needs. Analyzing the learning outcome as a function of each Council's learning process reflects the applied nature of catch share management. Change in the learning outcome as measured by program design that may or may not include certain elements should be based on whether it was appropriate for that particular fishery rather than due to the Council not learning from previous programs that incorporated that design provision. Within case analyses will allow for this distinction to be drawn.

2.5 | **Diffusion theory**

In addition to being guided by learning theory, this work is also grounded in the theory of diffusion as a facilitator of the learning process. Rogers (1995) states that, "Diffusion is the process by which innovation is communicated over time among members of a social system." Boehmke and

Witmer (2004) frame their definition of policy diffusion as the process that increases the likelihood of an entity adopting a particular policy if other similar entities have already adopted it. Diffusion processes as they relate to learning can also be referred to as 'lesson-drawing' whereby one entity benefits from the policy or instrument experiences of other similar entities (Rose 1991). Theories of diffusion have been examined in a variety of policy arenas; specifically there are numerous studies of policy diffusion focused on state policies for environmental regulation (Sapat 2004; Daley and Garand 2005; Stafford 2006; Dolšak and Sampson 2011). These articles presented research on the role of various factors or drivers that may be influential in leading a particular state to adopt a specific policy innovation. The application of diffusion theory to fisheries management for the purposes of this work will draw heavily on the work done by Dolšak and Sampson (2011) on the adoption of market-based mechanisms in air pollution state policies. Dolšak and Sampson (2011) developed a framework to examine the diffusion of policy for air pollution control based on innovation driving variables external and internal to the learning entity. A few of these variables; federal pressure, problem severity, institutional capacity to respond to a problem, and political context; will be operationalized for fisheries and catch share management.

Using these definitions, diffusion is the generalized process of the spread of innovations in a course of action or tools to reach specified objectives among similar groups (i.e. policy peers). Innovation may be an ambiguous term therefore this work will adopt the definition put forth by Walker (1969). Walker identified innovation as any adopted course of action new to the adopting entity, regardless of any prior use of it outside of the designated entity. Examination of the diffusion process is silent on the merit or success of the innovation itself, it only traces the path of a specific policy or policy instrument among a group of policy peers. Proof of diffusion may most simply be noted in reports of correlations between a policy innovation adopted by a policy peer and the adoption of the same innovation by a designated group. This research will examine how catch shares as a policy instrument have disseminated across, and been adapted by, the Councils. In this work the definition of diffusion will be kept broad to examine any potentially influential factors internal to or external to the Council for the specific FMP in question.

2.6 | Operationalizing diffusion theory for catch share management

The theory of diffusion helps explain the pathway of adoption of a specific policy or policy instrument among policy peers. This can be applied to the employment of catch shares as a general policy instrument by the Councils. While much of the literature specifies this process component as policy diffusion, here the diffusion theory is applied to instrumental learning in particular rather than

more broadly to policy learning. This work defines the innovation being diffused as simply any market-based mechanism for the allocation of fishing opportunities developed and adopted within a specific FMP managed by a Council. The categorization of policy peers in this situation may be complicated by the fact that individual Councils may develop and adopt several catch share programs for different fisheries, and each adoption must be considered separately. In such a case, one Council would act as a policy peer to itself for learning between different FMPs. The instrumental diffusion process is the sum of the drivers that influence catch share program development across Councils. It is the ways in which information, knowledge, and experience are gained by the Council in its program development decision-making process.

There are two general categories of variables that may influence the learning process of a Council as it develops a catch share program, external and internal factors. In addition to diffusion drivers that are external to the Council for the purposes of an individual program, forces internal to the Council will also be examined to fully inform an understanding of the learning process. The data collection procedures that will be used to aid in the analysis of the learning process variables will include the use of secondary data sources that relate to the development of the four catch share programs. Specific emphasis was given to using documents put forth by the Council and NMFS as major data sources to maintain a direct causal chain between the Council and the information, knowledge, and experience gained by the Council through the various variables analyzed. The use of such evidence increases the validity of the conclusions drawn on the ways in which Councils are learning in the development of catch share programs.

External process variables

External factors or sources of the diffusion of information, knowledge, and experience that can affect the learning process include vertical diffusion, or federal pressure (Boehmke and Witmer 2004). Vertical diffusion drivers specific to fisheries may include federal legislation such as the MSFCMA, the NOAA Catch Share Policy (2010) and Technical Memorandums (1998 and 2007). Vertical diffusion drivers may be especially influential on Councils when they are accompanied by financial incentives to pursue a particular management option. Additionally, NMFS guidance or intervention in management through its role in determining if Council actions satisfactorily meet the law may be a source of vertical diffusion and influence. The vertical diffusion variable is also operationalized as case law guidance in reference to how earlier catch share program implementations may be challenged in the courts and the

court ruling may then weigh on Councils subsequently considering developing a catch share management option.

In addition to vertical diffusion, horizontal diffusion may be a significant external diffusion driver in the learning process (Daley and Garand 2005). Horizontal diffusion is the process by which groups learn about the viability of different policies or policy instruments from other similar groups (Daley and Garand 2005). Busenberg (2001) argues that the process of learning occurs through the diffusion of policy experience and innovations between different policy peers. Likewise, Grossback et al. (2004) articulates that policymaking entities look to previous adopters of a particular policy or instrument to minimize uncertainty about the suitability of that alternative for reaching policy objectives and/or its applicability to the relevant political arena. Observing the success of a particular policy innovation for one entity can increase the confidence of policymakers in other similar entities that it could be successfully adopted there as well (Brooks 2005). The occurrence of learning also relates to how certain attributes of an innovation influence its successful diffusion such as the credibility and successful communication of the entity diffusing the innovation (Potoski and Prakash 2004).

The application of horizontal diffusion to catch share management in fisheries could be demonstrated as a Council that evaluates the success or failure of catch share programs already in place during its own development process in transitioning to catch shares. Having extant programs operated by other Councils may guide later Councils in the development process (Anderson and Holliday 2007). Walker (1969) affirms that regional diffusion of policy is often motivated by social learning. In horizontal diffusion, learning lessons based on new information, knowledge, and experience are drawn from policy peers, which in the regards to catch share programs include the Council itself if it manages more than one distinct catch share program, other Councils, and other countries operating catch share programs. International catch share policy peers specifically include countries such as Canada, Iceland, New Zealand, and Australia.

In this work, the external factors that will be analyzed as process variables for the potential influence on the development of catch share programs by Councils in the four specific cases will be:

- Vertical diffusion
- Horizontal diffusion

Internal process variables

Factors that contribute to the learning process may also be categorized as factors internal to the learning entity (Bacot and Dawes 1996). Internal process influences may include the problem severity,

the institutional capacity to respond to the problem, and the political context of the policymaking arena (Sapat 2004). Problem severity as a variable can be defined within the understanding that if necessity is the impetus of innovation, then serious problems with policy or policy instruments should encourage policy experimentation (Dolšak and Sampson 2011). The problem severity variable in fisheries can be encapsulated in the status designations of a fishery in terms of if it is subject to overfishing, if the stock is overfished, and/or if the fleet is overcapitalized. Problem severity as an important variable in the learning process may also reflect need-based policymaking (Daley and Garand 2005).

The institutional capacity to respond to a problem can be indicative of any constraints on policies or instruments that may exist due to policy legacies (Beem 2006). Institutional capacity to respond to a problem also relates to the management instruments legally available to a Council (i.e. catch share programs or limitations on them). Institutional capacity may also take shape as the enforcement capacity for regulations and the basic monetary and staff capacity available to push the development process forward. This latter issue may be especially relevant in fisheries management because of the restrictions on management cost recovery. Cost recovery is prohibited for the design stage of catch share programs and is limited to 3% of the ex-vessel value of the fishery once the program is in operation (MSFCMA 2006). The costs for program exploration, design, and implementation are significantly higher for a Council without previous experience developing and operating a catch share program (Anderson and Holliday 2007). Councils operating numerous catch share programs may be able to create economies of scale with monitoring and enforcement; this may be measured in the institutional capacity variable. Economies of scale may also create an effect in which Councils may be more likely to develop a catch share program in the first place if it has already done so in other fisheries. Daley and Garand (2005) argue that an entity with a more proactive management record may be more likely to adopt an innovative environmental policy instrument.

Political context as an internal variable in the learning process in fisheries management includes other contexts of a fishery and the management that shape the policymaking process. The economic, social, and ecological contexts of a fishery may or may not uniquely situate it to be receptive of a catch share program as the most appropriate management alternative. The unique characteristics of a fishery and the fishery-specific management objectives determine if catch shares make sense as a management instrument to pursue or not. Economic factors influencing the development process may include the fleet size, labor characteristics such as part-time or full-time participants or joint activity with other fisheries, length of season, and whether the fishery is prosecuted in distant or coastal waters. Ecological factors may include the stability or uncertainty of the stock status, habitat of the species, life history

characteristics, and bycatch within the fishery. The social context characteristics of a fishery that influence the program development may include the type of industry participant (e.g. large corporations or owner-operator participant involvement) and the cultural or community reliance on the fishery.

An additional internal driver in the learning process specific to fisheries management includes industry participation in the policymaking process, or industry buy-in. Industry buy-in is recognized as an important component of management program development because it can facilitate greater trust in the system, less conflict after program adoption, and more support of the outcome (Ostrom et al. 1992). This may result in increased compliance and perceived legitimacy of the management (Sutinen and Kuperan 1999). Fisheries management in the U.S. is by design significantly participatory (Okey 2003). Therefore, industry plays a major role in shaping the learning process as Councils determine how to develop the most preferable management strategy. Additionally, industry members must then learn alongside the Council as a catch share program is designed. This participation may help or hinder the development process.

The internal diffusion variables that will be analyzed for influences on the learning process culminating in the adoption of catch share programs by Councils will include:

- Problem severity
- Institutional capacity
- Industry buy-in
- Contextual attributes: ecological, economic, and social context

2.7 | Catch share program outcome variables

To examine the outcome of the learning process relative to the design and use of catch share programs, several variables will be analyzed in each of the four cases. Taking stock of the design of each catch share program will allow the analysis of why the inclusion and exclusion of specific design elements was or was not appropriate in relation the learning process of each Council in developing the program. The variables that will be examined are a collection of design options presented in several self-described catch share design manuals. These data sources are: “The Design and Use of Limited Access Privilege Programs” (NOAA Technical Memorandum 2007), “Catch Share Design Manual: A Guide for Managers and Fishermen” (Environmental Defense Fund report 2010), “Market Design for Limited Access Privileges Programs in U.S. Fisheries” (Ecotrust report 2007), and “Sharing the Fish: Towards a National Policy on Individual Fishing Quotas” (NRC report 1999). The variables described below are all sources of variation between different catch share programs that present options for Councils to apply a

catch share program to the specific needs or goals of an individual fishery. The data for these variables will be collected primarily from the Council documents specific to the adoption of the catch share program, often in an amendment to the FMP. Additionally, data for determining the learning outcome is available from the various design manuals included above from which the variables were developed. The following aspects of catch share program design will be analyzed as the learning outcome variables for the individual cases:

- Specifications of the privilege
 - Type of allocation
 - Management unit
 - Transferability
- Specifications of privilege holders
 - Eligibility to acquire shares in initial allocation
 - Eligibility to hold shares/subsequent eligibility
- Specifications of the program
 - Consolidation controls
 - Directed conservation elements
 - Social equity elements
 - Administrative features
 - Monitoring
 - Enforcement
 - Program review and administration
- Issues not addressed in original design
 - Major changes made after implementation
 - Unaddressed issues

Specifications of the privilege

This category of variables refers to the nature of the privilege created by each catch share program. The type of allocation variable refers to what type of activity in the fishery a quota share is designated for, i.e. harvesting or processing activity. The management unit variable denotes how many species or stock aggregations are included under a single quota share. Transferability design elements may be developed in a catch share program to allow the unrestricted selling and/or leasing of shares to

any person or entity or a program may have restrictions on transferability related to boat size class, for example.

Specifications of privilege holders

Eligibility to acquire shares in the initial allocation as a program design element indicates who or what is allowed to be initially allocated shares in a program, such as vessel owners or communities. The eligibility to hold shares refers to subsequent eligibility, which may differ from the initial allocation requirements. Entities that may not be eligible for initial allocations may later be able to buy or lease shares from others in the fishery. Cooperatives are an entity frequently allowed to hold shares under this variable but may not be allowed to receive quota under the initial allocation category. The way in which shares are allocated both initially and subsequently is frequently the most contentious program design element and often refers to how allocations are calculated or what factors the allocation formula is based on, such as years of participation or catch histories.

Specifications of the program

A specification of a catch share program may include design elements that control the accumulation of shares to individual holders or to individual vessels (i.e. use caps). These are categorized here as consolidation controls. A catch share program may also incorporate directed conservation elements in the design which can include specific features to address bycatch or elements to prevent high-grading activity. This variable only addresses program elements explicitly designed to address ecological issues and does not include the secondary ecological benefits that result from many programs such as reduced bycatch due to the slowing of the race to fish. Social equity elements refers to community provisions such as special harvesting or processing privileges afforded to coastal communities or loan program features to help increase opportunities in the fishery for smaller entities and new participants to acquire quota. Administrative features in the design include monitoring, enforcement, and review of program regulations. A catch share program may include design elements that compel official evaluations of the program. Enforcement features in the program are especially important in determining the operational success of catch share management. The administrative features variable may address program elements that relate to administration from the managers point of view as well as features relative to the point of view of the resource user such as the level of regulatory simplicity in the program.

Issues not addressed in the original design

Issues that were not addressed in the original program design convey unmet policy objectives or unintended consequences that the catch share program design elements did not address. If issues were subsequently dealt with, they will be considered major changes to the program design after implementation. Those that have not been dealt with remain unaddressed issues.

2.8 | Correlating the learning process and outcome

The process component of learning in the development of a catch share program correlates with the design of an individual program as the outcome to represent the holistic view of learning. The translation of the learning process into the outcome may be conceptualized as policy re-invention which describes how courses of action and tools to achieve specific objectives are modified over time through innovation by later adopters of a particular policy or instrument. In the application to fisheries management, the analysis of learning is also the analysis of the success of Councils learning how to most effectively apply the catch share management tool to each fishery's specific needs. Innovation in the use of market-based mechanisms in fisheries is general while the adoptions are applied interpretations. Each program development is unique therefore the eventual design of each program is also an innovation as Councils must determine how to adapt the template of the catch share instrument to each fishery. Therefore, tracing the instrumental learning process between catch share program adoptions should inform the analysis of the progression in the design and use of catch share programs in the U.S. across time. The results of this analysis apply to the adaptation and development of future catch share programs informed by an understanding of which fisheries may be appropriate for such a management direction based on the previous adoptions. Continued learning in the development of catch share programs may help contribute to the success of subsequent programs in achieving the *a priori* objectives of each.

2.9 | Research design methodology

The basic research design of this project is a multiple case study approach. A case study approach is most appropriate for this study because the central questions that are addressed are how and why questions that are cannot be manipulated and are non-extractable from their real-life context (Yin 2009). Using the case study approach allows the analysis to retain a holistic view with the meaningful characteristics and contextual details that are integral to the understanding of the data (Yin 2009). This also allows for post hoc analysis since what is being analyzed, the development of catch

share programs, has already taken place. Additionally, this methodology allows for the use and synthesis of multiple sources of data. The case study methodology was chosen because of the flexibility that it allows, which is important because of the lack of feasibility in carrying out experimental research on policy or management in this situation. An important caveat to the flexibility that the research design allows is that it places more responsibility on the researcher to be self-disciplined in ensuring the validity of the data and the analysis (Hakim 2000). Validity in this research was maintained by drawing on the extant literature to inform the operationalization of the variables analyzed and by using data primarily from documents sourced from the Councils and NMFS. The case study methodology is also conducive for studies with small sample sizes but individually significant data points, as are the circumstances in this research (Ragin 2004). Applying case study methods to small sample size research facilitates the in-depth analysis of causal complexity (Ragin 2004). In general, this work is an explanatory multiple case study that seeks to analyze how learning has occurred in catch share management and what the result of that learning was based on four representative cases.

2.10 | Case selection rationale

Individual cases that will be analyzed are individual catch share programs developed for federal fisheries. The case selection process followed Yin (2009) with representative cases, programs, sampled along a temporal trajectory. Four cases will be analyzed. Case one is the Atlantic Surf Clam and Ocean Quahog ITQ program implemented in 1990 by the Mid-Atlantic Fishery Management Council (MAFMC). This case is representative as the first federal catch share program adopted and thus offers a baseline from which to trace learning. Case two is the Alaska Halibut and Sablefish IFQ program implemented in 1995 by the North Pacific Fishery Management Council (NPFMC). Case two is representative¹¹ of catch share program design and use under the guidance of the 1976 FCMA, before the moratorium under the SFA and the NRC report. Additionally, this program is more complex in design than case one because of the separation of vessel categories and combination of both IFQ and CDQ components (Anderson and Holliday 2007). Case three is the Bering Sea King and Tanner Crab Rationalization program implemented in 2005 by the NPFMC and is representative of arguably the most complex adaptation of a catch share program in the U.S. (Anderson and Holliday 2007). Case three also was developed after the SFA was adopted and the results of the NRC report were released so offers the potential analysis of the influence of the moratorium on learning in catch share management. Case four is the New England Multispecies Sectors program implemented in 2010 by the New England Fishery Management Council (NEFMC). This

¹¹ In addition to case one.

case is representative of a catch share program design and implementation post-MSFCMA Reauthorization 2006 and 2007 NOAA Technical Memorandum. Additionally, this program encompasses a complex of species and is one of the most recent catch share program implementations; this facilitates tracing learning to current day fisheries management.

The multiple case study design utilized a case selection criteria framework based on theoretical replication, that cases were chosen based on the prediction of contrasting results for anticipatable reasons (Yin 2009). Individual cases were included based on *a priori* hypotheses about how the learning outcomes of program design would differ because of anticipated differences in the learning processes of each. The differences in the learning processes stem from prior knowledge of the differences in specific process variables, especially the vertical diffusion variable. Considering time as an independent variable, cases were selected for variation that will allow analysis of artificial cut-offs between cases of when there were significant policy changes or significant federal guidelines put forth on the management use of catch shares. Therefore, the coarse rationale for the case selection relates to the timing of the cases, the program developments, and significant policy changes or federal guidance that was put forth. The relevant timeline is included below:

Timeline of cases and policy guidance or policy changes

1976- FCMA passed

1990- Case 1: Atlantic Surf Clam/Ocean Quahog ITQ program

1995- Case 2: Alaska Halibut/Sablefish IFQ program

1996- SFA passed with moratorium on new catch share program implementations

1999- NRC report: "Sharing the Fish: Towards a National Policy on Individual Fishing Quotas"

2002- Moratorium expires

2005- Case 3: Bering Sea King and Tanner Crab Rationalization program

2006- MSFCMA Reauthorization

2007- NOAA Technical Memorandum: "The Design and Use of Limited Access Privilege Programs in U.S. Fisheries"

2010- Case 4: New England Multispecies Sectors program

2010- NOAA Catch Share Policy

The cases differ by implementation year and implementing Council. Additionally, there are numerous other variations between the cases chosen that cannot be controlled for in the case selection

because of the limited number of federal catch share programs in existence. The general policy arena of the program was controlled for though and only federal programs were considered because the policy arena within which state catch share programs operate is considerably different among states as well as from the federal level. Therefore, state programs were not considered to maintain as much comparability between cases as possible. A challenge with the time variable is that policy development often begins years before the stated implementation date. And often a Council may have made the final decision on the design of a catch share program a year or more before the program is ultimately approved, further complicating the time variable. To acknowledge this, analyses will attempt to retain validity by following Council timelines of program development alongside major federal policy developments rather than observing the approval dates as the only time value.

2.11 | Analytic methodology

Each case will be individually assessed within the framework of learning process variables as well as catalogued for its unique catch share program design characteristics according to the matrix of program design. The analysis of the learning process variables is based on an analytic framework previously published by Dolšak and Sampson (2011). The use of an already tested framework strengthens the construct validity of this work because the concepts being analyzed are appropriately operationalized (Yin 2009). Basic secondary data analysis will be carried out within a multiple case study structure following Yin (2009). Analyses will draw on the theoretical groundings in policy and instrumental learning and policy diffusion discussed previously. The results of this research therefore will draw on analytic generalization of the learning theory as a template applied to catch share management (Yin 2009). Applying the same frameworks for analyzing the process and outcome components of learning in each case will facilitate theoretical replication because the same variables will be examined in each case so general analytic comparisons across cases can be made.

The most significant component of the analyses in this work will be carried out within each case in an examination of the correlation between the learning process and outcome of each catch share program development. The unique nature of each program and the integral nature of the context of each case reduce the potential gains that would be seen in carrying out extensive analyses across cases. Since the learning outcome of each case is a function of the learning process of each Council, there will be limited comparisons of the program outcomes. Generalities will be drawn on the learning processes of each case to inform a discussion of how learning is occurring in the development of catch share

programs to most appropriately design and use this management tool to meet the management objectives.

Pattern matching will be employed as an analytical method between cases in reference to the drivers of the learning process in each program development. Time series analysis will also be utilized with the sampling of cases across a temporal trajectory in reference to the influence of drivers of diffusion and potential adaptation of catch share program design via learning. Additionally, explanation/theory building will be employed as an analytical method to determine how instrumental learning is occurring and to assess potential diffusion both regionally across Councils and temporally. Limitations of this study design relate to how learning can be demonstrated. Results may be limited by a lack of data confirming that a Council actually used specific information, knowledge, or experience available to it during the development process.

3.1 | Background on the Atlantic surf clam and ocean quahog fishery

Atlantic surf clams (*Spisula solidissima*) are a bivalve mollusk found off of the eastern coast of the U.S. in depths up to approximately 60 meters (NRC 1999). The species is distributed from the southern portion of the Gulf of St. Lawrence to Cape Hatteras off of North Carolina in nearshore and offshore waters of the continental shelf (McCay and Brandt 2001). Surf clam population structure does not show a strong correlation between adult population size and the recruitment of young clams into the adult population and populations often have a considerably unequal age distribution with significant dependence on stochastic large year classes (NRC 1999). The directed commercial fishery for surf clams began in the 1940s and remained an open access fishery until 1977 (NRC 1999). The proximity of the resource to shore allowed for the fishery to be dominantly a day-trip fishery (Weninger 1998). The fishery is concentrated where surf clams are similarly concentrated; which is in the waters off of Massachusetts to Virginia (McCay and Brandt 2001). The 1970s brought significant population depletion problems for the surf clam fishery because of open-access overexploitation and an anoxic habitat condition event (NMFS 1996). The declining productivity of the surf clam fishery triggered the beginnings of the ocean quahog (*Arctica islandica*) fishery in the 1970s; a species that can be harvested with similar gear and is a partial market substitute for surf clams (NRC 1999). Both can be processed in the same way into similar end products such as strips, pieces, broth, canned or frozen products (McCay and Brandt 2001). The ocean quahog is only a partial market substitute for surf clam because the latter is considered to be of higher quality so can fetch a higher market price comparatively (Marvin 1992). Ocean quahogs follow a distribution similar to that of the surf clam with populations in Atlantic waters from Newfoundland to Cape Hatteras, though further offshore than surf clams because the species favors cooler water (Marvin 1992).

3.2 | Regulation of the Atlantic surf clam and ocean quahog fishery prior to rationalization

With the original implementation of the FCMA in 1977, the surf clam and ocean quahog fisheries became the first to be managed under the new law by the newly created MAFMC (NRC 1999). One FMP was created for both species, though management was mostly focused on the surf clam fishery as the ocean quahog fishery was not significantly active until the 1980s (McCay and Brandt 2001). The dominant objective of the FMP was to stop and reverse the population depletion of the surf clam (NRC 1999). The FMP established an annual quota setting process based on yearly optimum yields determined for surf clams with a 10 year time horizon and for ocean quahogs with a 30 year time horizon. The time horizons related to setting quota at levels that would allow for sustained product availability for the

respective timeframe (NRC 1999). The surf clam quota was divided and administered quarterly with restrictions on fishing days and total hours per week to stabilize product supply to processors across the year (McCay and Brandt 2001). The ocean quahog quota was administered on an annual basis without effort restrictions to allow for effort spillover from the more restricted surf clam fishery (NRC 1999). The FMP also contained reporting requirements including logbooks for harvesters and product input data from the processors, an important regulation for initiating record-keeping of individual vessel catch history (NRC 1999).

Federal management of the surf clam fishery was also the first implementation of a limited access fishery in the newly claimed 200 nautical mile extension of U.S. control (NRC 1999). The limited access system was administered in the FMP through a moratorium on new vessel entry (McCay and Brandt 2001). Only vessels that had actively fished surf clams between November 1976 and November 1977 were allowed to continue operating (NMFS 1996). This cap on entry led to the initial issuance of 184 limited entry permits to applicable vessels which was later adjusted down to 142 because of vessel inactivity (McCay and Brandt 2001). The permit gave the holder harvesting access to the surf clam resource, conditional upon the payment of a modest permit fee (McCay and Brandt 2001). The moratorium permit was tied to an individual vessel and therefore prohibited vessel replacement except for involuntary damage or loss (McCay and Brandt 2001). Enhancement of the harvesting capacity of permitted vessels was not, however, regulated (Marvin 1992). Therefore, despite a cap on the number of active vessels, the capacity of the entire fleet continued to rise. Regulations also allowed the coupled vessel and moratorium permit to be bought and sold which resulted in a highly capitalized value of the permits, often between \$50,000 and \$150,000 (McCay and Brandt 2001).

The vessel entry moratorium was originally intended to be a temporary year-long management measure until the MAFMC could develop a new management program for the fishery, however the program ultimately stayed in place until 1990 (NMFS 1996). During the time the fishery was regulated under the vessel moratorium, the effort capacity of the surf clam fishery fleet continued to swell. This was at least in part due to the population cycling of surf clams that had significant boom years of unusually large year classes, which allowed for excess harvesting capacity to accumulate (NRC 1999). The increase in harvesting power was also aided by technological innovations such as hydraulic dredges that pumped water into the muddy sea floor to raise mollusks to be more easily harvested by the dredge (McCay and Brandt 2001). Quotas had initially been set conservatively because of the long-lived nature of both surf clams and ocean quahogs and this had allowed the rebuilding of the surf clam population in particular which later increased the overall fleet quota (NRC 1999). However, the

harvesting power growth surpassed that of the quota increase and matching the two led to increasingly restricted fishing time allotments (NMFS 1996). By the mid-1980s, surf clam fishing vessels were restricted to about 25 fishing days a year (Weninger 1998). Continued restrictions on surf clam fishing effort led to a spill-over effect of capacity into the ocean quahog fishery as it was a means for industry participants to prevent the inertia of excess capital (Weninger 1998). The vessel moratorium in the surf clam fishery had successfully tackled the stock depletion issues but failed to address the growing overcapacity issue that was also beginning to affect the ocean quahog stock (Marvin 1992). Ultimately, the MAFMC decided to pursue the development of a catch share program as the preferred option to address the overcapitalization problem. In 1989, the MAFMC approved Amendment 8 to the Surf Clam and Ocean Quahog FMP that led to the 1990 implementation of an ITQ program, the first domestic catch share program (Marvin 1992).

3.3 | Learning in the transition to catch share management

The path to the implementation of the Atlantic Surf Clam and Ocean Quahog ITQ program involved significant learning by the Council on the viability of using catch shares to achieve its specific fishery management objectives. The process of learning in the design and use of such policy instruments was influenced by several categories of variables that brought knowledge, information, and experience to the Council as it developed the program. The variables external to the MAFMC included vertical sources such as the FCMA and NMFS. Horizontal sources of experience included existing international catch share programs. Internal factors were also relevant to how and why the MAFMC ultimately employed market-based mechanisms as a management tool and helped shape the adaptation of a basic policy instrument into a program specifically fitted to the fishery. These internal drivers of the learning process included the severity of the overcapitalization problem and the institutional capacity of the Council to address the problem, which included the existing regulatory structure with quota and limited entry management. Other variables internal to the Council's development process that were influential included industry buy-in to the preferred program design and the contextual characteristics of the fishery and its management, including the unique historical participant structure. All played an important role in both initiating and guiding the MAFMC's development of the Amendment 8 ITQ program.

3.4 | External learning process variables

Vertical diffusion

The dominant source of the vertical diffusion of information influencing the learning process in the design and use of market-based mechanisms as a policy instrument in the Surf Clam and Ocean Quahog ITQ program case was legislative guidance under the FCMA and pressure from NMFS in its role under the Act. The Surf Clam and Ocean Quahog FMP was implemented concurrently with the FCMA in 1977 and the implementation of the Amendment 8 ITQ program preceded any reauthorization of the Act. Therefore, the original language of the Act was the guiding legislative force influencing the actions of the MAFMC as it developed FMPs and determined the appropriate policy instruments to employ. The dominant channel through which the FCMA influenced Council actions and the management instrument choices was NMFS in its role of approving or disapproving FMPs and amendments based on consistency with the Act. The issues with the surf clam and ocean quahog fishery that led to the eventual catch share design and implementation were a significant test of the novel legislation, of what the relationship was between the National Standards, and of the Congressional intent on how Councils were to manage individual fisheries. The 1976 FCMA allowed Councils to use a system for limiting access to a fishery under Section 303(b), stating that common forms of this a management strategy were licensing and stock certificate systems (MAFMC 1990). The Act dictated that a system of allocating fishing privileges could be used to ameliorate overfishing, overcrowding, or overcapitalization in a fishery to achieve optimum yield (MAFMC 1990). Additionally, the Act specifically encouraged Councils to consider limited access systems to reach economic objectives of FMPs (FCMA 1976).

After the implementation of the vessel moratorium in the surf clam fishery, the Council debated many alternative options for a limited entry program (MAFMC 1990). While caught in deliberations as to the best alternative solution, the Council added incrementally more restrictions to the moratorium to attempt to address its ineffectiveness. As the FCMA required, Council actions were subject to approval by the Secretary of Commerce, or in practice NMFS. NMFS frequently disapproved of the MAFMC's decisions for the incremental moratorium restrictions because of a lack of consistency with the National Standards (MAFMC 1990). Generally, the disapproval was in regards to the actions being inconsistent with National Standard 5; which required the promotion of efficiency by management measures where practicable (FCMA 1976). Additionally, NMFS frequently concluded that Council actions such as a proposed permit limitation system failed to address the accumulation of excess harvesting capacity in the fishery (MAFMC 1990). NMFS also pointed out that the Council's FMP amendments failed to address

the specific provisions for economic efficiency in the use of limited access systems in Section 303(b)(6) of the 1976 FCMA (MAFMC 1990).

During the decade long debate about alternatives to the vessel moratorium in the surf clam and ocean quahog fishery, NMFS frequently reproached the MAFMC for not designing and implementing a more effective and comprehensive management program (NRC 1999). The Federal government also pressured the Council to pursue a new management direction because of the high administrative burden the regulations and enforcement of the moratorium program put on NMFS (NMFS 1996). NMFS continually emphasized the inconsistency between the Council actions and the resulting management of the fishery with the Congressional intent included in the FCMA. Adhering to Section 304 of the Act, NMFS offered advice or alternative options upon disapproval of Council actions. Even though NMFS was not legally allowed to disapprove a Council action simply because it disagreed with the Council's instrument choice, NMFS' suggestions on management approaches to address the serious overcapitalization of the surf clam fishery were taken to heart by the Council. NMFS eventually suggested that the MAFMC look into limited entry alternatives that utilized the marketplace to ameliorate efficiency problems, but suggested that the Council employ a program that still had provisions for new entry opportunities (MAFMC 1990).

NMFS' legislative interpretation of the FCMA for the Council was very important because it helped clarify the Council's responsibility to directly address economic problems in fisheries when developing FMPs. However, due to the lack of existing domestic catch share programs, NMFS did not have any experience with the actual design of a limited entry alternative that utilized the marketplace. This is likely why the advice it offered to the MAFMC was limited to the general choice of management instruments rather than the actual development of them. Though limited in scope, this input was integral to the process by which the MAFMC learned about the appropriateness or projected efficacy of various policy instruments to reach the surf clam and ocean quahog FMP objectives. The FCMA and NMFS' interpretive actions coupled as a significant vertical source of the transmission of knowledge and information related to the use of policy tools to reach specific fishery objectives. By the Councils own admission, this federal input played an important role in the learning process that ultimately led to the Amendment 8 ITQ program adopted by the MAFMC (MAFMC 1990).

Horizontal diffusion

The Surf Clam and Ocean Quahog ITQ program was the first domestic catch share program design and implementation (NRC 1999). Therefore, there were no existing domestic programs or

experience by other Councils available for the MAFMC to take information or knowledge from in learning how to design and use market-based mechanisms in managing its fisheries. However, the lack of domestic program models did not mean there was no on-the-ground experience with catch shares in fisheries management. In the Surf Clam and Ocean Quahog ITQ program case there were many potential sources of learning lessons on the design and use of catch shares as a policy instrument available from other countries, which act as policy peers to the Councils. At the time of the Surf Clam and Ocean Quahog program development and implementation, there were several successful and unsuccessful catch share programs in fisheries worldwide. The international programs in operation at the time of the ITQ program development were in Iceland, the Netherlands, Norway, New Zealand and Canada. Understanding why these countries pursued catch share options as well as their experience with them may have provided valuable lessons to be adapted to the U.S. legal and regulatory framework (Tipton 1994). Whether or not the MAFMC in fact learned from these international models is not fully apparent from the data used in this research.

The modern Icelandic fisheries management experience began in earnest with its assertion of ownership over the waters surrounding it. The island nation asserted an Exclusive Economic Zone (EEZ) to 50 nautical miles in 1972 with the extension to 200 nautical miles in 1975 in reaction to significant foreign harvests¹² of valuable fish around the nation and the relative importance of the fish resources to the nation's economy (Eythórsson 2003). The nationalization of fishery resources allowed for a rapid expansion of domestic harvesting capacity to replace the banished foreign fleet. As a result, this allowed the replacement of foreign overexploitation and overcapacity with domestic (NRC 1999). Early crises in stock collapses contributed to Iceland's pursuit of the use of market-based mechanisms in fisheries management and so began the nation's role as a trailblazer in program design (Sanchirico et al. 2005). Iceland implemented its first catch share program in 1976, a nontransferable vessel quota system in its herring fishery. The restriction on transferability coupled with a low TAC split among many vessels made fishing the allocated quota not profitable for many (NRC 1999). In response, the Icelandic government eased the transferability restriction in 1979. A similar vessel quota program for capelin was implemented in 1980, though again without transferability until 1986 (NRC 1999). 1983 saw the implementation of an ITQ system for the cod fishery that seemed on the brink of collapse (NRC 1999). Iceland pursued the use of a catch share program for cod after the failure of other management measures such as a system limiting vessel investment, a fishing days limitation, and spatial closures to

¹² Icelandic conflict with foreign fishery fleets, from Britain in particular, has been termed the 'cod wars' (Eythórsson 2003).

specifically to address the frequent overshooting of the TAC and the overcapitalized fleet responsible (NRC 1999). Additionally, a catch share approach was seen as a solution to an overly complex and inefficient management system (NRC 1999). Just as the U.S. implemented its first experiment in catch shares in 1990 (the Surf Clam and Ocean Quahog ITQ program), the Icelandic Parliament passed the 1990 Fisheries Management Act that established a permanent quota management system for the majority of the nation's fishery resources (NRC 1999).

The Netherlands also was responsible for some of the early experiments with catch shares in fisheries management. The nation's Ministry of Agriculture, Nature Management and Fisheries implemented an individual vessel quota (IQ) program in 1976 for its sole and plaice fisheries (Davidse 2001). The program languished through the late 1970s and early 1980s with unfavorable perceptions by fishery vessel-owners and a lack of discernible impact on reducing the harvesting capacity to the level that could efficiently harvest the available resource. The lack of positive impact on the overcapitalization problem was often linked to a lack of quota enforcement (Davidse 2001). Additionally, the IQ system did not prevent the fleet expansion that occurred directly after years of high profitability that quickly dissipated any gains realized previously (Davidse 2001). The tides turned in 1985 with the allowance of quota transfer, the increased enforcement of existing regulations, and the implementation of an engine-power license-scheme that served to solidify and augment the value of the IQ privilege (Davidse 2001). More systematic enforcement of landings and the management in general served to bring acute awareness to the seriousness of the overcapacity in the fishery, which helped spur increased commitment to develop more effective solutions to the excess capacity issue (Davidse 2001). A significant implication of the program that began to be realized in the 1980s was that the loose transferability rules led to a continued concentration of rights and the increased value of the right itself; effectively pricing-out new entry into the fishery (Davidse 2001). The Dutch experience with catch share program strategies in fisheries management has seen ups and downs and continues to be adapted as the nature of the fisheries and its participants changes. Understanding the Dutch experience and why some design elements and the operation of the program initially failed to achieve the management objectives was a potential learning lesson available to other fisheries managers considering the catch share transition.

Norway also contributed to the collective international experience on the design and use of catch shares. Norway followed an unsuccessful management trajectory similar to that of the MAFMC with its trawl and purse seine fleets. These fleets experienced rapid expansion post WWII fueled by optimism in technological innovations and abundant recruitment in profitable stocks such as North East

Atlantic cod and haddock (Standal and Aarset 2008). Successive years of high catches by both Norway and foreign fleets soon surpassed the cod population's ability to replenish itself and the fleet's profitability began to fall. Soon after Norway's assertion of its EEZ, the government implemented a limited entry system with TACs, vessel quotas, licenses and other technological restrictions like mesh size (Standal and Aarset 2008). Norway soon found, very much similar to the MAFMC, that catch quotas themselves did little to prevent or stop the accumulation of harvesting capacity in the fleet. Government reports concluded that the traditional management methods and weaknesses in the regulatory system itself, such as limited flexibility to adapt to a changing resource base, had allowed significant overcapitalization to occur in the trawler fleet (Standal and Aarset 2008).

Subsequently, in 1984 the Directorate of Fisheries, Norway's fishery management body, implemented a unit quota (UQ) system for the fleet. The system incorporated transferability of the licenses and quota and retirement provisions on vessels that quota was transferred away from and on the transferred quota itself (Standal and Aarset 2008). This early implementation of catch shares largely failed to reach its goal of capacity reduction, however. The failure has been blamed on a weak or misguided incentive structure that while overall reducing the number of vessels operating, allowed the justified technical upgrading of remaining vessels (Standal and Aarset 2008). Liberal regulation on capacity replacement in the end increased fleet capacity beyond that which the vessel reduction had created (NRC 1999). Issues of quota and program duration have also been blamed for the program's failures to reach its stated objectives and management of the fishery continued to flounder for several years after the program was implemented (Standal and Aarset 2008). Norway's early experience with the design and use of catch share techniques, though unsuccessful, contributed useful on-the-ground experience that could be used by other countries such as the U.S. as learning lessons on applying market-based mechanisms as fisheries management tools.

New Zealand's experience with catch share fishery management was prefaced by a history not unlike the other international catch share programs discussed. New Zealand asserted claim over its EEZ in 1978 (NRC 1999). With an increasing nationalistic view of utilizing its marine resources, New Zealand's domestic commercial fisheries expanded quickly and so did the problems (Bess 2004). The nation implemented limited entry systems with new license moratoriums for rock lobsters and scallops in 1978 and finfish in 1982 (NRC 1999). However, as was the case in the U.S. surf clam fishery, limited entry did not equate to limited effort. The expansion in harvesting capacity outpaced the resource's productivity, resulting in overcapitalization and overexploitation of the nation's fisheries. Additionally, conflicts between different fishery sectors escalated and management became an arms race of regulatory

controls between resource users and resource managers (Bess 2004). In 1983, New Zealand implemented its first catch share program in the Deepwater Fisheries Policy that utilized allocations of company individual quotas for the deepwater trawl fisheries (NRC 1999). The allocations were based on an index of harvesting investment, onshore capital, and onshore production input (NRC 1999). In a 1986 Amendment to New Zealand's Fisheries Act, the government allowed for the development of an ITQ program for the inshore fishery as well as the deepwater fishery (NRC 1999).

New Zealand pursued the catch share management direction because it sought to achieve reductions in government intervention in the industry and to use market forces to help the industry achieve biological sustainability and economic efficiency in harvesting activity (NRC 1999). The sum of the New Zealand comprehensive ITQ fisheries management program is termed the Quota Management System (QMS). The QMS program encountered problems in the first decade of its operation that required tweaking of the management. These included equity issues with the native Maori, setting TACs on data poor stocks, bycatch issues, overshooting of TACs, and the more general regulatory complexities of adjusting to the new catch share management system (NRC 1999). One especially critical design flaw was the allocation of quota in fixed tonnage rather than percentage (NRC 1999). The shift to the QMS was a great undertaking for New Zealand, and its experiences offer valuable learning lessons on the design and practice of catch share management to achieve specific management objectives. Significant insight can be gained from analyzing the New Zealand experience (Boyd and Dewees 1992). Its experiments with catch shares were especially applicable to the MAFMC's surf clam and ocean quahog fishery because many of the managed fisheries bore similarities (Litz 1994).

The final important international model for catch share fishery management prior to 1990 came from Canada. Canada's catch share policy experiments began in 1976 with the implementation of a vessel share program in the Bay of Fundy herring fishery. Canada established its EEZ in 1977 and subsequently began a sweeping application of limited entry systems to all commercial fisheries (NRC 1999). The herring vessel share system allocated shares of the annually set herring quota to the various industry vessels (NRC 1999). Despite industry commitment to co-managing the system, the program languished with weak enforcement (NRC 1999). Canada gave catch shares another shot in 1986 with an experimental ITQ program approved by the Federal Minister of Fisheries and Oceans for the offshore scallop fishery (Barrow et al. 2003). The lead up to the trial program involved concerns over the health of the stock and the economic stability and efficiency of the fleet. The pilot project was deemed a success in reaching those objectives and was made permanent in 1989 with the near complete support of the industry (Barrow et al. 2003). An important lesson from the experience of this fishery

rationalization is the industry support for the program despite the significant job loss that occurred with the management change. The support is likely due to the greater stability and profitability of the remaining employment opportunities (Barrow et al. 2003). The U.S. and others may have benefited from Canada's experience in foretelling the potential costs of transitioning to catch shares and the potential benefits balancing out the costs. Additionally, Canada was an important policy peer to the MAFMC in the realm of fisheries management (Litz 1994). However, in the discussion of the development process of Amendment 8 to the Surf Clam and Ocean Quahog FMP, the MAFMC does not directly state that it incorporated the international experience available at the time into the design of the ITQ program.

The management experiences of Iceland, the Netherlands, Norway, New Zealand, and Canada certainly contributed significantly to the early fisheries management experimentation with catch shares, both with successes and failures. Early international catch share models were important in showing peers what gains could be realized through the use of market-based mechanisms in fisheries (Tipton 1994). How the MAFMC in particular may have used the international experience to its benefit is not fully clear through the Council's discussion of the development of the Atlantic Surf Clam and Ocean Quahog ITQ program.

3.5 | Internal learning process variables

Problem severity

If necessity triggers innovation, the severity of the management problem should play a considerable role in driving change in the management approach (Dolšak and Sampson 2011). The specific nature of the issues affecting the surf clam and ocean quahog fishery played a vital role in the process of the MAFMC learning about the applicability and the design and use of market-based mechanisms as policy tools. The characteristics of the surf clam and ocean quahog fishery problems were important in the decision to pursue the development of a catch share program instead of other potential management options. The vessel moratorium management system had been successful in at least some dimensions of its intended impact, specifically in stopping and reversing the overexploitation of the surf clam stock (MAFMC 1990). However, the system had the unfortunate unintended consequence of allowing the considerable overcapitalization of the industry, which was a dominant driver first in the decision to pursue alternative management strategies to the status quo and second in the ultimate selection of catch shares as the preferred option (Weninger 1998). The underlying management problems were largely economic in nature, so a tool utilizing the market to create efficiency in the fishery was appropriate. The regulatory structure of the vessel moratorium with

quarterly quotas and vessel time limitations also encouraged the development of a race to fish (McCay and Brandt 2001). To remain profitable in the derby-style fishery that was eventually restricted to six hours every other week, participants had to invest in increased vessel effort capacity to harvest as many surf clams as possible before the fleet as a whole reached the quota cap (NOAA Fisheries Service Office of Policy 2009a). This created serious occupational health and safety concerns with much loss of life and vessels (McCay and Brandt 2001). The high administrative burden of program operation and enforcement for the vessel moratorium system was also an important facet of the problem that was relevant in the MAFMC's process of developing Amendment 8 (McCay and Brandt 2001).

Institutional capacity

The existing management infrastructure for the surf clam and ocean quahog fishery was an important contributor of institutional capacity that influenced the MAFMC's pursuit of management alternatives to the vessel moratorium in general and the catch share program design in particular. Two such critical infrastructure components were the biologically-based TAC and provisions for limited entry with which the fishery was already managed. Entry to the fishery had been limited since 1977 so it was not a step that needed to be taken in the development of a catch share program (McCay and Brandt 2001). The surf clam and ocean quahog fishery was also experienced with operating under a managed TAC; a settling-in period for the fishery under that management technique had already occurred and the TAC was rarely exceeded. Due to the stock rebuilding that the TAC management had facilitated, transitioning to a catch share management program did not have to include significant harvest cuts (McCay 2001). The fishery's experience with a TAC and limited entry helped reduce the severity of pursuing the development of an ITQ program and likely then reduced general resistance to the new management direction. Additionally, an important existing infrastructure component of the Surf Clam and Ocean Quahog FMP was the requirement of detailed catch data recorded in vessel logbooks (McCay 2001). This allowed there to be a record of the historic catches and distribution of catch across the vessels in the fishery on which potential allocation schemes developed by the Council could be based. These existing management components were critical in contributing to the necessary institutional capacity for the Council to more easily transition to catch share management in the surf clam and ocean quahog fishery. However, the design phase of the ITQ program still dominated the MAFMC's overall management activities in a decade-long debate in the development of Amendment 8 (Marvin 1992).

Industry buy-in

The nature of U.S. commercial fisheries management as structured by the FCMA is unique among U.S. natural resource policy sectors. The Act sought to devolve management authority from the Federal government into the Regional Management Council structure that could allow significant input from the resource users as well as other stakeholders (NRC 1999). Within the participatory decision-making process, industry has a specific role in management through Advisory Panel membership associated with each Council and can participate in Council policymaking through public comment requirements under the Administrative Procedures Act (APA) (P.L. 79-404) (Okey 2003). The industry also exercises lobbying power with Congressional entities. As a result, the U.S. fishing industry as a whole has long had significant clout in the management of the Nation's fisheries (Okey 2003). Gaining industry buy-in during the management process contributes significantly to increased regulatory compliance when the program is actually in operation. The theoretical reasoning behind this effect is that a participatory management process can lead to greater trust in the system and therefore more consensus-based support of the resulting outcome (Ostrom et al. 1992). Addressing conflict during the process of developing a new management program may result in less conflict upon its implementation and therefore more voluntary compliance with its operation. Garnering support from industry was an especially important guiding force in the policymaking process as the MAFMC learned about the applicability of catch shares in the development of the Surf Clam and Ocean Quahog ITQ program because of the program's arguably radical nature as the first U.S. experiment with market-based mechanisms in fisheries.

Industry as a stakeholder in the fisheries management process and outcome played an important role in the awareness of the failure of the vessel moratorium system for the surf clam and ocean quahog fisheries. Industry participants were vocal about their frustration with the ratcheting up of fishing time restrictions due to the increasing overcapitalization of the fishery (McCay and Brandt 2001). Participants were concerned with the idle capacity in the fishery that the program created because it acutely impacted their individual profitability. Additionally, the industry criticized the moratorium management for weak enforcement that led to widespread cheating (Marvin 1992). Participants that followed the existing regulations in good faith felt unfairly punished by the cheating of other participants that further tightened restrictions on the fleet as a whole. The industry also felt that fishery regulations were becoming overly complex and difficult to follow (Marvin 1992). Years of dissatisfaction with the management led many industry participants to believe that almost any alternative management scheme would be preferable to the status quo (Marvin 1992).

Having industry on board with a collective agreement on the failure of the vessel moratorium management and on the reasons behind the failure was a necessary and significant step for the MAFMC to eventually pursue a catch share program option. The suitability and favorability of an ITQ program option was generally agreed upon by both managers and industry participants (MAFMC 1990). In general, industry support for a catch share option stemmed from the perception that ITQs could allow for increased individual profitability and also better facilitate the obtainment of financing from banks for fishing ventures because of the increased security obtained from ITQ holdings (NRC 1999). The ITQ program development phase was significantly participatory with the MAFMC seeking full industry approval of the eventual design, though industry representation was generally limited to vessel-owners with little input from non-owning captains and crew members (McCay 2001). High stakeholder participation did not, however, mean that the actual development process was not contentious.

The program design decisions relating to the allocation of fishing privileges and the choosing of ‘winners’ and ‘losers’ was a highly controversial step of the development process for the Surf Clam and Ocean Quahog ITQ program. While industry participants generally agreed that the status quo management structure needed to be significantly changed, they voiced concern that new management would change the status quo distribution of shares of the harvest across fishery participants (McCay 2001). The learning process for the MAFMC specific to decisions about the design of the initial allocation scheme was therefore highly attuned to industry input in an effort to gain the necessary industry buy-in for the new program to have the desired compliance. Industry input was not unified in this matter, though, and competing claims for favorable allocation schemes were made by long-time fishery participants and newer entrants. Newer entrants to the fishery were concerned that an allocation scheme dominantly based on catch history would unfairly penalize them and fail to adequately value their significant, though recent, investments in the fishery (Creed 1991). Industry participants also voiced desire to the MAFMC as it continued to develop the Amendment 8 program that an allocation scheme would correct for the rampant cheating in the preceding years of the fishery (McCay 2001). Additionally, with the Council pursuit of catch share management, industry participants expressed worry about how a program may lead to undesired concentration and therefore unfair market control (McCay 2001). Decisions about how to address these concerns were continually debated as the MAFMC developed the ITQ program.

Contextual attributes

Catch shares are not a management tool suitable to all fisheries (NRC 1999). The unique ecological, economic, and social characteristics that gave context to the surf clam and ocean quahog fisheries were important in how the MAFMC learned to apply the basic catch share approach to the fisheries in particular. These contextual attributes shaped the suitability of catch shares as a management instrument alternative and the eventual design of the Amendment 8 program. The ultimate program design was reflective of the fisheries and management context, and even more specifically, the management objectives related to the fisheries' unique attributes. Due to the historical objectives that sought economic efficiency and less centralized regulation, the surf clam and ocean quahog may have been self-selecting for a transition to catch shares (NRC 1999).

Ecological context

The ecological context of the surf clam and ocean quahog fishery did not receive significant focus during the transition to catch share management. The fisheries for both stocks historically had little to no bycatch because of the specificity of the harvesting gear used as well as the preferred habitat substrate of the shellfish (MAFMC 2010). The commonly used gear in both fisheries was a hydraulic dredge that injected water into the muddy substrate to raise the molluscs to be more easily captured by the dredge (McCay and Brandt 2001). The specificity of the gear also limited any significant interactions with protected species as well as negated any gear conflicts between fishery participants (MAFMC 2010). The basic biology of the surf clam and ocean quahog did have to be taken into account with the management changes, specifically the long-lived nature of the resource and the limited known relationship between recruitment and the adult stock size (McCay 2001). This required cautionary quota setting focused on the long-term sustainment of stocks that were only somewhat understood.

Economic context

Significant learning on how to apply catch share methodologies on the part of the MAFMC was related to the economics of the fishery, and specifically the market interplay between surf clams and ocean quahogs (Marvin 1992). There was much debate during the development of the Amendment 8 program as to whether the ocean quahog fishery should be lumped into the program even though it had not had the overexploitation and overcapitalization that the surf clam fishery had (Marvin 1992). The ease of transferability of effort between the two fisheries and the partial market substitutability for the respective products created the potential for market leakage that necessitated the regulation of both.

These economic factors had to be addressed as the MAFMC learned how to apply the principles of market-based mechanisms for its purposes.

Social context

Prior to the transition to catch shares, the surf clam and ocean quahog fishery was characterized by a participant structure that included many small participants or ‘independents’ and few large entities, the ‘processors’, which were frequently vertically integrated (McCay and Brandt 2001). The ‘independent’ participant was typically an owner-operator entity in which the vessel owner actually worked on the vessel (McCay and Brandt 2001). The ‘processor’ segment of the fishery was heavily dependent on hired captains (McCay 2001). The power structure of the fishery showed a product market dominated by the large entity owners and vertically-integrated firms that incorporated both harvesting and processing capacity (NMFS 1996). These economic attributes were important in how the MAFMC applied catch share principles to its needs with specific decisions relative to whether quotas would be tied to vessels due to fears of further tipping the power structure in favor of the vertically integrated firms (NRC 1999).

3.6 | The learning outcome

The Amendment 8 outcome of the MAFMC process of learning how to adapt and apply catch share principles to the surf clam and ocean quahog fishery is summarized below.

TABLE 1 | Amendment 8 Design of the Atlantic Surf Clam and Ocean Quahog ITQ Program

Specifications of privilege	Type of allocation	<ul style="list-style-type: none"> • ITQ <ul style="list-style-type: none"> ○ Allocation certification results in yearly cage tags ○ Significant divisibility of allocated shares allowed to minimum of 160 bushel units
	Management unit	<ul style="list-style-type: none"> • Atlantic surf clams (SC) (<i>Spisula solidissima</i>) • Ocean quahogs (OQ) (<i>Arctica islandica</i>)
	Transferability	<ul style="list-style-type: none"> • QS can be transferred freely • Yearly allocated coded tags can be transferred
Specifications of privilege holders	Initial eligibility	<ul style="list-style-type: none"> • Owners of permitted vessels harvesting SC or OQ between 1979 and 1988 eligible for initial allocation of shares • Allocation formula for SQ vessels making landings at Mid-Atlantic ports: <ul style="list-style-type: none"> ○ 80% vessel’s average historical catch 1979-1988 (last 4 years counted twice and worst two years excluded; results summed and divided by total catch of all harvesters for period)

		<ul style="list-style-type: none"> ○ 20% “cost factor”, cubic capacity of vessels ● Allocation formula for SQ vessels making landings at New England ports and for all OQ vessels: <ul style="list-style-type: none"> ○ Average historical catch for years actually fished between 1979 and 1988, lowest catch year excluded
	Subsequent eligibility	<ul style="list-style-type: none"> ● After initial allocation, any person meeting U.S. requirements for fishing vessel ownership (actual vessel ownership was not required) could purchase or lease quota
Specifications of program	Consolidation controls	<ul style="list-style-type: none"> ● None in practice
	Directed conservation elements	<ul style="list-style-type: none"> ● No direct conservation provisions
	Social equity elements	<ul style="list-style-type: none"> ● No direct social equity provisions
	Administrative components	<ul style="list-style-type: none"> ● Monitoring <ul style="list-style-type: none"> ○ Cage-tagging requirement and mandatory reporting to NMFS by vessel owners and dealers of clams landed and purchased ○ Allocation permit numbers must be reported on both vessel logbook reports and dealer-processor reports ○ At-sea and air surveillance conducted to reduce possibility of vessels with state permits or cage tags straying into federal waters ● Enforcement <ul style="list-style-type: none"> ○ Allocation permits and dealer/processor permits may be suspended, revoked, or modified for violations of FMP ○ Enforcement relies heavily on shore-side surveillance, cage tag system, and cross-checking logbooks between vessels and processors ● Program administration and review <ul style="list-style-type: none"> ○ Dealers and processors must have annual permits ○ Allocation permit fees collected to help cover administrative costs (production and distribution of cage tags)
Issues not addressed in original design	Major changes after implementation	<ul style="list-style-type: none"> ● Amendment 10 added Maine ocean quahog (also called the mahogany clam) fishery to program ● Changes to meet new Reauthorized MSFCMA requirements addressing overfishing regulations
	Unaddressed issues	<ul style="list-style-type: none"> ● Excess consolidation of quota ● Cost recovery requirements

Sources: Marvin 1992, Weninger 1998, NRC 1999, McCay and Brandt 2001, Anderson and Holliday 2007, NOAA Fisheries Service Office of Policy 2009a, and MAFMC 2010

3.7 | Connecting the learning process and outcome

There were many sources of guidance and influence that played a role in the process by which the MAFMC learned about how applying market-based mechanisms in management could facilitate the achievement of specific policy objectives. Dissecting the details of these innovation drivers can shed light upon why the MAFMC developed the Surf Clam and Ocean Quahog ITQ program as it was implemented in 1990, offering explanation of why that was the outcome of learning. The vertical sphere of influence that guided the MAFMC's experiment with fishery management rationalization was the 1976 FCMA and the resultant verdicts from NMFS in its judgment responsibility over the Council's decisions. In particular, guidance from NMFS as to the most appropriate management alternative to the vessel moratorium was fundamental in that it was unofficial federal endorsement of management rationalization using market-based mechanisms (MAFMC 1990). NMFS' frequent criticism of how Council decisions ineffectively addressed the issue of inefficiency in the fleet further showed the appropriateness of market-based mechanisms for addressing the problems of the surf clam and ocean quahog fisheries (NRC 1999). And the federal emphasis on the Council's need to craft management that facilitated and incentivized economic efficiency in the fishery could have supported the Council's development of a program with very few, if any, roadblocks to efficiency by way of equity provisions in the program design.

The direct impact on the MAFMC's learning process in the development of the ITQ program by the horizontal diffusion variable is less evident. Many horizontal sources of learning lessons existed during the Council's development timeframe; however correlations to the learning process or to the learning outcome are not fully clear. The horizontal sources that may have guided the instrumental learning process to the Amendment 8 outcome included the experiences of international policy peers and specifically the leadership in using the instrumental innovation provided by New Zealand and Canada (Litz 1994). The New Zealand experience may have benefited the MAFMC because the two shared nearly identical fishery management problems, problems that had guided New Zealand to pursue and develop market-based policy solutions (NRC 1999). Hind-sight on New Zealand's experiences offered a close simulation of how the design of a catch share program would potentially operate and what its implications could be for the surf clam and ocean quahog fisheries. Specifically, New Zealand's experiments showed that catch shares could effectively address economic efficiency concerns. Canada's rationalization experiments may also have shown the MAFMC that enforcement provisions were a key design feature for a program to actually reach its objectives (NRC 1999). A parallel could be drawn between this lesson learned and the multiple avenues of fishery monitoring that were included as

provisions in the Amendment 8 framework design, however the actual correlation is unknown. The MAFMC may have also looked to how Canada's fishing industry reacted to its management changes to understand that while problematic for gaining industry support of the transition, the job loss that came with the realization of efficiency was not an insurmountable obstacle to rationalizing the management. A tentative conclusion can be drawn from these findings that if in fact the MAFMC did not use the existing international experience with catch shares to help inform its development of the Surf Clam and Ocean Quahog ITQ program, it may have missed out on valuable learning lessons. In particular, many of the international models, New Zealand especially, had shown that excess consolidation in the fleet could be an unintended consequence of rationalization if the specific catch share program design did not take steps to prevent it (NRC 1999). However, the MAFMC ITQ program did not ultimately include any protections against excess consolidation and it remains an issue that the Council is trying to retroactively address (NOAA Fisheries Service Office of Policy 2009a).

The internal influences shaping the MAFMC's learning process in applying catch share principles to the surf clam and ocean quahog fisheries also help explain why the Amendment 8 ITQ program looked as it did upon implementation. The problem severity of why a new management direction was pursued centered on rampant overcapitalization (NRC 1999). The fishery was without significant ecological and social equity concerns, at least to the level of the economic problems. This likely paved the way for a program dominantly focused on righting the economic ills of the fishery with full investment in allowing market forces to ameliorate the management problems. Additionally, the prior management of the surf clam and ocean quahog fisheries under a limited entry system eased the burden of potentially having to design a rationalization program with a broader initial allocation to win the support of stakeholders in an open-access fishery. Industry concerns also populated the Council's deliberations about the transition and distinctly resulted in design elements such as the "cost factor" element of the initial allocation scheme that recognized the capital input of newer entrants that had not developed significant catch histories (McCay and Brandt 2001). In regards to contextual influences on the learning process, as the Council grew to better understand the root of the surf clam fishery's problems and therefore the most appropriate solution, it saw the undeniable parallels of it with the ocean quahog fishery (Marvin 1992). So it preempted having to deal with the same problems in the ocean quahog fishery separately down the road by developing an IFQ program that could be applied to both fisheries.

While the MAFMC did take debate many issues over the ten year development phase of the catch share program, there were many debated issues that never left the drawing board. The issues that

were not taken into account in the eventual ITQ program design included the industry's concerns with cheating under the vessel moratorium being addressed or the concerns on how the program could have negative implications on the existing economic power structure by not preventing excess consolidation. The initial allocation scheme did not penalize participants that had flagrantly broken many of the regulations under the vessel moratorium management (McCay 2001). And the general lack of rules on transferability allowed consolidation activity to quickly change the fishery's prior economic framework (McCay 2001). Excess quota consolidation has been a serious criticism of the ITQ transition with the MAFMC still trying to retroactively address this implication (NOAA Fisheries Service Office of Policy 2009a). The experience of the MAFMC in designing the rationalization of the surf clam and ocean quahog fishery and what may have perhaps not been learned during the development process has since contributed significantly to the national learning process on the costs and benefits of market-based mechanisms as a fisheries management instrument (McCay and Brandt 2001).

4.1 | Background on the Alaska halibut and sablefish fishery

Pacific halibut (*Hippoglossus stenolepis*) and sablefish (*Anoplopoma fimbria*) are long-lived bottom-dwelling species found in North Pacific waters from the Sea of Japan to the Bering Sea and to California and Baja California respectively (NRC 1999). Halibut are mainly found in waters 15-200 meters deep with sand, gravel, and cobble substrates (NRC 1999). Sablefish tend to be in slightly deeper waters of depths 100-1,500 meters (NRC 1999). Commercial fisheries for halibut and sablefish have a long history in the waters off of the Pacific Northwest, British Columbia, and Alaska with documented fisheries having been prosecuted for more than 100 years (NRC 1999). The two species are caught similarly with longline gear and sablefish can also be caught with pot and trawl gear (NRC 1999). Longline and pot gear are collectively termed fixed gear (NRC 1999). The difference in habitat preferences between the two species results in different preferred fishing grounds with halibut fisheries historically closer to shore in shallow water (Hartley and Fina 2001). The halibut fishery is prosecuted in small boats, most range from 30-59 feet in length (Witherell et al. 2012). With sablefish occurring in deeper water habitats, the fishing grounds are moved farther offshore often requiring a larger vessel for harvest activities (Hartley and Fina 2001). Beginning more recently, the halibut and sablefish fisheries are prosecuted by mostly small catcher vessels (CV) with activity by a few catcher processors (CP), also known as freezer-longliners (NRC 1999).

4.2 | Regulation of the Alaska halibut and sablefish fishery prior to rationalization

Management of the Pacific halibut commercial fishery began in 1923 as a treaty between the U.S. and Canada under the Convention for the Preservation of the Halibut Fishery of the North Pacific Ocean and the Bering Sea (NPFMC 2011a). The Convention, also known as the Halibut Treaty, established the International Fisheries Commission (IFC) management body; now known as the International Pacific Halibut Commission (IPHC) (NRC 1999). Conditions prompting the initiation of management were stock declines expedited by technological innovations such as diesel-powered vessels and mechanical longline gear that allowed catch per unit effort (CPUE) to rise and total harvest levels to climb (Hartley and Fina 2011). The advent of the diesel-powered vessel also opened up the possibility of new fishing grounds farther from shore which expanded the fishery's pressure on the halibut stock (Hartley and Fina 2001). One of the first regulations set down by the IFC closed the fishery for 3 months to protect spawning stocks (Hartley and Fina 2001). The nature of the average halibut fishery participant was that of a part-timer, the fishery had been a substitute fishery for many fishermen since the 1930s (Hartley and Fina 2001). This characteristic was facilitated by the relatively small amount of specialized

gear need to fish for halibut and the innately high catchability of the species (Hartley and Fina 2001). In the 1970s, the implementation of limited entry programs in Alaska's salmon fisheries further triggered the spillover of excess small boat capacity into the halibut fishery (Hartley and Fina 2001).

After the passage of the FCMA in 1976, the U.S. and the newly created NPFMC claimed authority over the fisheries of the Bering Sea now in U.S. waters (Hartley and Fina 2001). The nascent NPFMC immediately pursued the development of a limited entry program with a moratorium on new entry for the halibut fishery in 1977, but the efforts were put on ice because of jurisdictional issues for the Council with the Halibut Treaty (NRC 1999). The fishery remained open-access and the 1980s also saw a spillover of capacity into the fishery of larger vessels displaced due to a decline in crab stocks (Hartley and Fina 2001). The U.S.-Canada Convention was later renewed and the North Pacific Halibut Act of 1982 (P.L. 96-176) delegated limited entry and allocation decisions by the U.S. to the NPFMC and the Pacific Fishery Management Council (PFMC) for different regulatory areas (NRC 1999). The IPHC retained biological management responsibilities for the Pacific halibut fishery with management activities including determining annual allowable harvest levels for commercial catches by regulatory subarea (Hartley and Fina 2001).

The sablefish fishery off Alaska was prosecuted by a significant foreign fleet from the 1950s to the 1980s (NRC 1999). The U.S. act of asserting jurisdiction over the 200 nm Fishery Conservation Zone (FCZ) through the FCMA did not automatically end all foreign fishing in the sablefish fishery (Hartley and Fina 2001). Joint venture fishing continued until the 1980s (Holland and Ginter 2001). Foreign fishing activity was eventually displaced by a growing domestic harvest fleet and the pace of the domestic capitalization of the fishery surpassed all expectations (Pautzke and Oliver 1997). Between 1981 and 1988, the domestic sablefish fleet had grown more than 10 fold and surpassed the historical foreign harvest levels (Hartley and Fina 2001). A system of TAC allocations by gear type was implemented by the NPFMC in the sablefish fishery in 1985 (NRC 1999). Additionally, the sablefish fishery was split into 4 management areas spanning the Gulf of Alaska (GOA), Aleutian Islands (AI), and the Bering Sea (BS) (NRC 1999). The division into regulatory subareas allowed better harvest management to avoid localized stock depletions (Hartley and Fina 2001).

Both the halibut and sablefish fisheries were open-access fisheries that required only a fishing permit and vessel registration to participate, and the permit was available for a nominal cost (Hartley and Fina 2001). The conventional management for the halibut and sablefish fisheries involved a blend of area, season, and gear restrictions (NRC 1999). Individual vessel trip limits were also employed as a management measure for the halibut fishery from 1988 to 1994 but often were not applied until later in

the fishing season when the fishery neared the TAC (NRC 1999). Trip limit management was also structured to be graduated by vessel class (NRC 1999). However, with the open-access nature of the fishery, capacity continued to build. The speed of the halibut fishery was too fast to allow for real-time in-season monitoring so managers developed hard season openings and closings (Hartley and Fina 2001). As harvesting capacity continued to grow, season length shrank to ensure the bloated fleet would stay within the TAC. In the 1990s, one day seasons were common for the halibut fishery and trip limits were a necessity to prevent overharvesting (NRC 1999). The sablefish fishery pace was slightly slower and did allow for in-season monitoring (Hartley and Fina 2001). Additionally, the season timing for halibut and sablefish was arranged to limit any conflict with the fishing seasons for other species. This again facilitated the spill-over of capacity from other fisheries and reinforced the part-time nature of participation (Hartley and Fina 2001).

Management struggled to keep up with the severely overcapitalized fisheries; the halibut fishery was more severely affected by excess capacity but the sablefish fishery was following the same trajectory. Participants and managers acknowledged the similar trends in the two fisheries and felt the two should be dealt with simultaneously. The Council evaluated several management alternatives to the in-place open-access system. The NPFMC had pursued limited entry options for the halibut fishery since its inception but had been spurned multiple times with moratorium management plans disapproved by NMFS; the agency pushed the Council to pursue more comprehensive and long-term solutions (Hartley and Fina 2001). Likely jaded from the frequent rejections, the NPFMC pursued management changes for the sablefish fishery first. The early IFQ program discussions were originally only for sablefish even though the manifestations of parallel issues with the halibut fishery were more severe (NOAA Fisheries Service Office of Policy 2009b). The NPFMC used the development of an IFQ program for sablefish as a prototype for the larger halibut fishery (Hartley and Fina 2001). Ultimately halibut and sablefish were packaged together into a single IFQ program because the NPFMC believed that simultaneous implementation in the fisheries would be the most effective method of overcoming potential program obstacles and reducing anticipated program opposition from the halibut fishery in particular (Hartley and Fina 2001). In 1991 the NPFMC decided on IFQs as the preferred management alternative for the sablefish and halibut fisheries. The program was approved by NMFS in 1993 and slated for implementation as Amendment 15 to the Groundfish FMP in 1995 (NRC 1999).

4.3 | Learning in the transition to catch share management

The path that the NPFMC traveled in the development of the Amendment 15 IFQ program for halibut and sablefish benefited from and was fundamentally influenced by informational and experiential guidance paving the way forward in the design and use of catch shares. These sources of knowledge were external authorities and models that facilitated the diffusion of knowledge and therefore influenced the learning process for the IFQ program development. Two categories of sources of learning lessons were important to the NPFMC's endeavor, vertical influences that included the guiding fisheries management legislation, agency input, and case law. Horizontal influences that shaped the Council's learning process included catch share models under the jurisdiction of other Councils and other countries, especially Canada and New Zealand. Additionally, many influences on the NPFMC's learning process of developing the Alaska Halibut and Sablefish IFQ program were internal to the Council and the fishery. The sources of internal influence on the rationalization process included the problem severity of how overcapitalized the fleet was and what other problems that excess capacity spawned and the existing institutional capacity of the Council to respond to the problem that required significant time and money investments to take on the task of rationalization. Other internal influences included industry buy-in to the problem and the preferred solution; industry members had many reservations about the development of the new program and brought often conflicting concerns to the Council during the process. The final internal influences were the unique contextual factors that the fishery was nested in, especially the historic fleet structure and large part-time participant base. All of these various sources of information, knowledge, and experience helped shape the learning process of the NPFMC as it developed the IFQ program and directly influenced the program design outcome.

4.4 | External learning process variables

Vertical diffusion

The North Pacific Halibut Act of 1937 gave authority to the IPHC for management of the halibut stock straddling the U.S. and Canadian border. This management was in place prior to the original passage of the 1976 FCMA which gave management authority over fish resources out to 200 nm from the coast to the Federal government and Regional Councils. Therefore, it was unclear in the first few years of the NPFMC's operation where the Council fit in with the international management regime of halibut. Several years of attempts by the NPFMC to put the U.S. halibut fishery under limited entry management control were unfruitful as the power relationship between the Council and the IPHC was still unresolved (NRC 1999). However, the resolution of the role of the NPFMC in halibut management

came when the North Pacific Halibut Act was modified and renewed in 1982 with the renewal of the Halibut Convention. As legislation stemming from an international treaty, the Halibut Act of 1982 still superseded the FCMA in management authority for the U.S. halibut stock but gave authority to the NPFMC for management decisions such as limited entry and quota allocation (NRC 1999). Under the Act, the NPFMC was given authority to develop regulations for the U.S. portion of the Convention waters that would act as an addition to the regulations adopted by the IPHC, thus the Council regulations needed to not be in conflict with those of the IPHC (North Pacific Halibut Act 1982). Regulations drafted to implement Council decisions on how to proceed with management of the halibut fishery were accordingly developed under the auspices of the Halibut Act (NPFMC 1992).

Fortunately in terms of regulatory simplicity, the Halibut Act had nearly parallel requirements for the Council to take into account in establishing a system for limiting access into the fishery (NPFMC 1992). These requirements included developing limited access systems with the consideration of present participation, historical participation and fishery dependence, equity in allocations, prevention against excess share accumulation, the fishery's economics, other fishery participation options, and the basic cultural and social framework of the fishery with specific reference to opportunities for rural coastal Alaskan villages (North Pacific Halibut Act 1982). Keeping in line with the IPHC regulations was an important influence on the Council's policymaking process as it pursued more rational management models for the halibut fishery. Specifically, the Council sought to design the IFQ program to be based on respecting and benefiting from the existing IPHC regulatory area divisions for the U.S. halibut stock (NOAA Fisheries Service Office of Policy 2009b). This negated the need for a separate management design to make sure shares were distributed geographically to avoid localized depletions of the stock (NOAA Fisheries Service Office of Policy 2009b).

The primary legislation guiding the management role of the NPFMC with respect to the sablefish fishery and the development of the IFQ program was the 1976 FCMA. The Act required that the Council follow the 7 National Standards included at the time in crafting FMPs and outlined required factors in Section 303(b)(6) that Councils needed to take into consideration in developing a limited entry program. These included past and present participation and dependence of participants on the fishery; and the economic, social, and cultural facets of the fishery (NPFMC 1992). The management guidelines promulgated under the 1976 FCMA also disallowed Councils to charge fishery participants for QS issued under a limited entry system (FCMA 1976). The Council used this rule to support its decisions about allocation frameworks because QS distributed without cost helped meet the management objectives of preserving the small vessel, owner-operator fleet character and concurrently helped avoid some

components of program opposition (Hartley and Fina 2001). The Council recognized, though, that this FCMA requirement that took some of the allocation program design details out of the Council's hands also created the potential for 'windfall gains' or private gains from a public resource that could result from the allocation of privileges for no cost rather than distribution of shares through an auction. This was a concern that weighed heavily on the Council's learning process in experimenting with catch shares (Hartley and Fina 2001).

Significant influence on the learning process of the NPFMC in developing the Halibut and Sablefish IFQ program was also conveyed by NMFS' input in the management process as the body charged with approving or disapproving Council management decisions and then developing regulations for implementation. The NPFMC spent many years directly after its conception pursuing limited entry options for both the halibut and sablefish fisheries. A NPFMC development of a 3 year entry moratorium in 1983 was ultimately disapproved by NMFS (Hartley and Fina 2001). NMFS instead recommended that the NPFMC pursue less transient limited entry system management options (Hartley and Fina 2001). The 1983 rejection followed a series of rejections of NPFMC proposed management options for the halibut fishery and ultimately slowed new management development for halibut by the dispirited Council (Hartley and Fina 2001). The NPFMC instead focused management attention on the sablefish fishery and began investigating the possibility of a license limitation program for the fishery in 1985 (Hartley and Fina 2001). The management discussions shifted to instead seeking to develop an IFQ program in 1988, at which time the Council decided to revisit the halibut fishery challenge and lumped the two fisheries together into the consideration of transitioning both to IFQs in 1988 (Hartley and Fina 2001).

Vertical drivers of the diffusion of information helping to shape the Council's learning process in the development of a catch share program for the halibut and sablefish fisheries also came from the Office of Management and Budget (OMB) in fulfilling its role under the Executive Order 12291. Executive Order 12291 was created to allow for presidential oversight of the agency regulatory process to ensure burdensome regulations were well-reasoned (Executive Order 12291). Therefore, the OMB was charged with reviewing the NOAA proposed regulations on the NPFMC's 3 year entry moratorium for the halibut fishery. The OMB ultimately determined that the moratorium regulations were not consistent with the Executive Order because they failed to resolve the excess capacity problem in the fishery without creating new economic problems (Pautzke and Oliver 1997). The OMB specifically recommended the Council pursue an IFQ option as a longer term solution to the growing overcapitalization of the halibut fishery (Pautzke and Oliver 1997).

A final vertical source of guidance in the learning process of developing the Halibut and Sablefish IFQ program came from case law that was fall-out specifically from the Atlantic Surf Clam and Ocean Quahog ITQ program implemented only a few years earlier. After airing their grievances during the MAFMC's ITQ program development but not achieving their desired result, a group of disgruntled processors and disenfranchised vessel owners filed a lawsuit in an effort to stop the ITQ program's implementation (McCay 2001). *Sea Watch International v. Mosbacher*¹³ was filed in 1991 (Marvin 1992). The suit centered on the controversy of the allocation design decisions made by the MAFMC and specifically how allocations were based on the catch history of the vessel rather than on the fisherman that received the allocation. The plaintiffs argued that this system unfairly punished active surf clam and ocean quahog fishermen that had purchased new vessels prior to the ITQ program development and effectively lost any catch history they had accumulated on their prior vessels (Marvin 1992). They also argued that fishermen who purchased older vessels were unfairly benefited by the program allocation design because their catch history included the prior high catch histories of the previous owners of the vessel (Marvin 1992). Ultimately, the court upheld the MAFMC's program design and the ITQ program went into effect for the Mid-Atlantic surf clam and ocean quahog fishery (McCay 2001). The Court decision in upholding the Council's design decisions altered the arena for future legal recourse by fishery participants disgruntled by the Council pursuance and design of a catch share program. The negative ruling of the Court in favor of upholding the Council actions gave guidance to all later Councils. Specifically for the NPFMC, this case demonstrated that the Council could develop a catch share program as it saw fit with the acknowledgment that an option was legally pursuable even if it created controversial 'winners' and 'losers' in the chosen initial allocation scheme. This was especially relevant to the NPFMC as in its IFQ program development, the design decisions in regard to the initial allocation of quota was certainly the most controversial and arduous step (Hartley and Fina 2001).

Horizontal diffusion

The Alaska halibut and sablefish IFQ program was an experiment with fishery rationalization in that the use of market-based mechanisms and the actual design of the program were novel and innovative approaches for the Council (Bromley and Macinko 2007). Catch shares were still a relatively new policy instrument at the time of the IFQ adoption in 1995; only two domestic programs were in operation at that time. Bromley and Macinko (2007) argue that the novelty of the IFQ program innovation, of any innovation in public policy, can be problematic because of a lack of relevant policy

¹³ 762 F. Supp. 370

experience and it may therefore be difficult to predict the full implications of the program. However, there were models of catch share management that the NPFMC could draw parallels from and analyze in the learning process of how to transition the halibut and sablefish fishery to an IFQ program. Sources of the diffusion of experience, knowledge, and information were important contributors to the NPFMC's learning experience in rationalizing management to meet its management objectives. The NPFMC was influenced by existing U.S. catch share systems, both the Atlantic Surf Clam and Ocean Quahog ITQ program implemented in 1990 and the South Atlantic Wreckfish ITQ program implemented in 1992. Additionally the Council gained significant guidance from analyzing both the New Zealand and Canadian experiences with market-based mechanisms in fishery management. In fact, the halibut and sablefish IFQ program developers felt that international experience could sufficiently fill in information voids for the effects of program design components that could not be forecasted or modeled (NPFMC 1992).

The MAFMC Surf Clam and Ocean Quahog ITQ program as well as the South Atlantic Fishery Management Council's (SAFMC) Wreckfish ITQ program offered opportunities for the diffusion of experience, knowledge, and information to the NPFMC as it went through the learning process of developing its first catch share program. The federal approval and implementation of the MAFMC and SAFMC's innovative management systems existed as a measuring stick for other Councils' pursuit of similarly innovative management techniques (Tipton 1994). Specific learning lessons for the other RFMCs came from the implications of the first two U.S. experiments in catch shares, lessons like program designs that allowed the consolidating flow of quota into the hands of vertically integrated processors as well as banks (Dawson 2006). Indeed fall-out from the MAFMC ITQ program included some members of the industry voicing concern to Congress and nationally to the Councils about this negative implication reoccurring in later developments of catch share systems (Dawson 2006). While important in blazing the way in the U.S. experience with the design and use of market-based mechanisms to meet fisheries management goals, the perceived negative implications of the MAFMC's program focused wary attention on subsequent rationalizations. The concentration of ownership that occurred in the Surf Clam and Ocean Quahog ITQ program contributed to the general resistance to the development of catch share systems for other fisheries in the region and across the nation (McCay and Brandt 2001). The significant job losses among captains, mates, and deckhands through the intended reduction of vessels fueled the development of the early catch share resistance movement in the U.S. that contributed to the later moratorium on new catch share programs under the 1996 Reauthorization of the FCMA (McCay 2001).

Other learning guidance came to the NPFMC from international models of catch share fishery management that offered hindsight as to the successes and pitfalls of both the transition to management with market-based mechanisms and the implications of specific program design elements (NPFMC 1992). Analyzing and learning from other countries' experiences lent important guidance to the NPFMC as it learned how to apply the policy instrument to its purposes in the halibut and sablefish fishery. In exploring various limited entry and quota management options through the FMP Amendment process, the Council had to complete an Environmental Impact Statement (EIS) as required by the National Environment Policy Act (NEPA) (P.L. 91-190) in which it fully scrutinized the management options and their implications. In fact, the progression to the final IFQ program as it was implemented included the composition of several EIS and Supplemental EIS (SEIS) documents. In scrutinizing the Council choices, the FMP and its EIS focused on the Canadian and New Zealand catch share experiences to gain advice and experience for the benefit of the Council's work (NPFMC 1992). First and foremost, the international catch share prototypes from New Zealand and Canada contributed solid and convincing evidence of the benefits of catch share programs in lessening the controversial heavy hand of the government in resource allocation and allowing the market to successfully fulfill that role and help management reach its objectives (NPFMC 1992).

The Council also drew learning lessons from the New Zealand experience to forecast potential difficulties in garnering industry support and cooperation through the program design process and later into its implementation and operation (NPFMC 1992). Specifically in analyzing choices for initial allocation frameworks and how to best kick-start the removal of capacity from the fishery, the NPFMC looked to the implications of how New Zealand approached the problem (NPFMC 1992). New Zealand administratively removed part-time fishers from the fishery through the design of the QMS which resulted in significant complaints about disenfranchisement from the excluded participants (NPFMC 1992). This example was especially applicable to the learning process of the NPFMC in the design and use of catch share principles because of the predominantly short duration of the halibut fishery especially but the sablefish fishery as well. This allowed salmon fishers, herring fishers, and others to develop a portfolio of fisheries to participate in. The Council had to decide whether to allocate privileges to all participants regardless of their level of activity and allow the market to weed out the excess capacity or to use the initial allocation itself to reduce the participant pool.

During the design process of the rationalization option, the NPFMC was also concerned about a perceived trend in existing catch share programs for quota to consolidate into the hands of larger operators (NPFMC 1992). The Council saw that international experience specifically from the New

Zealand QMS evidenced this trend (NPFMC 1992). Therefore, during the development process the Council debated how to create program elements to prevent this implication. The Council also looked to the New Zealand catch share program to analyze and understand the tradeoffs in the design of enforcement provisions between allowing flexibility for fishermen to occasionally slightly overshoot quota allocations and assuring that landings would not substantially exceed quota (NPFMC 1992).

In the learning process of the applicability and adaptability of market-based mechanisms to the needs of the NPFMC in the halibut and sablefish fishery, Canada was also a significant source of the diffusion of knowledge, experience, and information. Canada had catch share programs that were operational both prior to and during the timeframe of the NPFMC's development of its IFQ program. Canada implemented the Bay of Fundy herring vessel share program in 1976, an IVQ program for the sablefish longline and pot fisheries in 1990, and a 1991 IVQ program for the halibut longline fishery (NRC 1999). Canada's development and implementation of catch shares in its halibut and sablefish fisheries were especially opportunistic for the NPFMC as it had highly analogous models to learn from with obvious similarities in the biological and ecological nature of the fisheries as well as similarities in the processing and market characteristics of the product. U.S. halibut and sablefish product often competed in the same markets, so there may have been a neighborhood effect of Canada influencing the U.S. development of catch share management. The neighborhood effect refers to economic competition or similarity in situational public policy problems between neighboring entities that encourages mimicking behavior in the adoption of specific policy innovations (Rincke 2004). Therefore, the U.S. proximity to Canada, the market competition between the fishery products harvested from shared fishery resources, and the joint management activities may have further facilitated Canada's influence on the NPFMC learning process in transitioning to catch share management for the halibut and sablefish fishery. The NPFMC could draw lessons from Canada's development of its catch share programs and apply it to the relevant policy and management arena of the U.S.

In the FMP and accompanying EIS, the NPFMC specifically looked to the Canadian sablefish program to forecast what the potential implications of an IFQ program would be on behaviors that were thought to be negative outcomes of the transition to catch shares such as high-grading (NPFMC 1992). Lessons from Canada also dispelled worries that benefits of rationalization in the desired changes in fisherman behavior would be diluted by federally limited quota duration rules (NPFMC 1992). The FMP and EIS used the analysis of data from the Canadian IVQ program to analyze the potential effect of an IFQ program on U.S. ex-vessel prices and to forecast changes in the processing framework of the fishery based on the size of active firms (NPFMC 1992). The modeling of these changes showed that Canadian

fishermen profited from increased bargaining power and the formation of a market for fresh halibut that was possible with the slowing of the race to fish. The Council additionally benefited from the Canadian experience in forecasting the biological impacts of rationalization with respect to how program design affected bycatch and the attainment of the TAC (NPFMC 1992). The NPFMC also learned of the potential profitability benefits to industry participants in savings from redundant gear and bait that accumulated in the open-access fishery. It also observed the tradeoffs between profitability gains and design decisions to maintain the diversity of operations in the fishery like quota blocking (NPFMC 1992). This information influenced the NPFMC's development process in regards to selling the proposed program to the industry and garnering the necessary support and buy-in. The NPFMC specifically cited persons involved in the development and monitoring of the Canadian sablefish IVQ program that advised the Council that industry cooperation was a critical element in determining the ultimate success of the program (NPFMC 1992).

4.5 | Internal learning process variables

Problem severity

Elinor Ostrom argued that imperfect but adequate systems often lack the necessary impetus to gain commitment to the often costly process of developing and implementing superior systems (Ostrom 1992). The extension of this line of reasoning is that the needed motivation for a change may be a crisis (Holland and Ginter 2001). The halibut and sablefish fisheries under traditional management were in crisis. Prior to the transition to the IFQ program, the open-access fishery with TAC management used season length to crudely control effort and harvest. The open-access system encouraged each fisherman to increase his or her personal effort capacity so as to better compete with the other industry participants; each racing to capture as much as possible before the overall fishery TAC was hit. Regulators set the season length inversely to the harvesting capacity of the fishery; the overall capacity grew with individual decisions to increase effort which then prompted the further attenuation of season length (NRC 1999). Catch tripled between 1977 and 1995 while the season length contracted from 47 days to just 2-3 days (NRC 1999). For many of the regulatory areas for the halibut fishery, the season contracted to a 24-hour opening (Hartley and Fina 2001). Short season lengths led to vessel owners over-equipping vessels with redundant gear to maximize catch (Hartley and Fina 2001). And the vicious cycle continued to dissipate rents from the resource to the detriment of industry and individual profitability and to the ire of management. The overcapitalization of the harvesting sector demanded the mirrored effect in the processing sector to handle the stochastic high volume of fish, frequently

creating idle capacity in processors when the season closed (Holland and Ginter 2001). The consistently expanding harvesting capacity of the fishery and the speed of season prosecution led managers to be unable to satisfactorily predict TAC overages or underages, which obliged a cautionary approach to closing the fishery when it approached the TAC (Hartley and Fina 2001).

Other negative implications of the race to fish in the halibut and sablefish fisheries were the loss of product quality and the reduced availability of fresh product in the market as the fast and furious harvest precluded careful handling of fish so product was generally processed as frozen (Hartley and Fina 2001). The quick and hasty fishery prosecution also had the effect of creating a market glut of product that lowered the price the product could command, a reduction in the product wholesomeness (NRC 1999). This also reduced the bargaining power harvesters held in negotiating price with processors. Other problems included particular concern for the economic stability and fate of sensitive communities in coastal Alaska held by managers of the Alaskan halibut and sablefish fisheries. In the development of alternative management regimes to the open-access fishery, program objectives included cultivation of the development of a small-boat fishery for the rural coastal communities (NRC 1999). Safety was also a major concern in the halibut and sablefish fisheries. The derby-style prosecution led to a high accident rate (NRC 1999). In the years just prior to the transition to catch share management there were between 20 to 30 search and rescue cases each year (NOAA Fisheries Service Office of Policy 2009b). Safety issues were especially pronounced in the halibut fishery due to the combination of the short season length and the small vessel industry participation (Hartley and Fina 2001). If the other problems were not enough, the halibut and sablefish fisheries were also plagued with allocation conflicts between gear sectors when there were spatially and temporally preferable and profitable fishing grounds that each group sought to capitalize on (NRC 1999).

Biologically speaking the problems with the fisheries were not as extreme as the economic problems. Preceding the implementation of the IFQ program, both halibut and sablefish stocks were not considered overfished and overfishing was not considered to be occurring (Anderson and Holliday 2007). However, the sablefish stock had been in decline since 1986 with poor recruitment documented since 1982 (NRC 1999). Additionally, there was evidence that the average halibut weight-at-age was in decline (NRC 1999). And bycatch of halibut and sablefish in other fisheries was an issue of major concern for the stocks as well. Non-hook-and-line caught halibut or halibut that was caught out-of-season was subject to mandatory discard regulations prior to the transition to IFQs (NRC 1999). Halibut had known high bycatch mortality, thus posing potential population decline problems (NRC 1999). Similar restrictions existed for sablefish as well (NRC 1999). Fishing gear loss was also a serious concern for

management. The derby fishery resulted in a high occurrence of lost and unrecovered gear; contributing to significant ghost fishing deadloss (NRC 1999). The indiscriminate mortality due to ghost fishing was estimated to account for 3% of the commercial catch in 1990 (NRC 1999). And the ghost fishing issue was a perennial one with multiple cycles of killing by the same gear because fish that were caught on abandoned gear became bait for subsequent fish to be caught (Hartley and Fina 2001). Regulations may have exacerbated the gear loss problem because in an effort to maximize catch in a condensed season, fishers would set more lines than they could retrieve in the allotted season time, and upon season closure were prohibited from retrieving additional gear without special permission from management (Hartley and Fina 2001). So oftentimes, un-retrieved lines were simply abandoned.

Institutional capacity

The existing management structure and regulations applied to the halibut and sablefish fisheries had significant influence on the learning process in the NPFMC's development of the IFQ program. Prior to rationalization, management components included TAC regulations divided into regulatory areas and subareas specific to each stock (NRC 1999). For halibut, the NPFMC set the TAC by sector based on the Allowable Biological Catch (ABC) and Overfishing Limit (OFL) decisions set down by the IPHC (NRC 1999). For sablefish, the NPFMC set down the ABC and OFL as well as the TAC divided by sector (NRC 1999). The existing regulation of TACs allocated by sector was important in facilitating the transition to catch shares. Developing a catch share system for species that are targeted by multiple gear types in the fishery initially requires a partitioning of the quota between the gear types so having this already in place reduced at least a small amount of the transaction costs of a significant management change (Pautzke and Oliver 1997). Even though the TAC was sometimes exceeded in the fishery, having the framework for TAC management already in place gave the NPFMC a head-start in the learning process of transitioning to catch shares (Pautzke and Oliver 1997).

What was missing in terms of institutional capacity of the Council before rationalization was limited entry, a necessary component of any catch share system. Thus in the consideration of the Halibut and Sablefish IFQ program, the Council had two hurdles to clear. The first was the imposition of a limited entry system that had been the subject of sustained and contentious debate and then there was the quota share program itself (Pautzke and Oliver 1997). In regards to limited entry management, the Council had endured a long and ultimately unfruitful pursuit of a moratorium on entry into the fishery and had temporarily retreated from the deliberations in 1985 (Pautzke and Oliver 1997). This added a layer of complexity and controversy in the process of the NPFMC learning about what it would

take to complete the transition to catch shares. Additionally, there continued to be disagreement among Council members as to the overall benefits and costs for the fisheries in transitioning to an IFQ program (Pautzke and Oliver 1997).

In existing institutional capacity, the NPFMC benefited from the existing availability of data on the fishery and especially on vessel owners and catch histories. NMFS and the Alaska Department of Fish and Game (ADF&G) had already been collecting the necessary official data on vessel owners and catches (NRC 1999). This simplified the process of determining entitlement to quota and quantities for initial allocations in a framework based on catch histories (Hartley and Fina 2001). Data limitations did exist in some areas, though, like for vessel leaseholder interests (an important consideration in initial allocation), deceased vessel owners, divorced couples and dissolved corporations and partnerships (Hartley and Fina 2001). The limitations in the existing management in terms of the preceding data collection practices impacted what the final allocation framework decision could be. Not having collected official data on crew member participation effectively barred any possible consideration of developing an initial allocation framework that incorporated crew members (Hartley and Fina 2001).

Prior to making the final decision to pursue the development of an IFQ program as the preferred management alternative to the status quo, the Council invested serious time and effort into fully vetting all other options including FMP and EIS analyses on license limitation and annual fishing allotments and then analyses of design options for an IFQ program (NPFMC 1992). Initiating the development of management alternatives for the halibut and sablefish fishery required substantial funding commitments to the tune of \$2 million at the outset (Hartley and Fina 2001). Fully fleshing out all management alternatives contributed to a more than 15 year development period for the program from the drawing board to implementation. Developing the framework for the initial allocation was especially data intensive and costly in both time and effort to be implemented (Hartley and Fina 2001). The long gestation time of the program can be ascribed to the controversy and gravity of the management changes and the resulting program (Pautzke and Oliver 1997).

Industry buy-in

Industry buy-in to the problem and the preferred solution is a key component in the transition to catch share management in a fishery and was a significant driver in the Council's learning process. Ostrom (1992) states that in order to develop mutually agreed upon cooperative solutions, resource users must share a common conceptualization of the problem and an understanding of the alternatives to address the problem. Garnering industry support can motivate compliance with the new

management thereby potentially reducing enforcement needs because compliance is often greater when the user group views the rules as legitimate (Sutinen and Kuperan 1999). In developing a catch share program for the halibut and sablefish fishery, the NPFMC saw industry support and involvement as a key objective to allow the industry to feel ownership of the management decisions and to forecast and prevent later program problems or discontent (NPFMC 1992). Both the industry and the Council agreed on the need for a substantial change in the management course of action, that status quo was not an option, however the actual process of change and learning in considering management options was protracted and contentious (Hartley and Fina 2001).

The development of the final IFQ program as it was implemented for halibut and sablefish involved several cycles of the fisheries management policymaking process in which alternatives were test-driven through the Council process with public comment, and industry consultation (Hartley and Fina 2001). Full participation in the development process later eased administrative burdens in the actual quota allocation process by having participants do the leg work of applying for the quota they were eligible to receive (Hartley and Fina 2001). The NPFMC worked to include industry in the negotiations from the beginning, the Council requested industry input on what they felt would be the preferable alternative to the status quo management in 1985 (NPFMC 1992). Representatives of the longline component of the industry brought a proposal to pursue a license limitation program for the fishery to the NPFMC in 1987 (Ginter and Muse 2002). The NPFMC assembled workshops in 1988, focusing on analyzing the management alternatives available for the sablefish management change, it looked to use workshops as a vehicle to further facilitate industry's participation in the process (Hartley and Fina 2001).

Industry involvement in the management negotiations of determining the preferred alternative to the status quo and ultimately developing the IFQ program brought forth many of the reservations industry participants had about the potential new direction. The industry voice proved to not be unified in its concerns. Some participants were apprehensive about pursuing an IFQ program because of what the implications of the initial allocation framework could be (NRC 1999). They felt that allocation design decisions would favor vessel-owners and thereby instigate an undesired shift of market power distribution in the fishery (NRC 1999). Representatives of the processing sector of the fishery saw themselves being disenfranchised in the catch share program design because their contribution and capital commitment was not recognized with the allocation of privileges (NRC 1999). Due to this concern, the Council did discuss the potential implications of a program on the processing sector (Pautzke and Oliver 1997). Ultimately, the initial allocation design decisions were the most heated and

protracted step in the IFQ program's development. This is not unique to the NPFMC or the Alaska Halibut and Sablefish IFQ program as the program design for quota allocations is often a critical issue in the development process and may create significant obstacles to final implementation (Brown 2000).

The NPFMC sought to develop the design framework for the initial allocation through full investment in the public process as the most effective way to prevent later grievances with the program (Hartley and Fina 2001). The Council specifically decided on developing the program with a broad definition of eligibility for initial allocation of quota to preempt appeals of inequitable lack of quota designation due to participant hardships (Hartley and Fina 2001). With many stakeholders involved and learning concurrently with the Council as to the most agreeable design for the initial allocation, many options were considered such as having provisions for minimum catch history qualification caps, a component of the quota allocation only tied to participation and not catch history, and a graduated system of quota eligibility based on the number of participating years (Hartley and Fina 2001). The Council learned that in pursuing some design options, ease in implementation could only be gained at the sacrifice of industry endorsement (Hartley and Fina 2001).

Contextual attributes

The learning process for the NPFMC in the design and application of market-based mechanisms to the management objectives of the halibut and sablefish fishery was influenced considerably by the unique ecological, economic, and social context in which the fishery and management were nested. Indeed Pautzke and Oliver (1997) asserted that the existing social and economic fabric of the fishery may be the most important determinates of the appropriateness of catch share management for reaching that fishery's goals. In the case of the halibut and sablefish fishery, these aspects were a significant consideration in the development of the IFQ program (Pautzke and Oliver 1997).

Ecological context

The ecological context of the fishery and the management was important in regards to the status of the stocks and additional sources of mortality beyond the directed fishery that needed to be incorporated into the management approach. While neither halibut or sablefish was considered overfished and overfishing was not occurring in either, the halibut stock did show moderate decline and the sablefish stock was found to be in strong decline (NRC 1999). The ecological characteristics of sablefish being farther offshore made it subject to less intense harvest competition (Hartley and Fina 2001). However, the stock status still showed the implications of the fishery's excess harvesting

capacity. Additionally, these fisheries were not dependent on stochastic booms of large year classes to supply the fishery, multiple year classes of the fish were susceptible to the fishery (NRC 1999). This gave a level of stability to the age structure of the population and contributed at least mild protection against boom and bust population cycling due to significant recruitment variability. The other sources of mortality for halibut were an especially important consideration in developing sustainable management of the stock. The species is a large component of bycatch in other fisheries of all sector types; commercial, sport, and subsistence (NRC 1999). And the sport fishing catch of halibut was growing so it became even more important to manage for its interplay with a commercial catch share program (NRC 1999).

Economic context

The economic nature of the fishery distinctly influenced how the Council approached the rationalization of management using catch share principles. The fishery had a heterogeneous mix of participants; some had complete economic involvement, investment in it, and dependence on it while others retro-fitted their vessels active in other fisheries like salmon for an occasional halibut or sablefish fishing trip (NRC 1999). The average participant in the halibut fishery though was a part-timer with a non-fishing occupation as their primary employment (NRC 1999). An average of 3,275 different vessel owners were documented to be participating in the halibut fishery between 1984 and 1990 and more than two-thirds of these vessel owners made landings of other species (Hartley and Fina 2001). A catch share program had yet to be applied to a fishery with that level of participation (Hartley and Fina 2001). This mix of participants also had a regional pattern to it, with the dedicated halibut vessels generally based out of the Pacific Northwest while the vessels occasionally adding halibut to their broader fishing activity were mostly Alaska-based. This regionalism to the fleet structure had to be accounted for in the Council's program development. The management legacy of the continually shortening season length opposite the growing capacity of the fleet reinforced the part-time participation of most fishermen because the short season length did not allow fishermen to be profitable enough not to need other employment (Hartley and Fina 2001). The part-time fishery affected the way the Council could measure what the efficient level of capacity should be, to understand first of all how severe the overcapitalization was but then to know what the new program's objective would be in terms of results (Hartley and Fina 2001).

This part-time fishery feature was less pronounced in the sablefish fishery often because of the requirement of larger vessels to operate in the Bering Sea and Aleutian Islands, sablefish fishery

participants also more often made their living off the sablefish fishery alone (Hartley and Fina 2001). The larger size of the sablefish vessels often disqualified the owners from participating in other fisheries such as salmon because of its management restrictions in regard to vessel size; this further increased the fishermen's dependence on the sablefish stock (Hartley and Fina 2001). Both the halibut and sablefish fisheries were prosecuted by two distinctly different types of vessels, CVs and CPs, or freezer-longliners, requiring different management protocols because of the significant difference in fishing activity. The sablefish fishery was more populated with CPs than was the halibut fishery (Hartley and Fina 2001).

The Council's extensive learning process in how to achieve its objectives for the fishery in the initial allocation and quota eligibility design provisions was shaped by the economic context of the fishery and the changes to that context that the Council sought to prevent. The NPFMC recognized the traditional owner-operator characteristic of the fishery and proceeded with designing a program that would disallow growth in the corporate ownership and control in the fisheries (Hartley and Fina 2001). Determining the initial eligibility was based on how the Council perceived the relative investment of different groups to the fishery. Decisions had to be made in regards to rewarding those that had operated in the fishery for a significant amount of time over the newcomers and potentially speculative entrants to the fishery as well as in regards to juxtaposing the roles of vessels owners and crewmembers (Hartley and Fina 2001). Ultimately it was decided that most crewmembers had not had significant enough capital investments in the fishery to warrant initial eligibility status, so instead provisions were pursued to open other avenues that encouraged crewmember investment in the fishery (Hartley and Fina 2001). The broad participation eligibility decision was also an economic decision in that the Council sought to leave the distribution of fishing activity to the market forces through the market activity of numerous quota holders, allowing the consolidation that facilitated efficiency gains to be done through the perceived fairness of the market rather than by the hands of the Council (Hartley and Fina 2001).

Social context

The social context of the halibut and sablefish fisheries played an especially dominant role in shaping how the NPFMC learned how to apply catch share principles to the situational needs. Some characteristics of the social context included the fleet structure with historically small vessel, owner-operator prosecution of the fishery (NOAA Fisheries Service Office of Policy 2009b). The Council saw the importance of designing a program to protect that feature and worked to learn how to achieve that objective through the program's design. Additionally, the Council had concerns in the development

process of balancing the concern over the implications of management changes on sensitive and vulnerable coastal Alaskan communities that were looking to increase their activity in the halibut fishery and the component of the fleet based out of the Pacific Northwest. Both the halibut and sablefish fisheries had regional importance to both groups (NRC 1999). Throughout the Council’s process of analyzing and crafting management changes, concern about what the implications would be on hindering the increased participation of Alaskan communities remained a salient topic of debate (Pautzke and Oliver 1997). Additionally, the place of native Alaskans especially in the remote communities of Western Alaska as a key thread in the social fabric of the fishery caused concerns of equity in the program design (Anderson and Holliday 2007). The Council wanted to design a program to protect the viability of the vulnerable communities that had few other economic opportunities (NOAA Fisheries Service Office of Policy 2009b). The NPFMC’s learning process in developing a catch share program for the context was significantly influenced by debating how to balance the desired efficiency gains through rationalization with the social equity concerns of how rationalization would change the existing social structure.

This was especially relevant in discussions of how transferability should be approached in the program design, how to gain efficiency without losing the potential for new entry and especially stake in the fishery by Alaskans (Pautzke and Oliver 1997). These concerns ultimately led the Council to decree a separate set-aside of quota into a specially-designed program just for those vulnerable communities, the CDQ program (Anderson and Holliday 2007). This raised other equity concerns, though, in regards to how the Council designated the quota set-aside to protect native Alaskans and if it unfairly affected certain groups of non-Alaskan fishermen that had established catch history in those areas (NRC 1999). Eventually, the quota set-aside for the CDQ program necessitated a change in the catch distribution consideration for the Western Alaska regulatory areas and the Council had to compensate certain disenfranchised non-native fishermen with quota in other regulatory areas (Hartley and Fina 2001).

4.6 | The learning outcome

The Amendment 15 program design outcome of the NPFMC process of learning how to adapt and apply catch share principles to the halibut and sablefish fishery objectives is summarized below.

Table 2 | Amendment 15 Design of the Alaska Halibut and Sablefish IFQ program

Specifications of privilege	Type of allocation	<ul style="list-style-type: none"> • IFQ <ul style="list-style-type: none"> ○ Separate share classes for CVs and CPs ○ Regulatory area specifications ○ Vessel size category designations
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		<ul style="list-style-type: none"> • Halibut: CV <35 ft, CV 35-60 ft, CV 60+ ft; all CP • Sablefish: CV <60 ft, CV 60+ ft; all CP
	Management unit	<ul style="list-style-type: none"> • Pacific halibut (<i>Hippoglossus stenolepis</i>) <ul style="list-style-type: none"> ○ All commercial hook-and-line harvests of halibut in state and federal waters off Alaska ○ Except subsistence, treaty, sport fisheries or bycatch in trawl and pot gear • Sablefish (<i>Anoplopoma fimbria</i>) <ul style="list-style-type: none"> ○ Longline and pot gear sablefish harvests in federal waters off Alaska ○ Except state water harvests and trawl harvests • Controlled divisibility, minimum of 20,000 lbs in quota block
	Transferability	<ul style="list-style-type: none"> • Permanent transfers between initial recipients and qualified crew allowed (150+ day sea time requirement) for CV QS <ul style="list-style-type: none"> ○ Restrictions of transfers across vessel size classes and area • Leasing of CV QS by initial recipients allowed up to 10% during first 3 years of program operation <ul style="list-style-type: none"> ○ After 3 years, leasing of CV QS is prohibited • Leasing allowed for CP QS • QS cannot be bought by trawlers for directed or incidental take
Specifications of privilege holders	Initial eligibility	<ul style="list-style-type: none"> • Initial allocation to vessel-owners or vessel leaseholders that had landings at any time between 1988-1990 <ul style="list-style-type: none"> ○ CV QS required documented 150+ days experience harvesting fish in any U.S. fishery ○ CP QS required entity defined as U.S. citizen under IFQ regulations (50 C.F.R. part 679) • QS allocation framework calculated by vessel class, minus CDQ allotment : <ul style="list-style-type: none"> ○ Based on sum of best five years of sablefish catches between 1985 and 1990 ○ Based on sum of best five years of halibut catches between 1984 and 1990 ○ QS area allocation based on geographic distribution of landings during qualifying years
	Subsequent eligibility	<ul style="list-style-type: none"> • 150+ day sea time requirement for CV QS
Specifications of program	Consolidation controls	<ul style="list-style-type: none"> • 0.5% cap on control of regional TAC for halibut • 1% cap on control of regional TAC for sablefish • Similar vessel use caps • Limited consolidation of small blocks of quota (quota blocking)
	Directed conservation	<ul style="list-style-type: none"> • Prohibited high-grading

	elements	
	Social equity elements	<ul style="list-style-type: none"> • Owner-on-board requirement (similar between halibut and sablefish) <ul style="list-style-type: none"> ○ Unless owner is corporation or partnership ○ Allowed use of hired masters in certain halibut areas ○ Carries through to second-generation IFQ owners • Community quota purchase program • Low-interest loan program for eligible skippers and crew to purchase quota
	Administrative elements	<ul style="list-style-type: none"> • Monitoring <ul style="list-style-type: none"> ○ 30% observer requirement for sablefish vessels 60+ feet ○ 100% observer requirement for sablefish vessels 125+ feet ○ Landings must be delivered to Registered Buyers with advance notice to NMFS of landings <ul style="list-style-type: none"> • Buyers must record landings on fish tickets (official landing receipts) from ADF&G, WDFW¹⁴, or ODFW¹⁵; halibut landings data forwarded to IPHC ○ Post-transaction auditing • Enforcement <ul style="list-style-type: none"> ○ NMFS conducts routine dockside boardings and Coast Guard conducts routine at-sea boardings, monitors offloads, and conducts after-hours surveillance ○ System of roll-overs for overages and underages up to 10% of IFQ holdings ○ Enforcement sanctions: confiscation of harvests for overages more than 10% • Program administration and review <ul style="list-style-type: none"> ○ Specific entity created to handle allocation tasks: NMFS Alaska Region RAM¹⁶ Division ○ Nominal license fees and 2% landings tax
<p>Issues not addressed in original design</p>	<p>Major changes after implementation</p>	<ul style="list-style-type: none"> • First amendments submitted before program implementation <ul style="list-style-type: none"> ○ Changes to blocking of quota lbs ○ Adjustments of set-asides for CDQ program ○ Ownership limits in BSAI¹⁷ for halibut increased • Implementation of cost recovery fee program • Full observer requirements on halibut CPs and partial observer coverage requirements on halibut CVs • Recent changes to relax transferability provisions

¹⁴ Washington Department of Fish and Wildlife

¹⁵ Oregon Department of Fish and Wildlife

¹⁶ Restricted Access Management

¹⁷ Bering Sea/Aleutian Islands

		<p>between size classes, QS originally allocated to larger vessels can now be fished on smaller vessels</p> <ul style="list-style-type: none"> • Community purchase program • Charter Halibut IFQ program in two regulatory areas
	Unaddressed issues	<ul style="list-style-type: none"> • Continued dissatisfaction with initial allocation scheme <ul style="list-style-type: none"> ○ exclusion of crew members and processors ○ delay between qualifying years and implementation date • Allocation to vessel-owners changed market power in fishery • Continued concerns with enforcement adequacy and community impacts • Continued discussion of changing observer requirements • Conflicts between sectors subsistence and sport catches

Sources: NRC 1999, Hartley and Fina 2001, Anderson and Holliday 2007, and Fina 2011

4.7 | Correlating the learning process and outcome

The process through which the NPFMC learned about the applicability and potential effectiveness of employing catch shares to obtain the desired management objectives was shaped by many influences. Parallels can be drawn between specific sources of guidance and the ultimate program design, or learning outcome. One of the most central influences in how and why the Council saw catch shares as the preferred management alternative relates to the conceptualization of the fishery's problems. The significant safety concerns, administrative burdens, dissipation of profitability, and ghost fishing deadloss all radiated from the central problem of excess capacity in the fleet and misaligned incentives in the regulation (NRC 1999). Understanding the economic root of the problem helped determine that catch shares could most effectively help achieve its management objectives.

Much of the guidance the NPFMC had in the development of the Halibut and Sablefish IFQ program coalesced as insight on how to design the initial allocation scheme within the program's framework. The vertically-oriented influence on the Council by the FMCA and the Halibut Act emphasized the crucial need to obtain equity in allocations through the design of the limited access system (NPFMC 1992). The existing social context of the fishery further necessitated that the Council invest significant development time in understanding the implications of program design on vulnerable Alaskan coastal communities and how to balance that with the impact on the Pacific Northwest based participants (NPFMC 1992). In learning how to achieve the protection of the native Alaskan cultural element, the Council eventually decided on a separate catch share program uniquely designed to the needs of those people, the CDQ program (NRC 1999). Additionally, concern for keeping opportunities available for native Alaskans and newcomers to participate in the fishery resulted in the Council

choosing design details such as quota blocking and a low-interest loan program to make the purchase of quota with limited capital attainable.

Input brought to the Council by industry members participating in the development of the design of the initial allocation scheme weighed heavily on the Council, especially because of the importance the knowledge gained from the Canadian IVQ experience put on gaining industry support. Some of the input from industry members was ultimately not incorporated in the program's design such as recognition of crewmembers or processors in the initial allocation of privileges (Hartley and Fina 2001). While the Council made exceptional attempts at incorporating industry say in the IFQ program development, the Council found that different industry groups often wanted opposing outcomes. Gaining support and buy-in was more complicated than simply inviting industry to the negotiation table, but the Council did find that many issues with industry dissatisfaction in the outcome could be preempted by a broad eligibility allocation scheme (Hartley and Fina 2001). Additionally, the final outcome of the initial allocation framework was constricted by the existing institutional capacity of the fishery and management, specifically with what data existed on patterns of participation.

Other sources of knowledge, information, and experience had bearing on how the Council determined the applicability of market-based mechanisms to the halibut and sablefish fisheries' needs with specific reference to the perceived flaws and failures of other catch share program models. The NPFMC development process entailed learning on the tradeoffs in the design of a policy instrument deployed to operate through market forces. Using the models that lay before it like the Atlantic Surf Clam and Ocean Quahog ITQ program and the New Zealand QMS, the NPFMC analyzed how a program could be designed to achieve the efficiency gains the tool seemed conceived for but to retain control over what was sacrificed for that efficiency.

The Council examined what had been done before in the name of efficiency and saw the implications in extreme consolidation that it did not want to repeat in its experiment (NPFMC 1992). The Council incorporated design elements to protect against excess consolidation, to facilitate efficiency gains but temper them to maintain the economic and social framework of the fishery. To ultimately protect the vessel size structure of the fleet, the Council looked to design elements like excessive share caps and distributed quota shares specific to various vessel categories (NOAA Fisheries Service Office of Policy 2009). Additionally, specific elements were needed to maintain the viability of owner-operator operations in the fisheries, accomplished through restrictions on transferability across the vessel size classes in the CV component of the fleet (NOAA Fisheries Service Office of Policy 2009b). These elements were an important contribution from the NPFMC's learning process in the design and use of catch

shares to the national dialogue on the management tool because it modeled how the FCMA federal requirements for preventing excess accumulation of shares in limited entry systems could actually be operationalized.

5.1 | Background on the Bering Sea king and tanner crab fishery

Fishing for king crab in the Eastern Bering Sea began in the 1930s by Japanese fleets that later branched out to fish tanner crabs as well in the 1950s (NPFMC 2011b). These stocks generally have habitat in the Bering Seas and Aleutian Islands areas. The U.S.S.R. joined the fishery in the late 1950s and foreign harvests of the crab resource continued until the 1970s when foreign harvests of king crab were stopped, followed by tanner crab in the 1980s (NPFMC 2011b). Americanization of the crab fishery began in the 1960s and domestic harvests eventually displaced the foreign fleet harvests (NPFMC 2011b). The king and tanner crab stocks in the Bering Sea off of Alaska have sustained considerable domestic commercial exploitation since then (NPFMC 2011b). However the fishery has long had significant fluctuations in harvest levels due to considerable variability in stock abundances (NPFMC 2011b). The crab resource encompasses many stocks and populations of a few different species including red, blue, and golden king crab, tanner and snow crab; groups are distinct from each other through geographic or regulatory divisions (NPFMC 2011b). The specific recognized stocks are: the Bristol Bay red king crab (*Paralithodes camtschaticus*), Bering Sea snow crab (*Chionoecetes opilio*), Bering Sea tanner crab (*Chionoecetes bairdi*), Aleutian Islands Golden king crab (*Lithodes aequispinus*), Pribilof Islands red king crab (*Paralithodes camtschaticus*), Pribilof Islands blue king crab (*Paralithodes platypus*), St. Matthew Island blue king crab (*Paralithodes platypus*), and Western Aleutian Islands red king crab (*Paralithodes camtschaticus*) (NMFS 2011). Crab are harvested using crab pots (fixed gear) that can be deployed by catcher vessels that deliver the crab live to shoreside processors or by catcher processor vessels that process the crab onboard (Anderson and Holliday 2007). With the location of the crab resource in the rough waters of the Bering Sea, the fishery is prosecuted by large, industrial vessels and a sizable shoreside processing sector that has strong community ties (Fina 2011). Processing plants are often located in small and remote communities such as the Pribilof Islands, Kodiak Island, and Dutch Harbor, AK.

5.2 | Regulation of the Bering Sea king and tanner crab fishery prior to rationalization

Early domestic management of the crab fisheries in the Bering Sea was the task of the U.S. Bureau of Commercial Fisheries that later handed management duties over to Alaska's Board of Fisheries and ADF&G when Alaska gained statehood in 1959 (NPFMC 2011b). Early regulations on the fishery included minimum size limits and the prohibition of harvesting female crabs or soft-shelled

crabs¹⁸ (NPFMC 2011b). When the Board of Fisheries took over management activities it instituted a registration system for fishery participants. After the 1977 implementation of the FCMA, the Secretary of Commerce adopted a preliminary FMP for the foreign fishery on king and tanner crab that ended foreign harvests of king crab and severely restricted foreign harvests of tanner crab (NPFMC 2011b). In 1978, a domestic FMP for tanner crab was implemented that incorporated much of the management structure that Alaska had developed and used under its management authority (NPFMC 2011b). The FMP gave shared management duties to the NPFMC and the state of Alaska (NPFMC 2011b). King crab was likewise jointly managed starting in 1981 (NPFMC 2011b). An FMP under consideration for king crab in the Bering Sea and Aleutian Islands that would have tipped the management authority balance in favor of the NPFMC was disputed in 1984 by Alaska for excessive federalism and unnecessary duplication of management activities (NPFMC 2011b). In 1986 the NPFMC formed a working group to address the joint management issue in addition to issues with the consistency of regulations in the tanner crab FMP with the FCMA (NPFMC 2011b). The group and the Council eventually chose to address the problems through a joint FMP covering king and tanner crab in the Bering Sea and Aleutian Islands that would emphasize devolution of management activities to Alaska as much as possible (NPFMC 2011b).

The king and tanner crab FMP for commercial fisheries was submitted for the approval of the Secretary in 1989 (NPFMC 2011b). The Plan continued the shared management structure with the state of Alaska under oversight by the NPFMC; much of the day-to-day management activities were charged to the State while the NPFMC dealt with more controversial management tasks such as limited access provisions and allocation (NPFMC 2011b). The FMP utilizes a flexible approach through which it outlines alternative options for management to pursue the objectives described in the Plan without pre-selecting particular tools to be used (NPFMC 2011b). In 1996 the Council adopted management strategies to limit effort in the fishery; a moratorium on vessel entry was put in place for vessels exceeding 32 feet in length overall (LAO) (NPFMC 2011b). Vessels were eligible to continue fishing if they had made a landing between 1988 and 1992 (NPFMC 2011b). The program also capped the participating vessel sizes to a maximum of a 20% increase in length overall (LOA) for all vessels less than 125 LOA (NPFMC 2011b). At this time, the Council decided to pursue a more permanent limited access system and began consideration of an ITQ program for the crab fishery (Fluharty 1995). Amendment 5 to the crab FMP was introduced in 1997 and went into effect in 2000, establishing a vessel license limitation system to

¹⁸ Soft-shelled crabs are crabs that have recently molted and are temporarily more vulnerable to mortality threats such as cannibalism until the new carapace hardens (Lovrich and Sainte-Marie 1997).

replace the moratorium (NPFMC 2011b). Eligible vessels had to have made a landing between 1996 and 1998 and were subsequently issued a Federal crab license with designations for vessel types (catcher-vessel or catcher-processor), vessel sizes (<60', 60-125', >125'), and species and area endorsements (NPFMC 2011b). The licenses were transferable between vessels, leasing was prohibited, and the program contained an ownership cap of 5 licenses maximum per license holder (NPFMC 2011b). Vessels active in the U.S.S.R./Russian crab fisheries were excluded. The program also had provisions for a skipper reporting system (NPFMC 2011b). Other management measures in place included restrictions on fishing season to protect crabs during molting and mating and minimum size restrictions (NPFMC 2011b).

The license limitation system was an important step for management by limiting the number of participants but it ultimately failed to address the accumulation of excess capacity in the fishery and the escalating race to fish (Fina 2011). Under this system some of the crab fisheries had seasons of just a few weeks, like the Bering Sea snow crab fishery, or just a few days, like the Bristol Bay red king crab fishery (Fina 2011). The license limitation system set the stage for the Council's pursuit of rationalization for the fishery because it did not address the growing overcapacity problem (NPFMC 2004a). While discussions of rationalizing the fishery had frequented the Council table since 1992, more serious discussions began with the failure of the license limitation system to meet the management's objectives. Additionally, significant impetus was added to the discussions by the race to fish that had made the crab fisheries among the most dangerous in the world. In 2003, the NPFMC adopted the preferred management alternative, the voluntary three pie cooperative program for the Bering Sea Crab Rationalization program (NPFMC 2011b). In 2004, Congress mandated the Secretary of Commerce to adopt the Rationalization program as the Council designed it through a rider on the Consolidation Appropriations Act of 2004 (P.L. 108-199, Section 801) that amended Section 313(j) of the Sustainable Fisheries Act (NMFS 2011). The Secretary published the final rules and regulations to adopt the program in 2005 (70 FR 10174) (NMFS 2011).

5.3 | Learning in the transition to catch share management

There were many significant influences on the NPFMC in the development of the Bering Sea Crab Rationalization program; several sources of guidance shaped the learning process through which the NPFMC determined how to apply market-based mechanisms to the needs of the crab fisheries. The fundamental drivers of learning in this case were both external and internal. External sources included vertical drivers of innovation like the 1996 Reauthorization of the MSFMCA, the NRC study on the use of

IFQs, and Congressional influence on the Council. Drivers of innovation and learning were also horizontal to the Council, with specific influence by other catch share programs managed by the NPFMC like the American Fisheries Act (AFA) (P.L. 105-277) pollock cooperative program and the Halibut and Sablefish IFQ program as well as guidance from Canada and other international programs. Additionally, elements internal to the Council like the unique social context of the crab fisheries in remote communities of Alaska played a fundamental role in how the NPFMC learned in the transition to rationalization and innovated in the ultimate design of the program.

5.4 | External learning process variables

Vertical diffusion

One of the most significant drivers of the unique learning process the NPFMC went through in transitioning to catch share management in the Bering Sea crab fisheries was legislative change to the central policy guiding the management of the Nation's federal fisheries. In 1996, the FCMA was reauthorized as the SFA (NPFMC 2004a). The SFA incorporated a few departures from the course of action prescribed by the FCMA by adding three new National Standards. These additions included specific conservation requirements to protect fisheries from overfishing and to rebuild those already declared overfished; to consider the impacts of fishing on habitat, other species in the ecosystem that may be affected as bycatch, and fishery-dependent communities; and to promote safety at sea (NPFMC 2004a). The SFA also included provisions on the use of IFQs as a management tool, including requirements for procedural reviews and revisions of programs, and mandating that Councils consider including allocations for crew members in new programs (NPFMC 2004a). Most importantly in regards to catch share management, the SFA put in place a moratorium on the implementation of new IFQ programs until 2000 (NPFMC 2004a). Although there had only been four implementations¹⁹ of catch share programs, the controversial nature of the implications of the programs, especially the Halibut and Sablefish IFQ program, prompted Congress to place a four-year moratorium on new implementations until a comprehensive study on the management tool could be carried out by the National Academy of Sciences (NAS) (Fina 2011). General concerns fueling the moratorium included negative or otherwise unknown implications of the programs like impacts on communities, barriers to new entry, and ownership of IFQ privileges (NPFMC 2004a). Congress also directed the NAS to specifically analyze the costs and benefits of catch share programs economically and socially as well as provide direction on the

¹⁹ By 1996 the four existing federal catch share programs were the Atlantic Surf Clam and Ocean Quahog ITQ program, the Wreckfish ITQ program, the Community Development Quota (CDQ) program, and the Alaska Halibut and Sablefish IFQ program (Fina 2011).

potential use of processor allocations and mechanisms to achieve fair and equitable initial allocations of privileges associated with the programs (NPFMC 2004a). Congress further stipulated in the SFA that the findings and recommendations of the NAS in the forthcoming report were required to be taken into account by Councils and the Secretary of Commerce in designing catch share programs after the moratorium ended (NPFMC 2004a).

The comprehensive study on the design and use of IFQ programs as a management tool, Sharing the Fish: Toward a National Policy on Individual Fishing Quotas, was published by the National Research Council (NRC) in 1999. The moratorium implemented by the SFA was extended to 2002 in the Consolidated Appropriations Act of 2001 (P.L. 106-554), however Congress made an exemption for the NPFMC to pursue options to rationalize the crab fishery (Fina 2011). The NRC report spelled out many directives that were applicable to the NPFMC as it considered transitioning the Bering Sea crab fisheries to catch share management. The NRC found that successful IFQ programs needed broad support from stakeholders in the fisheries which could be accomplished by garnering participation in the development process (NPFMC 2004b). Additionally, the report noted that programs needed adequate information in the design stage to predict and mitigate potential negative economic and social impacts on both individuals and communities (NPFMC 2004b). Recommendations of the report included allowing and encouraging the holding of privileges under IFQ programs by fishing communities and that such quota holdings could encourage community development (NRC 1999).

The NRC also included findings and recommendations specific to addressing crewmembers and processors in new programs. It recommended design elements such as quota blocking, developed in the Halibut and Sablefish IFQ program, to allow for the purchase of privileges by crewmembers (NPFMC 2004b). On the subject of the potential effects of catch share programs on processors, the NRC found that no existing programs allocated privileges to processors and few allowed processors to hold privileges (NRC 1999). The report also stated that changes in the geographic distribution of landings had not resulted in significant shifts from traditional processing communities under the Halibut program (NPFMC 2004b). The NRC noted that processors felt disadvantaged by the catch share design used in the existing programs and perceived negative impacts on profitability resulting in stranded capital and impacts on isolated small communities (NRC 1999). Some economists supported the processor argument that they should receive an allocation of harvester privileges or be allocated their own type of privileges because shares allocated to harvesters shifted the market bargaining power relationship in favor of harvesters (NRC 1999). The NRC report did not recommend a wholesale provision for processor allocations as a nationwide catch share mandate, however, and only noted that such an element should

be considered if the specific management objectives included avoiding economic losses to the processors (NRC 1999). The report included suggestions for alternative options like buyouts or processor-held harvesting allocations instead of specific processor allocations or a ‘two-pie’ system that was argued to potentially and unnecessarily complicate a program or even subsidize excess capacity in the processing sector of a fishery (NRC 1999).

An additional significant source of guidance in the learning process through which the NPFMC developed the Bering Sea Crab Rationalization program included Congressional input on Council activities specific to the crab fishery management. Congress specifically directed the NPFMC to investigate the potential rationalization of the crab fisheries under the Consolidated Appropriations Act of 2001 (Appendix D), an action that was necessary because Congress otherwise restricted all Councils to shelve any consideration of catch share program development during the moratorium period (Fina 2003). Congress specifically charged the Council with analyzing potential program elements such as processor quotas, community held quotas, and cooperatives along with more traditional IFQs (Fina 2005). With the direct Congressional orders, the Council was able to work on rationalizing the fishery during the moratorium and also gain authority to develop and implement certain program elements that were not necessarily allowed in FMPs under the SFA such as those that regulated processors (NPFMC 2004a). Congress also gave NMFS regulatory authority to allocate quota shares to processors (NOAA Fisheries Service Office of Policy 2009c). A lot of back-and-forth occurred in the Council’s development of the rationalization program as the Council clarified with Congress the bounds of its authority to incorporate novel catch share measures into a potential program, like community protections and binding arbitration (Fina 2003). The inclusion of many program bells and whistles untested in other U.S. catch share models ultimately required a close relationship between Congress and the Council in developing the rationalization program. However, the Congressional role in the program development and implementation was not without controversy (Ecotrust 2007). The final program design agreed upon by the Council was congressionally authorized in an amendment to Section 313(j) of the SFA under the Consolidated Appropriations Act of 2004 (P.L. 108-199 Section 801) that required the Secretary of Commerce to implement the program as it was by 2005 (NPFMC 2005).

The timeframe before and during the development of the crab rationalization program was a period of growing national discussion on catch shares as a fisheries management tool. From 1994 to 1997, an ad hoc group in NMFS, the Limited Access Working Group, held a series of workshops and then drafted the 1998 NOAA Technical Memorandum: *Issues and Options in Designing and Implementing Limited Access Programs in Marine Fisheries* (NOAA-TM-NMFS-SWFSC-252). The Memorandum was

developed as a vehicle for technical recommendations for Councils and NMFS in its regulatory capacity to develop and implement catch share programs (Pooley 1998). The Working Group and a separate NMFS intra-agency group, the Limited Access Oversight Board, added to the work of the NRC and a national dialogue on whether there should be strict national criteria that Councils would have to follow if catch share programs were allowed to be employed (Pooley 1998). Unsuccessful bills in both House²⁰ and Senate²¹ committees in 2003 touched on the same issue, and it was within this policy arena that the NPFMC pursued rationalizing the crab fishery. Other government involvement in the debate over catch shares that influenced how the NPFMC approached the crab rationalization included major hearings on the issue such as the 1994 hearing before the Subcommittee on Fisheries Management in the House. The hearing addressed the use of IFQs and included statements from a wide variety of stakeholders including industry representatives from the harvesting and processing sectors and from seafood retailers, agency representatives, and environmental groups (U.S. Cong. House 1994). A General Accounting Office (GAO) report on IFQs was also published during the timeframe before the crab program implementation. The 2002 report (*Individual Fishing Quotas: Better Information Could Improve Program Management* (GAO-03-159)) looked at the implications of catch share programs on consolidation and on processors.

Other national policies and activities that influenced the path the NPFMC traveled in learning how to rationalize the crab fishery included Executive Order (E.O.) 13175 (65 F.R. 67249). E.O. 13175 required consultation and coordination of government actions with affected Indian tribal governments (NPFMC 2004a). In this case, NFMS was required to consult with Native communities in Alaska that would be affected by management changes to the crab fisheries (NPFMC 2004a). Additionally, E.O. 12898 (59 F.R. 7629) concerning environmental justice played into how NMFS and the NPFMC considered the impacts of program changes on Alaska natives because of their economic dependence on the crab fisheries (NPFMC 2004a).

The final vertical source of guidance and influence on the NPFMC as it learned how to apply catch shares to the needs of the Bering Sea crab fisheries was case law guidance. Fall-out from the Alaska Halibut and Sablefish IFQ program included a court case in 1996, the *Alliance Against IFQs v. Brown* (84 F.3d 343). The plaintiffs argued that the NPFMC violated the provisions of the FCMA in its design of the IFQ program because the share allocations were not fair and equitable (*Alliance Against IFQs v. Brown* 1996). The group felt that the program was flawed because it did not provide privilege

²⁰ H.R. 2621 Fishing Quota Standards System bill in the House Merchant Marine and Fisheries Committee

²¹ S. 1106 National Standards for Fishing Quota Systems in the Senate Commerce Committee

allocations for crewmembers (Alliance Against IFQs v. Brown 1996). The Judge granted summary judgment in favor of NMFS, concluding that the Council was justified in not allocating privileges to crew. The Judge noted that under the authority Congress gave the Secretary of Commerce in 50 C.R.F. 602.14(c), a program could be designed that advantaged a group in the fishery to the detriment of another if it allowed for the benefit of the fishery as a whole (Alliance Against IFQs v. Brown 1996). The NOAA General Counsel (GC) responded to the lawsuit, concluding that the lawsuit also highlighted that the Halibut and Sablefish program failed to adequately consider recent participation in the initial allocation framework (NPFMC 2004b). Despite the ruling, the Judge wrote that the case was troubling because some fishermen were being disenfranchised by the changes in the federal regulatory structure with the transition to catch share management (Alliance Against IFQs v. Brown 1996). The lawsuit ultimately directed industry participants that felt disadvantaged by catch share programs to pursue their agenda not with the courts but with agency officials and the likely more sympathetic legislators (Black 1996). And Congress did respond sympathetically to the industry's concerns with, for example, the moratorium on IFQs limiting agency and Council authority until the catch share debate could be fleshed out (Black 1996). While the lawsuit did not retroactively change the Halibut and Sablefish program, the impacts of the judicial ruling certainly influenced the crab rationalization process.

Horizontal diffusion

In the NPFMC's learning process of adapting the principles of catch share management to the purposes of the Bering Sea Crab Rationalization, several sources horizontal to the Council imparted integral guidance, knowledge, and experience. First were the existing catch share programs under federal U.S. management including those developed by the MAFMC, the SAFMC, and the PFMFC as well as other catch share programs the NPFMC had itself developed previously. Council entities that were involved in the development of the Rationalization program; including an ad hoc industry committee, the Advisory Panel, and the Crab Rationalization Committee; analyzed the existing U.S. catch share programs to gain learning lessons applicable to the purposes of the crab program (NPFMC 2003). In regards to the South Atlantic Wreckfish ITQ program developed by the SAFMC, the analysis noted that a key driver in transitioning the management to the ITQ program was the high level of uncertainty in the population dynamics and basic biology of the species (NPFMC 2003). The crab resource showed similar uncertainty and fluctuation in the population dynamics. Additionally, the analysis stated that there was frustration with the underexploitation of the resource under the Wreckfish ITQ program due to significant underages of the TAC. The program lacked provisions for new entry to allow newcomers to

benefit from the unfishable portion of the TAC (NPFMC 2003). The NPFMC also analyzed the PFMC's experience with the implementation of a catch share into a single sector of one of its fisheries, the Pacific whiting fishery. The PFMC allocated a separate portion of the TAC to the offshore sector of the fishery and allowed the participating vessels to self-organize into a marketing cooperative under the Fishermen's Collective Marketing Act (15 U.S.C. 521) forming the Pacific Whiting Conservation Cooperative (NPFMC 2003). The cooperative helped the fleet realize major efficiency gains in the offshore sector, increased precision in fully utilizing the TAC, and significant bycatch reductions (NPFMC 2003).

The NPFMC was fundamentally guided in the rationalization of the crab fishery by its own experiments with catch shares. This experience was gained in the development process leading up to the 1995 Alaska Halibut and Sablefish IFQ program implementation and the 1999 Bering Sea AFA pollock cooperatives including the extensive trailing actions the Council developed to implement with the pollock program to address community impacts and impacts on other sectors. The Council's analyses of its experience in the development of the Halibut and Sablefish program and the effects of the transition to catch shares were mined for lessons to help the Council best design a catch share program for the needs of the crab fishery. Additionally, the Council saw that it could achieve administrative efficiency in economies of scale by utilizing the entity created to carry out quota allocations for the Halibut and Sablefish program and the AFA pollock program, RAM, to carry out the same duties in rationalizing the crab fishery (NPFMC 2004a).

With experience designing and operating catch share programs already under its belt, the NPFMC had a more detailed understanding of rationalization and could better predict how some components of the transition would play out in the crab fishery (NPFMC 2004a). The Council saw how the IFQ program successfully ended the race to fish that had plagued the halibut and sablefish fisheries, lengthened the season by a considerable amount, and improved the product quality (NPFMC 2003). Some of the lessons learned from developing the Halibut and Sablefish program included the perceived success of program elements such as the community purchase program and the low-interest loan program for crew and skippers in reaching the objectives they were employed to meet (Fina 2003). These elements were then considered for potential adaptation to the crab fishery during the learning process for the Crab Rationalization (Fina 2003). The NPFMC saw the low-interest loan program design element as an effective way to help eligible skippers and crewmembers invest in the fishery by purchasing quota shares (NPFMC 2004a). However, the Council did note that evidence from the Halibut

and Sablefish program showed negative impacts on crew did still occur by way of reduced crew shares and decreased employment opportunities because of consolidation (Fina 2005).

The Council's analyses of the Halibut and Sablefish IFQ program noted that while many industry participants were ultimately satisfied with the program, the disgruntled groups included those that were either excluded based on fishery participation that was not recognized by the qualifying years chosen in the initial allocation framework or those that had received small allocations based on their catch history that they felt could not be fished economically (NPFMC 2003). Additionally, after transitioning the halibut and sablefish fishery many crewmembers in the fishery were not satisfied with the program outcome because they felt unfairly harmed by not receiving initial quota allocations (NPFMC 2003). Another industry group disgruntled with the Halibut and Sablefish program was the processors who believed that their lack of initial share allocation was unfair because they had significant investments in the fishery similar to the harvesters who did receive privilege allocations (NPFMC 2003). The processors in the halibut fishery felt the program significantly reduced their profit margin and that rent gains from the IFQ program went only to the harvesting sector of the fishery (NPFMC 2003). As a result of this knowledge, the Council predicted that a traditional IFQ program in the crab fishery would have implications on the relative bargaining power of the harvesting and processing sectors (NPFMC 2003). Which would be advantaged in such a scenario was unknown; this uncertainty had to be addressed in the development process.

A flaw the NPFMC noted in both the Halibut and Sablefish IFQ program and the AFA pollock cooperatives program was the lack of data collection requirements, especially for the economic implications of the programs (NPFMC 2003). The Council saw this as a serious limitation of information from the experiences to aid the development of the most effective program for the crab fisheries (NPFMC 2003). The various Council entities that contributed to the debate about transitioning the crab fishery to catch shares critically examined the Council's experience with the AFA pollock cooperative program. The pollock fishery transition and trailing actions were especially important as the Council considered a cooperative option for the crab fishery (NPFMC 2004a). The Council and affiliated groups' analyses noted that industry participants felt the pollock cooperatives successfully ameliorated the excess capacity issue and slowed the rate of fishing so that the fleet could overall have a higher rate of utilization of the TAC (NPFMC 2003). The gains in efficiency and capacity utilization that came out of the AFA program contributed to the analysis of its potential applicability to the crab program in development (NPFMC 2003). Similar to the Halibut and Sablefish program, dissenting industry voices in the AFA program were those that felt unfairly cut out of the initial allocation of privileges (NPFMC 2003).

The comparison of the AFA cooperative structure with the Halibut and Sablefish IFQ program was especially indicative of the benefits and costs of different catch share methodologies and therefore the applicability to the crab fishery. The Council saw that the leasing limitations in the IFQ program reduced flexibility in the fleet while the cooperative structure fostered such flexibility for the AFA program, and participants in the IFQ program were unable to coordinate efficient harvests to the high degree that was seen in the pollock fishery (NPFMC 2004a). The cooperatives used in the AFA pollock fishery rationalization provided knowledge of the benefits that could be gained in a fishery by allowing and incentivizing the formation of cooperatives as a catch share program element (NPFMC 2004a).

In general, the Council saw the benefits of a cooperative management option to allow for reduced administrative burden because consolidation, quota movement, and a significant amount of enforcement was self-managed within cooperatives (NPFMC 2003). Additionally, the NPFMC saw that assessing the social implications of the AFA pollock program on communities was directly applicable to what the potential effects of a cooperative alternative in the crab fishery would be. The pollock program showed that the community impacts differed but were overall positive (NPFMC 2003). Specific components of the AFA pollock cooperative program that influenced the learning process by acting as a model for the rationalization of the crab fishery were the non-divisibility of the quota shares and how the AFA determined ownership. Both related to how ownership and harvest caps could be administered for the fishery under a cooperative alternative. The lack of divisibility in shares in the AFA program, because of their basis on an individual vessel's catch history, was seen by the Council as unfavorably restrictive of the full efficiency gains that could be achieved through cooperative management (NPFMC 2004a). Conversely, the Council saw the AFA's approach to determining ownership for ownership caps as a good model that it could adopt in a potential crab program as well as how a binding arbitration option could be structured to deal with changes in the bargaining power of harvesters and processors based on the AFA's cooperative administration (NPFMC 2003). The NPFMC also analyzed the specific type of cooperative the AFA allowed, those that included both harvesters and a processor. This allowed the Council to use the effects of the AFA program to understand what types of harvester-processor relationships were best suited for an AFA cooperative management option versus a Pacific whiting cooperative option, for example (NPFMC 2003). The direct transferability of the AFA pollock cooperative structure was limited as the Council noted fundamental differences in the nature of the resource between the two fisheries as well as the way in which the fisheries were prosecuted (NPFMC 2003).

Other sources of the diffusion of knowledge, information, and experience in developing catch share programs came to the NPFMC's learning process from international catch share programs. The

Council looked to the experience in the Netherlands with catch shares that employed a cooperative-type program and co-management of the resource (NPFMC 2003). The fishermen under the system viewed it favorably because of the flexibility and reduced government oversight it allowed as well as how it had helped the fleet end the race to fish (NPFMC 2003). Iceland's experience with catch shares also offered guidance to the NPFMC in the rationalization of the crab fishery. The NPFMC specifically noted how the Icelandic program had negatively impacted small entities (communities, vessel owners, crew, and processors) due to the extreme capitalization of quota shares that encouraged consolidation into the hands of larger owners (NPFMC 2003).

The NPFMC also extensively looked to Canada's experiences to inform its design of the Crab Rationalization program. The Council observed that in the management of Canada's groundfish fishery, the historic participation of skippers and crew in the fishery was recognized and protected through the Canadian Groundfish Development Authority Code of Conduct (NPFMC 2003). This management measure guaranteed crewmembers their historical crew share and made sure that crew shares could not be reduced by quota share owners taking the cost of shares out of the crew's pay (NPFMC 2004a). Additionally, the arbitration system that Canada developed in its Newfoundland crab fishery was specifically analyzed for its applicability to the crab fishery's needs and the consideration of a binding arbitration design element (NPFMC 2003). The Council sought direct advice from those involved in the Canadian snow crab fishery as to the efficacy of the arbitration system (NPFMC 2003). The Newfoundland fishery used a "last best or final offer" format for the arbitration system that was viewed favorably by many of its industry participants (NPFMC 2004a). The system was a transparent mechanism under the Newfoundland Fishing Industry Collective Bargaining Act of 2001 for resolving disputes between processors and harvesters over ex-vessel prices by utilizing pre-season market reports and a pricing formula (NPFMC 2003).

This was significant experience for the NPFMC to analyze because potential disputes between processors and harvesters due to shifts in relative market power were a concern for the Council in its development of the Bering Sea Crab Rationalization Program (NPFMC 2003). The Newfoundland arbitration system was not without flaws though, and some processors were critical of it because only harvesters could initiate arbitration and there was no way for the processors to enforce the price that was arbitrated (NPFMC 2003). Additionally, a similar arbitration mechanism in the Newfoundland shrimp fishery was not successful, though its lack of success has been blamed on market declines, issues with product quality, and the seasonality of the fishery rather than on the mechanism itself (NPFMC 2003).

5.5 | Internal learning process variables

Problem severity

The facets of the problems in the crab fishery that led the NPFMC to consider rationalization were numerous and helped shape how the Council decided to apply catch share methods to the management's objectives. The crab program being developed applied to eight different stocks of crab species, and none were subject to overfishing at the time of transition (Anderson and Holliday 2007). However, several of the stocks were overfished at various times prior to rationalization. The Tanner crab stock and snow crab stock in the Bering Sea were classified as overfished in 1999 as well as the St. Matthew blue king crab population (NOAA Fisheries Service Office of Policy 2009c). And in 2002, the Pribilof Islands blue king crab stock was declared overfished (NOAA Fisheries Service Office of Policy 2009c). The overfished status led to various season closures for the stocks (Fina 2005). Other crab stocks like Bristol Bay red king crab experienced declines in resource abundance that led to increasingly abbreviated season openings, sometimes just a few days or weeks (Fina 2005). And the coarse estimations of season timing under the license limitation system resulted in frequent overages of the TAC (Fina 2005). Short seasons contributed to the overcapacity problems that also affected the crab fishery. Under the license limitation system, the total number of vessels was limited but there were no restrictions on other measures of capacity (Fina 2005). Therefore, vessels with licenses competed to harvest as much as possible before the fleet-wide TAC was hit and the fishery was closed. As a result, though rebuilding plans were in place for some overexploited species, the Council felt that the race to fish was undermining the conservation efforts (NPFMC 2011b). Additionally, there were high bycatch and discard mortality concerns for undersize male crabs and for all female crabs (NOAA Fisheries Service Office of Policy 2009c).

Seasons shortened to prevent TAC-overages of vulnerable stocks and to address the growing capacity of the fleet only further encouraged overcapitalization under derby fishing and had safety implications for participants (Fina 2011). The safety concerns for crab harvesters were serious; between 2001 and 2005 the U.S. Coast Guard Search-and-Rescue cases recorded 8 deaths (NOAA Fisheries Service Office of Policy 2009c). Concerns about the loss of life in the fishery and the undesirable stochasticity in the fishery resulting in low resource utilization influenced how the NPFMC approached designing a catch share program to meet the crab fishery's unique needs (NPFMC 2011b). The derby fisheries required complicated management oversight as well and dissipated much of the resource rent that could have been captured by the fleet (Fina 2011). The derby fishery nature of the crab harvesting industry resulted in the overcapitalization of the processing sector as well to meet the demand and

minimize deadloss of crab, overall contributing to a glut of low-quality product on the market (Fina 2005). Additionally, the short crabbing seasons left much of the harvesting and processing capacity idle throughout the year (NOAA Fisheries Service Office of Policy 2009c). This inefficiency increased despite the activity of individual vessels and processors in multiple crab fisheries with staggered seasons (Fina 2005). The derby nature of the fishery also contributed to significant gear loss that impacted the ecosystem through ghost fishing (Fina 2005).

Institutional capacity

The prior management regime as well as characteristics unique to the NPFMC contributed to what institutional capacity the Council had to address the problems of the crab fishery and learn to design a catch share program for it. Existing management components that facilitated the transition to catch shares included the license limitation system because it had already limited entry into the crab fisheries as well as required vessels to operate under the State of Alaska's observer requirements (NPFMC 2004a). The learning process was also aided by the comanagement structure of the crab fishery so that ADF&G could provide institutional support for developing a program (NPFMC 2004a). For example, the crab fisheries were experienced in operating under harvest restrictions because ADF&G administered Guideline Harvest Levels (GHL) for each fishery (NPFMC 2004a). The Council's prior creation of the RAM division to handle the allocation of quota in the halibut and sablefish fishery and the pollock fishery was available to carry out the same tasks for the crab fishery. This removed an administrative burden from the Council in the development of the crab program. RAM could easily assemble the data that would be needed to rationalize the crab fishery including data on licenses, landings, ownership, processing, etc. that would help determine eligibility in allocations (NMFS 2011). The availability of data on the processing sector and ownership was especially important for the Council to even be able to consider a processor allocation option (Fina 2003). RAM itself also had valuable institutional capacity applicable to the Crab Rationalization in its experience carrying out allocations for the halibut fishery which had considerably more participants than that of the crab fishery (Fina 2005).

The institutional capacity within which the NPFMC developed the crab program was also bolstered by the Council's previous experiences with rationalization. Specifically, the Council was concerned about social impacts of the Crab Rationalization program but noted that many of the relevant communities in the crab fishery had already experienced the impacts of rationalization through the halibut and sablefish fishery transition (NPFMC 2003). So not only did the Council have its own experience to draw on in anticipating the effects of rationalizing the crab fishery, so did individual

communities. There were some program elements the Council considered that had no analogues either in its previous experiments or in other existing programs so therefore required considerable Council capacity to wrestle with the costs and benefits in the design of such elements and predict what the implications of each would be. This was especially true for the Processor Quota (PQ) system the Council considered; there was no precedent for such a program element and it added serious complexities to the development process for the Council (NPFMC 2004a). A 'two-pie' system that included processor shares demanded significant Council time and energy to design and required compiling highly detailed records on landings from both the State of Alaska and the State Commercial Operator's Annual Reports to fully flesh out the program option (Fina 2005). The potential for processor shares added to a large list of alternatives, options and even sub-options that the Council analyzed and debated in the Crab Rationalization Program development (NPFMC 2005). It convened various committees to analyze and develop other program elements such as community protection measures, skipper quota shares, and binding arbitration provisions (NPFMC 2004a). The Council and extensive committee work ultimately contributed to a six year development timeframe for the program (NPFMC 2005).

Industry buy-in

As in other catch share transitions, gaining the industry's support and participation in the development of a program for the crab fishery significantly influenced how the NPFMC learned to apply catch share measures specifically to the crab fishery. Some of the industry buy-in to the development of the crab rationalization program began with industry members attempting to go above the Council's authority (Ecotrust 2007). Members of the crabbing industry observed how the pollock cooperative program was developed through Congressional avenues and quickly transformed the fishery (Ecotrust 2007). They similarly went to Congress and voiced their rationalization intent and desires for a similar transformation of the crab fishery management in the Bering Sea (Ecotrust 2007). However, Congress was not receptive to the crab fishery participant's requests so the industry members returned to the Council process to address their concerns. The Council formalized the ad hoc committee of various industry interests that had formed in 1999 into the BSAI Crab Rationalization Committee (NPFMC 2004a). The Committee had representation from both the harvesting and processor sectors as well as from owners and crewmembers, communities, and environmental groups (NPFMC 2004a). The Committee gave recommendations to the Council on what alternatives and options should be considered in the catch share program development (NPFMC 2004a).

Industry members were involved in the rationalization development process through the variously convened working groups as well as the normal Council process with public comment and the AP (Fina 2005). In the development of the new management, the Council reached out to a variety of stakeholders in the fishery including processors, communities, captains, crewmembers and vessel owners and attempted to balance their different interests in a comprehensive program (Fina 2011). The Council realized that industry support and participation was especially important in this case because the program being developed had several elements that were untested in existing catch share programs and the Council ultimately did not know if the complex parts would come together as a working system for the fishery as a whole (Fina 2011).

Industry concern was especially pronounced over the Council's intent to create a program that addressed the equity criticisms of the traditional IFQ program with shares allocated only to harvesters (Fina 2005). Alternatives that the Council considered addressed processor contributions to the fishery through either a 'pie' system or through a cooperative structure that would license specific processors to be active in the fishery (NPFMC 2004a). Harvesters expressed concern about sharing rationalization rent gains with the processing sector because they felt the departure from existing catch share models could create market restrictions and limit competition for landings that would depress the price of the crab resource (Fina 2011). Worries about the implications of processor shares on market bargaining power led to the analysis of provisions like binding price arbitration to maintain a historical division of rents between the harvesting and processing sectors (Fina 2005). The binding arbitration option was seen as equitable and feasible to balance the interests of the two sectors (Fina 2005). An industry committee was called on to help develop an agreeable arbitration system and to determine how to operationalize the program to utilize an arbitrator, to take into account market fluctuations in product quality, and to provide a stable mechanism to cement the historical division of rents (Fina 2005). Other tasks that the Council directed stakeholder groups to analyze included seeking the advice of community representatives for creating a program element to help protect historical community participation, specifically the Right of First Refusal (ROFR) provision of the Rationalization program (Fina 2005).

Contextual attributes

The Crab Rationalization program was developed by the NPFMC as a direct function of the context of the fishery; including the unique ecological, economic, and social characteristics. These details included the nature of the resource, the way in which the fishery was prosecuted, and the social characteristics of the participants; all had to be taken into account through the design of the program.

One of the most significant contextual features of the fishery was the role of small remote Alaskan villages that would be considerably impacted by the Rationalization; therefore the Council had to focus on understanding what the implications of different program design options would be on these sensitive communities.

Ecological context

The ecological context that shaped how the NPFMC adapted catch share measures to meet the objectives of the crab fishery included the impact of the prosecution of the fishery on the resource. The crab fisheries experienced significant problems with deadloss; in 1990 the Bering Sea snow crab fishery reported 1.8 million pounds of deadloss (NMFS 2011). Additionally, the rebuilding status of a few of the crab stocks emphasized the need for a new management direction that protected rebuilding stocks and preventing TAC overages in other stocks (NPFMC 2011b). Bycatch of other fish in the crab fishery, however, was not a major concern that needed to be addressed in developing a catch share program (Fina 2003). The selectivity of the crab pot gear prevented significant capture of non-target species; although octopus, Pacific cod, Pacific halibut, and other flatfishes were occasionally caught (NPFMC 2004a). However, the capture of non-legal crabs (e.g. females or undersized males) was a concern in terms of discard mortality (NPFMC 2004a). The catches of these non-target crabs increased in the derby fishery with shorter soak times for the gear. And finally, the significant year-to-year stock variability and natural fluctuations in non-fishing mortality rates that was characteristic of crab limited the applicability of other catch share program models (NPFMC 2003). This was because factors such as this created limitations in how fishing seasons for crab could be managed.

Economic context

Many of the economic characteristics and objectives of the crab fishery management influenced how the NPFMC learned to adapt catch share measures to rationalize the fishery. Ultimately, the Council sought a new management direction that could allow the realization of efficiency gains and stability in the economics of the industry (NMFS 2011). The status quo management threatened the long-term viability of the crabbing industry (NPFMC 2011b). Additionally, there were few opportunities in alternative employment for harvesters and processors in the fishery because of the investment in crabbing-specific equipment and restrictions on entry into other fisheries that had been put in place to prevent the spill-over of excess capacity (NPFMC 2011b). Specificities in the economics of the fishery also influenced the Council's development process. The history of contention between harvesters and

processors over price negotiations had to be addressed in the transition to catch share management (NMFS 2011). The nature of processing crab into market product also influenced the options pursued because crab needed to be harvested and delivered to the processor live to prevent product spoilage which contributed to deadloss (Fina 2003). This heightened the need for coordination between processors and harvesters to achieve full resource utilization. Excess capacity in the processing sector also had to be addressed alongside the removal of capacity from the harvesting sector to maintain a competitive market. The Council especially wanted to encourage a stable and profitable market for both harvesters and processors (NPFMC 2011b). A final economic characteristic of the crab industry that had to be addressed in the development of a rationalization program was how to grandfather in the existing ownership structure which included owners of multiple vessels and a longstanding practice of hired skippers (NPFMC 2003). This feature played into the development of the quota allocation framework and shaped the objectives the Council sought to achieve with a rationalized fishery. For example, due to this characteristic some program design elements such as owner-on-board requirements would not be feasible.

Social context

The social characteristics of the Bering Sea crab fisheries that helped guide the NPFMC in its pursuit of catch share management included the cultural fabric of the participants. In its processing sector and to a much lesser extent in the harvesting sector, remote communities such as the Pribilof Islands were especially dependent on the fishery (NFMS 2011). Community representatives voiced valid concerns about the implications of management changes on the geographic distribution of landings in the fishery because movement in the processor sector could represent a significant loss in revenue and employment to a local area (NPFMC 2004a). Social equity was a constant concern in the program development, not only for vulnerable communities but also between both the processors and harvesters. The Council sought to balance the interests in a ‘three-pie’ system acknowledging harvesters, processors, and communities (NPFMC 2005).

5.6 | The learning outcome

The outcome of the NPFMC’s learning process in applying catch share methods to rationalize the Bering Sea King and Tanner crab fishery is detailed below.

Table 3 | Amendment 18 and 19 Design of the Bering Sea King and Tanner Crab Rationalization Program

Specifications of privilege	Type of allocation	<ul style="list-style-type: none"> • IFQs <ul style="list-style-type: none"> ○ Share classes by operation type (CV/CP) <ul style="list-style-type: none"> • CP shares have harvester and processor components which can be split and used separately in same region ○ Divided into 97% Owner shares (O) and 3% crew shares (C) ○ North and South regional distinctions ○ 90% of IFQs for CVO are Class A: must be delivered to processor holding matching IPQ shares ○ 10% of IFQs for CVO are Class B: deliverable to any processor • IPQs <ul style="list-style-type: none"> ○ Fishery, region, and ROFR community designations ○ North and South designations • Cooperatives • 3 types of allocations: CDQ, Adak, Quota fisheries
	Management unit	<ul style="list-style-type: none"> • BSAI King and Tanner crabs <ul style="list-style-type: none"> ○ Bristol Bay red king crab (<i>Paralithodes camtschaticus</i>) ○ Bering Sea snow crab (<i>Chionoecetes opilio</i>) ○ Bering Sea Tanner crab (<i>C. bairdi</i>) ○ Brown king (Al golden king) crab (<i>Lithodes aequispinus</i>) ○ Pribilof Islands red king crab (<i>P. camtschaticus</i>) ○ Pribilof Islands blue king crab (<i>P. platypus</i>) ○ St. Matthew Island blue king crab (<i>P. platypus</i>) ○ Western Aleutian Islands red king crab (<i>P. camtschaticus</i>)
	Transferability	<ul style="list-style-type: none"> • QS can be permanently transferred or leased to eligible U.S. citizens <ul style="list-style-type: none"> ○ Owner QS can be transferred to other initial QS recipients, others meeting sea time requirements (150+ days), CDQ groups, eligible crab community entities ○ Crew QS can be transferred to individuals demonstrating recent participation in fishery ○ Crew IFQ could be leased until 2008, Owner IFQ could be leased until 2010; leasing only allowed after with documented medical hardship or loss of fishing vessel • PQS²² can be transferred to anyone (no citizenship requirements) • Cooperatives can transfer IFQ to other cooperatives • NMFS approves transfers based on proposed receiver's eligibility to receive quota, use caps, and community

²² Processor Quota Shares

		protection measure requirements
Specifications of privilege holders	Initial eligibility	<ul style="list-style-type: none"> • Qualifying license holders under license limitation program and qualifying crew members based on historical landings <ul style="list-style-type: none"> ○ US citizen with 150+ days sea time in US commercial fishery in harvest capacity ○ Had to make at least one landing in 3 of the qualifying years and recent participation demonstrated by at least one landing in 2 of 3 most recent seasons prior to 2002 ○ Allocation formula to derive QS: % of total catch year by year during qualifying period in each fishery <ul style="list-style-type: none"> • Different qualifying periods for each stock • For PQS entity must meet qualifying criteria, allocations based on historic processing activity
	Subsequent eligibility	<ul style="list-style-type: none"> • Sea time requirement • Active participation requirement for C shares
Specifications of program	Consolidation controls	<ul style="list-style-type: none"> • 1%-10% cap on individual share holdings/use • 2%-20% vessel use cap if outside of cooperative • 30% of processor share cap
	Directed conservation elements	<ul style="list-style-type: none"> • No direct conservation provisions
	Social equity elements	<ul style="list-style-type: none"> • Class A IFQs subject to regional landing requirements to maintain processing activity in remote communities • Class C IFQs require active participation of share holder • Cooling-off (2 year port-specific landing requirement) • Community ROFR on transfers of processor quota • CDQ allocations • ECC²³ can form nonprofit entity to receive QS, IFQ, PQS, IPQ transfers on behalf of community <ul style="list-style-type: none"> ○ ECC entity can lease IFQ to community residents
	Administrative components	<ul style="list-style-type: none"> • Monitoring <ul style="list-style-type: none"> ○ Deliveries must be made to RCR²⁴ <ul style="list-style-type: none"> • RCR's submit real-time e-landing reports in new e-Landings system ○ VMS required on vessels to determine vessel position and activity ○ 100% observer requirements on CPs ○ 20-50% observer requirements on CVs • Enforcement <ul style="list-style-type: none"> ○ State of Alaska has penalty enforcement and transfer provisions responsibilities, does in-season monitoring,

²³ Eligible Crab Community

²⁴ Registered Crab Receiver

		<ul style="list-style-type: none"> observer coverage and permitting requirements ○ Shareholders can form harvesting cooperatives to aid in coordination of harvests <ul style="list-style-type: none"> ● Minimum of 4 distinct QS holders to form crab-harvesting cooperative, cooperative can hold IFQ but not QS ● Program administration and review <ul style="list-style-type: none"> ○ Arbitration for resolving price disputes of Class A IFQ deliveries between harvesters and processors <ul style="list-style-type: none"> ● Arbitration for equitable price and delivery terms done by independent third party to preserve historical distribution of revenues in fisheries ○ Scheduled program reviews: 18 month review of processing shares and price arbitration; broader 3 year review, full review at 5 years <ul style="list-style-type: none"> ● Included assessment of options to mitigate negative impacts of program
<p style="text-align: center;">Issues not addressed in original design</p>	<p style="text-align: center;">Major changes after implementation</p>	<ul style="list-style-type: none"> ● Shares initially allocated to captains made not subject to landings limitations of processing shares to increase harvest flexibility, allow active crew to receiver greater value for share holdings ● Loan program under Fisheries Finance Program was implemented in 2011 that grants captains and crew opportunity to purchase crab QS, IFQ permits, fishing vessels, and fish processing facilities ● BS Tanner crab stock split into 2 to accommodate management of geographically separate stocks
	<p style="text-align: center;">Unaddressed issues</p>	<ul style="list-style-type: none"> ● Crew pay declined as a portion of total vessel revenue (cost of share deducted before crew payments determined), Council is exploring the issue ● Crew job loss in remote Alaska communities with few job opportunities ● Strengthening community protections ● Increasing portion of harvest share pool available only to active crew

Sources: Fina 2003, Fina 2005, Fina 2011, NMFS 2011, Anderson and Holliday 2007, NOAA Fisheries Service Office of Policy 2009c, and NPFMC 2011b

5.7 | Correlating the learning process and outcome

The various influences both external and internal to the NPFMC during the learning process of rationalization directly shaped the catch share program outcome. Developing a catch share program was determined to be the preferred management path because the Council saw rationalization as the most effective mechanism to address the specific problems the Bering Sea crab fisheries faced. The Council learned that the race to fish that spawned a range of other problems like overages of the TAC and

discards of non-legal crabs could be effectively ameliorated by transitioning the fishery to catch share management (Fina 2005). Lessons that the Council had learned from its previous experiences with the rationalization of fisheries in the halibut and sablefish and pollock fisheries served as models for both what elements in a program could help the management meet its objectives and the ways in which the Council needed to depart from what had already been done to craft a program that uniquely fit the crab fishery. This was apparent in the Council's decision to develop program elements untested in other catch share models like crewmember and processor shares and community protection measures like regional landing requirements (Abott et al. 2010). The inclusion of these novel elements can be directly tied to the Council's learning process in rationalizing the crab fishery.

Early in the development process, the NPFMC rejected a traditional IFQ program that allocated shares only to harvesters (akin to the Halibut and Sablefish Program) because, among other reasons, the basic model did not align with the economic and social interests of the industry, especially with the significant investments of processors and community dependence on the crab fishery (NPFMC 2005). The Council also considered adapting its experience with the AFA for the purposes of the crab transition because it noted that the cooperative structure effectively facilitated the removal of capacity from the fleet and revenue sharing between harvesters and processors in addition to reducing the administrative burden for monitoring and enforcement (NMFS 2011). Analyzing the AFA program led to the acknowledgment that the NPFMC would need to develop a different cooperative structure more adapted to the needs of the crab fishery because of departures from the pollock fishery in the prosecution of the fisheries, the nature of the participants, and the relationship between harvesters and processors (NPFMC 2003). Learning this led the Council to pursue and develop a Plurality Assignment Fishery Cooperative (NPFMC 2003). The Council also decided against a wholesale application of the AFA cooperative model because while incorporating processor participation, the model would still not meet the needs of the crab fishery management to protect community interests as well (NPFMC 2005). The influence of community protection needs on the Council's learning process led to the development of a three-pie system for the crab rationalization. The Council determined that this framework was best suited to the inextricably linked components of the fishery; the harvesters, processors, and communities (NPFMC 2004a). The Council also felt that the three-pie system best protected small entities against the negative implications of transitioning to catch share management, an effect observed in other fisheries (NPFMC 2005).

The Council concern for how rationalization could hurt employment and revenues from the crab fishery in small and remote communities led it to pursue several design elements tailored to the social

and cultural fabric of the industry. The learning outcome that was the result of the learning process specific to program elements to meet that particular objective included geographic landings and transfer restrictions on some shares (NFMS 2011). Regional restrictions on quota were especially tailored to communities in the Pribilof Islands that depended heavily on the crab fisheries and had limited other employment opportunities (Fina 2005). Elements like the ‘cooling-off period’ after program implementation were incorporated to slow the inevitable consolidation that would occur in the industry (Fina 2005). And having processor specific quota shares allowed for the community ROFR program element that allowed communities to purchase processor quota shares if a processor sought to transfer the quota elsewhere (NFMS 2011). The Council learning process also resulted in provisions for ECCs to form nonprofit entities for the purposes of purchasing quota for the benefit of its residents (NFMS 2011). ECCs were designated as those that were associated with 3% or more of the historic landings in any of the relevant crab fisheries; ultimately 8 communities²⁵ were eligible for this program provision (NFMS 2011). The Council also protected community interests by allocating quota directly to communities like Adak or through the existing CDQ program (NFMS 2011). In designing the community protection components of the program, the Council benefited from its previous experience with catch shares because it saw that it could apply the rules governing the Halibut and Sablefish fishery program’s community purchase program to the ROFR and community group share holdings elements in the crab program design (NPFMC 2004a).

Other direct links between the driving forces behind the Council’s learning process and the rationalization program outcome are in the initial allocation framework developed for the needs of the crab fishery. The Council chose an alternative that departed from what it had developed and used in the Halibut and Sablefish program (NPFMC 2003). It determined that the unique contextual factors to the crab fishery including highly variable harvest allowances that resulted in highly variable individual catch histories year-to-year needed to be appropriately reflected in a novel allocation scheme (NPFMC 2003). The Council also observed the contention (and court challenge) with the qualifying years chosen for the halibut and sablefish fishery that recognized historical participation over present participation. In the crab rationalization program, the NPFMC instead designed a framework that tried to achieve a greater balance between historical and present participation while still cognizant of not rewarding speculative behavior (Fina 2005).

²⁵ Designated ECCs were: Akutan, Unalaska/Dutch Harbor, False Pass, King Cove, Kodiak, Port Moller, St. George, and St. Paul (NFMS 2011).

Creating different classes of share allocations was also directly tied to what the Council determined the crab fishery needed through the learning process. It created Class B shares to have fewer restrictions than Class A shares so there was flexibility in the program and competitive market price negotiations could still occur to some extent (NMFS 2011). Including Class B shares in the program design also bought support from harvesters that were wary of the processor share element during the development process because they perceived it as reducing their negotiating leverage (Fina 2005). Class C shares were employed by the Council to address its desire to protect the interests of crewmembers in the fishery, at least in part a reaction to what it saw as the unfair impacts of prior rationalizations on this segment of the industry (Fina 2005). Class C shares were designed to allow for entry and investment in the fishery by participants other than vessel owners and the Council coupled the provision with an intended loan program to help finance share purchasing that had been operationalized successfully in the halibut and sablefish fishery (Fina 2003). To further the protection of crewmember interests, the Council went beyond the design elements utilized in the Halibut and Sablefish program and created an initial allocation framework that designated 3% of the quota share pool to the eligible skippers and crew (NMFS 2011).

A significant part of the NPFMC's learning process in developing the Bering Sea Crab Rationalization program was spent on designing a unique processor share component for the program framework. The creation of a separate processor share and the initial allocation of shares to processors was an innovation of the program not seen in any existing catch share model (NPFMC 2004a). The Council learned that while the novel dual share allocation system was design-intensive, the obstacles could be overcome to create a program most appropriate for the objectives of the crab fishery (Fina 2005). The innovative nature of processor shares also required that the Council's learning process and development of the program provisions required close work with Congress to allow the Council the authority to pursue such an element²⁶ (NPFMC 2004a). The NPFMC determined that to achieve the desired effects of incorporating processor-specific shares, it would leave the task of capacity optimization up to the market as much as possible with few restrictions on transferability of processor quota shares (Fina 2005). Allowing for such flexibility was also determined to be an effective avenue to address the fisheries deadloss problems (Fina 2005). In learning how to balance the needs of the harvesting sector with the processing sector, the Council determined that a dual share allocation system would need other mechanisms to address changes in market bargaining power, especially since the crab

²⁶ This was ultimately accomplished by a Congressional revision to the SFA Section 313(j)(7) that established that IPQ would be subject to the same regulations as IFQs (NPFMC 2004a).

fishery had already been plagued by contentious price negotiations (Fina 2005). The learning in this component led to the inclusion of a binding arbitration system that would address price disputes and attempt to prevent negative impacts on harvesters due to the processor share allocations (Fina 2005). The pre-season component of the arbitration system similar to that of Newfoundland's crab fishery was included as the Council determined it would help facilitate coordination between harvesters and processors when the season began (Fina 2005). And giving the harvesters the unilateral power to initiate the arbitration bought crucial harvester support of the overall rationalization program design (Fina 2005).

The influence of the Council's previous experiments with transitioning fisheries to catch share management had significantly influenced how the crab rationalization program was designed. A program element that resulted from this learning was the extensive program review provisions the plan incorporated because the NRC report and the Council itself were critical of the lack of data collection requirements in the previously implemented catch share programs (NPFMC 2003). The Council included elements to collect in-depth economic data in particular to inform management on the effectiveness of the program in meeting its objectives and to provide information that could be analyzed for future catch share developments (NMFS 2011). The extensive review components also reflected the contentious nature of the development of the Crab Rationalization program because the Council understood the potential for negative implications and unforeseen effects of the novel program elements so wanted to keep all avenues open to ensure its long-term success (Fina 2005). Such review components ensured the continued learning by the Council as to how catch shares were best utilized in the Bering Sea crab fishery.

6.1 | Background on the New England groundfish fishery

Groundfish is a term applied to demersal or bottom-dwelling fish species such as cod and flounder (Singer 2011). The New England groundfish resource is a mix of species in waters off of Maine to Virginia (Wang and Rosenberg 1997). The fishery based on these fish has a history that began more than 400 years ago (Singer 2011). It has been a significant source of income for New Englanders in coastal communities ever since (Wang and Rosenberg 1997). The groundfish fishery is especially important for Maine and Massachusetts which together claim over 90% of the revenue from the fishery (Holland 2007). The New England groundfish species complex includes 15 species with some being further distinguished into separate populations. The species include: Atlantic cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*), pollock (*Pollachius virens*), yellowtail flounder (*Limanda ferruginea*), witch flounder (*Glyptocephalus cynoglossus*), winter flounder (*Pseudopleuronectes americanus*), windowpane flounder (*Scophthalmus aquosus*), American plaice (*Hippoglossoides platessoides*), Atlantic halibut (*Hippoglossus hippoglossus*), Redfish (*Sebastes fasciatus*), ocean pout (*Zoarces americanus*), white hake (*Urophycis tenuis*), silver hake (whiting) (*Merluccius bilinearis*), red hake (*Urophycis chuss*), and offshore hake (*Merluccius albidus*) (NEFMC 2009a). A declining trend in abundance in most of these species was first documented by a NMFS research trawl survey in 1963 and the trend has largely continued since then (Wang and Rosenberg 1997).

6.2 | Regulation of the New England groundfish fishery prior to rationalization

With the adoption of the FCMA in 1976 and implementation in 1977, the newly formed NEFMC created the groundfish FMP (Wang and Rosenberg 1997). With NMFS's approval, the plan incorporated catch quotas for three stocks; cod, haddock, and yellowtail flounder; as well as regulations for seasonal spawning-area closures, minimum mesh sizes, and minimum size limits for fish (Wang and Rosenberg 1997). Under the authority of the FCMA, the FMP banned foreign fishing but the domestic fleet was already more than capable of catching the full quota allowances (Wang and Rosenberg 1997). The quotas carried with them the provision of fishery closures when met which encouraged a race to fish among participants (Brewer 2011). Quotas were quickly reached and consequently those fisheries were closed for significant lengths of time (Wang and Rosenberg 1997). The FMP also had provisions for individual vessel trip limits designed to protect the historic share of the harvest for small boats (Wang and Rosenberg 1997). The catch quotas and vessel trip limits were, however, frequently flouted by fishery participants and the derby fishery that had been created by the quotas quickly instigated demands for new management techniques (Wang and Rosenberg 1997). The Council developed the new

Northeast Multispecies FMP which was adopted in 1986 for groundfish stocks from Maine to Cape Hatteras (NEFMC 2009a). The new FMP reflected the fleet's contempt for catch quotas and put in place less restrictive management provisions that removed quota and closure regulations (Wang and Rosenberg 1997).

As one might predict, the less rigid management provisions led to serious overharvesting problems and a number of important New England groundfish stocks were depleted by the late 1980s (Holland 2007). In reaction to this, in 1992 an environmental NGO, the Conservation Law Foundation, sued the Department of Commerce²⁷ (Holland 2007). The suit was successful and under a consent decree settlement, the Secretary of Commerce was mandated to incorporate rebuilding plans for overexploited stocks in the groundfish FMP and associated regulations (Holland 2007). The rebuilding plan was packaged in Amendment 5 (59 C.F.R. 9872), implemented in 1994 to the groundfish FMP and contained provisions for a limited access management program that would utilize both individual vessel and fleet-wide allocations of allowed days at sea (DAS) (Holland 2007). Under the limited access program, vessels received a limited access multispecies permit with a DAS allocation (Holland 2007). The DAS program was crafted as an effort reduction program, and the Amendment also included a moratorium on new vessel permits for stocks that were rebuilding (NEFMC 1994). Simultaneously with the Amendment 5 changes, the New England groundfish fishery was declared a disaster in 1994 (Singer 2011). This then allowed Congress to appropriate significant funds to carry out a vessel buyout program to further remove excess capacity from the fishery (Singer 2011). The vessel buyout program was seen as an economic recovery plan to facilitate the rebuilding of the overexploited groundfish stocks and help ease some of the hardship that the rebuilding restrictions caused for fishing communities (Singer 2011). The well intentioned program had little measurable effect on capacity in the fleet (Singer 2011).

The 1996 update to the Federal fisheries management policy in the SFA brought new mandates with which the NEFMC had to comply. The SFA included three new National Standards requiring that the Council incorporate steps within FMPs to reduce bycatch, minimize impacts on fishing communities, and improve safety at sea (NEFMC 2009a). In that year, the NEFMC passed Amendment 7 to the Northeast Multispecies FMP that attempted to increase the power of the so far unsuccessful DAS effort reduction system and reduce unacceptable fishing mortality levels (NEFMC 2009a). The Amendment tightened the DAS restrictions by removing exemptions from the program and incorporated larger area closures to better protect both spawning fish and juveniles (NEFMC 2009a). Additionally, the Council attempted to employ DAS controls to facilitate the rebuilding programs in place (NEFMC 2009a). 1996 also saw

²⁷ Conservation Law Foundation et al. v. Franklin et al.; 989 F. 2d 54 (1993)

another attempt at a buyback program to further expedite capacity reduction in the fleet (Holland 2007). The two year program utilized \$25 million to purchase vessels and permits worth a combined 20% of the revenue of the fishery as a whole (Holland 2007). Again the impact was minimal, apparently because of few restrictions on the re-activation of previously inactive vessels (Holland 2007). Excess capacity lingered in the fleet despite the additional troubles of decreased individual landings and revenues for industry participants (Holland 2007).

Even while the Council continued to ratchet up the restrictions, the DAS effort reduction program simultaneously failed to alleviate overcapitalization in the fleet and to reduce overexploitation of the groundfish stocks (Holland 2007). Groundfish landings increased from 1994 to 2001 and consequently the fishing mortality targets (and overfishing thresholds) for many of the stocks in the FMP complex were staggeringly exceeded (Holland 2007). So the ever-watchful environmental NGOs took action again. In 2001, the Conservation Law Foundation and others sued the Secretary of Commerce²⁸ on the grounds that the FMP rebuilding plans were inconsistent with the overfishing thresholds defined by the NEFMC in Amendment 9 of the FMP. Additionally, the plaintiffs argued that the FMP and Amendments did not contain adequate bycatch mitigation measures (Holland 2007). Again defeated in the courts, NMFS and the Council had to address the plan failures and make it consistent with the stock rebuilding mandates of the SFA. To do so, the NEFMC began development of Amendment 13 to the Northeast Multispecies FMP (Holland 2007). After a four year gestation, Amendment 13 was implemented in 2004 (69 C.R.F. 22906) (Holland 2007). In addition to addressing the mandates from the lawsuit, the Amendment also contained further reduction of DAS allocations to the fleet and took steps to prevent latent permits from reentering the fishery (Holland 2007). The issue of latent capacity was also addressed by a third buyback program in 2001 that used \$10 million to purchase latent permits and reduce the effort capacity of the fleet (Holland 2007).

In passing Amendment 13, the NEFMC realized the potential economic and social implications on the fishery of the continued reduction in DAS allocations. Many allocations had become so small that they could no longer be fished in an economically viable way and many participants had no other employment opportunities in other fisheries (Holland 2007). In an attempt to mediate this, the Council also incorporated provisions for the leasing of DAS allocations, special access programs to allow for targeting of underexploited stocks in the groundfish complex, and for the formation of sectors (Holland 2007). The DAS program was split into three classes of allocations; 60% became 'A' class DAS that remained under the 'normal' regulations, 40% became 'B' class DAS that could fish the special access

²⁸ Conservation Law Foundation et al. v. Evans et al.; 209 F.Supp.2d 1 (2001)

program, and latent permit holders had their DAS converted to 'C' class which was unusable (Holland 2007). Leasing of DAS was restricted to transfers between permit-holding vessels of equivalent size or transfers to smaller vessels (Holland 2007). Additionally, DAS allocations from multiple vessels could be consolidated on one (Holland and Wiersma 2010). Permanent transfers were also subject to a conservation 'tax' that reduced the DAS allocation by 20% upon transfer, so transfers by leasing were the predominant driver of consolidation (Holland 2007).

The provision for sectors in Amendment 13 created a self-selecting limited access management tool (Holland 2007). This tool allowed groups of fishermen to voluntarily form sectors with binding operations plans to keep catches within the pooled quota allowances of members (which became a hard TAC). This then allowed the group to opt out of certain components of the input control system regulating the rest of the groundfish fishery (Holland 2007). There were no restrictions on the make-up of the sector by way of gear-type or geographic requirements. However, the allocations that would be contributed by members to the sector were based on place-specific vessel catch histories, so the sector allocations would also have regional designations (Holland 2007). In forming a sector, members not only had to submit a yearly operations plan to NMFS for approval, but also an Environmental Assessment (EA) under the guidance of NEPA so that a regulatory analysis could be carried out (Holland 2007).

Once within an approved sector, members had the flexibility to determine how the allocation would be split up among members (Holland 2007). A provision to prevent excess allocation to a sector prevented more than 20% of the TAC of a stock within the stock complex to be held (Holland 2007). The NEFMC saw the benefits of sector formation as a way to achieve economic efficiency in harvesting, receive protection of allocations from overharvesting of 'common pool', and incentivize conservation and innovation in self-management (Holland 2007). The Council also hoped that sectors would encourage NGOs to pursue their agendas by partnering with industry members and promoting market incentives rather than bringing actions against the Council and NMFS in the courts (Holland 2007). However, only two sectors were ultimately formed under Amendment 13. The Georges Bank cod hook sector was approved simultaneously with the adoption of Amendment 13 (Holland 2007). The sector applied for and received an exclusive allocation of cod to be fished in Georges Bank and in return for their binding operations plan was exempted from trip limits and some seasonal closures (Holland 2007). Additionally, the sector was able to participate in the Closed Area I Hook Gear Haddock Special Access Program (NEFMC 2009a). However, the sector members also fished other stocks within the groundfish complex so were subject to the input control system regulations for those trips (Holland 2007). The second sector was approved in 2007 for Georges Bank cod fixed gear (sink gillnet gear) (Holland 2007).

This sector also only applied for an exclusive cod allocation so was still subject to the input control regulations for fishing of other complex species (Holland 2007). In general, the Amendment 13 sector idea largely failed to gain traction with most industry members.

The New England groundfish fishery continued its downward spiral after 2001, with groundfish landings and revenues taking a nose dive throughout the entire region (Holland 2007). With the introduction of Framework Adjustment 42 to the Northeast Multispecies FMP in 2006, the NEFMC further restricted the DAS allocation system with the introduction of differential DAS counting in which fishing in certain regions cost twice as many DAS (Singer 2011). 2006 also saw the passage of the Reauthorized MSFCMA (P.L. 109-479) that spelled out many big changes the NEFMC would need to make to remain in compliance with the federal policy. To address the required changes under the Reauthorization and the persistent excess capacity problem in the fleet, the NEFMC began work on Amendment 16 (Holland and Wiersma 2010). Issues that the Council intended to tackle with the Amendment included further restrictions on the fleet's DAS allocations or alternative management approaches that could deal with the overcapacity and the reduced economic viability that the input control system had brought (Holland and Wiersma 2010). One of the proposed alternatives was an expansion of the existing Amendment 13 sector program, which was ultimately the direction pursued in the adoption of Amendment 16 to the Northeast Multispecies FMP in 2010 (Holland and Wiersma 2010).

6.3 | Learning in the transition to catch share management

The path that the NEFMC took in both the original creation of the sectors program in Amendment 13 to the revisions and expansion of it into the Amendment 16 system was guided and influenced by a variety of sources of information, knowledge, and experience. Sources external to the Council included the vertical diffusion of the changes brought through the 2006 Reauthorization of the MSFCMA and federal pressure on the Council to transition the groundfish fishery into catch share management incentivized by funding made available from NOAA. Additionally, the Council's early experiences with two sectors adopted prior to the expansion of the sector program influenced the development of Amendment 16 through the horizontal diffusion of knowledge. Other horizontal sources of information and experience included the Pacific Whiting Conservation Cooperative and the AFA pollock cooperatives. Internal sources of influence on the process by which the NEFMC learned how to make catch share mechanisms work for its needs included the severity of the overexploitation and overcapacity problems, the nature of a multispecies fishery, the policy legacy of the fishery's prior

regulation, a significant bottom-up impetus from industry members for quota share management frequently funded and supported by NGOs, and the extensive cultural history of the New England groundfish fishery.

6.4 | External learning process variables

Vertical diffusion

Significant sources of the diffusion of information influencing how the development of Amendment 16 by the NEFMC took shape included the nascent changes to the SFA, reauthorized as the MSFMCA in 2006. The reforming of the groundfish fishery management occurred within the same political arena as the debate and development of the Reauthorization. The Congressional work on updating the MSFCMA included a very involved debate on the place of rights-based management on the national stage and the eventual Reauthorized Act promoted the use of market-based management in fisheries, codified as LAPPs (Singer 2011). The accumulation of experience with the use of catch shares since the implementation of the Atlantic Surf Clam and Ocean Quahog ITQ program in 1990 led to the decision to incorporate them in the Act as a management instrument a Council could choose to employ with no mandate compelling Councils to incorporate them into FMPs. Other changes to the MSFCMA in the Reauthorization included requirements for what a Council needed to consider in the development of a LAPP should it choose that direction. A provision specific to the NEFMC and the Gulf of Mexico Fishery Management Council (GMFMC) required that a referendum pass with the support of at least two-thirds of permit holders for either council to adopt an IFQ program in any of its fisheries (MSA § 303A(c)(6)(D)) (Holland and Wiersma 2010). This MSFCMA requirement had considerable influence on how the NEFMC approached the potential development of a catch share program for the New England groundfish fishery and fundamentally shaped the Amendment 16 outcome (Singer 2011). The referendum mandate forced the Council to evaluate whether the pursuit of developing an IFQ program would actually have a chance of winning the support of two-thirds of the industry participants (Holland and Wiersma 2010). The Council saw that it would need to design a program in a very specific way, such as with a broad initial allocation scheme, to win such industry buy-in especially from the majority of participants that would likely receive small allocations due to limited catch histories (Holland and Wiersma 2010). The uncertainty associated with whether an IFQ would actually be able to move forward after a protracted development effort was enough to lead the Council to drop the pursuit of an IFQ program as a catch share option for the groundfish fishery (Holland and Wiersma 2010).

Other changes in the MSFMCA that impacted how Councils managed fisheries also played into the dismissal of the IFQ option. The Reauthorization included strict provisions on ending overfishing in all of the Nation's fisheries and implementing hard TACs for all fisheries based on the advice of each Council's SSC (Holland 2007). This represented a major shift for the NEFMC that had previously managed its fisheries with target TACs (Holland 2007). Complying with this federal mandate led to a highly abbreviated timeframe in which the Council would need to develop and implement an amendment addressing these considerable new requirements. This activity took precedence over the pursuit of the development of a catch share program for the fishery (NEFMC 2009a). Ultimately the Council did not see how it could simultaneously develop an IFQ program and have it pass a referendum while making the changes necessary to implement hard TACs in all of its fisheries (NEFMC 2009a). The deadlines associated with complying with the federal mandates made other less-design intensive alternatives to address the fleet's overcapacity, such as adjusting the existing sector option, gain favor (Holland 2007).

The new catch share provisions in the Reauthorized Act also played into the NEFMC's learning process in transitioning the groundfish fishery away from the traditional input control system. The 2006 MSFCMA defined LAPPs broadly, beyond just IFQs, which is what the referendum requirement was specific to (MSFCMA 2006). As the Council considered the option of altering and expanding the existing sector program as its preferred alternative, it grappled with understanding how a sector program fit in with the federal provisions for LAPPs and IFQs (Singer 2011). The legal confusion continued as the Council's development of the Amendment 16 sector program occurred concurrently with industry discussions of how individual sectors would allocate the quota each received, many settled on IFQ-type programs within the sector (Singer 2011). NMFS also struggled with understanding its mandates in the development of Amendment 16 (Singer 2011). Ultimately both management entities determined that the sector program being developed was a limited access fishery but not a LAPP, at least legally, because allocations were not initially made to individuals so the plan did not need to abide by the Reauthorization's LAPP provisions (Singer 2011). However toeing the still somewhat uncertain legal boundary between sectors and LAPPs was a constant influence on the Council and played a role in shaping many of the development decisions in the learning process such as design elements for the allocation scheme and transferability provisions (Singer 2011).

An additional vertical diffusion source of information and influence on the learning process by which the NEFMC developed the Amendment 16 sector management program was the growing roar of the national dialogue on the use of catch shares in fisheries management. This included NOAA's development of the NOAA Technical Memorandum released in 2007, *The Design and Use of Limited*

Access Privilege Programs, and the NOAA Catch Share Policy that was eventually implemented in 2010. This publicized NOAA's advice on developing and transitioning fisheries to catch share management and extended the agency's offer to assist any Council seeking to consider adopting a catch share program for use in any of its fisheries (Brewer 2011). At the same time, the new Obama Administration expressed support for the development of market-based mechanisms in fisheries management along with several environmental NGOs (Brewer 2011). The new head of NOAA, Jane Lubchenco, also took a direct interest in the possibility of a transition to catch shares especially for the New England groundfish fishery (Singer 2011). Lubchenco brought together a group of industry leaders from the fleet and major environmental NGO players to discuss the development of the NEFMC's Amendment 16 groundfish plan (Singer 2011). The NEFMC's learning process in developing the Amendment 16 program was truly played out on the national stage, further intensifying the urgency of the Council's development and transition to catch shares (Singer 2011).

NOAA further pressured the NEFMC to proceed with the development of a catch share program for the struggling fishery through the expansion of the sector program with the enticement of \$16.7 million in funding support for transitioning the management (Singer 2011). Funding was apportioned to the Northeast regional NMFS office to add staff to help walk industry participants through the development of individual sectors with specific money to help potential sectors put together the necessary EAs for NEPA compliance (Singer 2011). Additionally, funding was made available to help industry members cover some of the other start-up costs associated with forming sectors (Singer 2011). Over the final two years of the Amendment 16 development and implementation, a total of \$47 million in federal appropriations funded the NEFMC's transition to expanded sector management, with funding secured to help pay for monitoring and observer coverage for the first years of the program's operation (Singer 2011). With the federal involvement in the learning process via its wallet, stakeholders in the fishery also saw the potential for the inclusion of federal loans to help fund sectors in purchasing additional permits or creating permit banks, a debated design element, based on previous federal buybacks (Holland 2007). While other output control system alternatives were considered in the NEFMC's learning process, the federal funding directed towards sector development increased the expectation that the groundfish fishery transition would be a retooled version of the Amendment 13 sector provisions (Brewer 2011).

Horizontal diffusion

Sources of the diffusion of knowledge, information, and experience horizontal to the NEFMC also played an important role in shaping the learning process and guiding the Council to the eventual design of the Northeast Multispecies Amendment 16 Sectors program. One of the most fundamental was the experience the NEFMC gained through the development of the original Amendment 13 sector option and the subsequent formation of two sectors. The first sector, the Georges Bank cod hook gear sector, was implemented concurrently with Amendment 13 in 2004 and was the brainchild of the Cape Cod Commercial Hook Fishermen's Association (CCCHFA) (Singer 2011). The CCCHFA was one of the key drivers behind the original inclusion of the sector option in Amendment 13 (Singer 2011). The industry group and others like it were highly involved in the Council policymaking process for Amendment 13 and were spurred by frustrations with the seemingly inevitable further DAS restrictions to begin looking for alternative management strategies for the groundfish fishery (Singer 2011). The CCCHFA led much of the behind-the-scenes discussion and began to think seriously about the potential of area-based management as the best way forward (Singer 2011).

The concept of area-based management took shape as a spatial rights-based management system in which community-based fishery groups would operate regionally under quota constraints (Singer 2011). The idea of sectors based on gear-type had been floated in meetings of the Groundfish Plan Development Team (PTD) (Singer 2011). This discussion was held back by the intractability of developing gear-based sectors when the existing permits fishermen operated under were not based on gear designations (Singer 2011). A fisherman who frequented the PTD meetings then suggested self-selecting sectors based on his familiarity with the Fundy Fixed Gear Council which was a similar idea employed in Nova Scotia's groundfish quota system (Singer 2011). The CCCHFA pushed the concept further and began to draw up plans to form two such sectors (Singer 2011). Other industry groups involved in the discussions ultimately did not pull the trigger at that time due to worries about being permanently restricted to fishing in a specific region (Singer 2011). The formation of the sectors involved asking for an exclusive allocation of quota, a request that drew the ire of some industry participants concerned both about the fairness of such a set-aside and also that the CCCHFA was actually pursuing the development of an ITQ system for the fishery (Singer 2011). Nonetheless, the CCCHFA took its sector plans to the Council and campaigned for the support of state directors and its fellow industry members to move the sector concept forward in Amendment 13 (Singer 2011).

The NEFMC eventually consented to the sector concept and included the provision in the adoption of Amendment 13, allowing for the formation of the Georges Bank cod hook gear sector

(GBCHGS), one of CCCHFA's two planned sectors at the time (Singer 2011). The sector stipulations allowed the voluntary formation of a sector by a group of New England groundfish fishermen who would apply for an exclusive quota allocation based on the pooled catch histories of the individual members (NEFMC 2009a). In exchange for a yearly binding operations plan and an EA, the sector could be freed from some input controls while fishing for the stocks covered under the allocation (NEFMC 2009a). At the time, there were no funds or advisory resources provided from the public to help prospective sectors jump through all the required hoops (Holland 2007). The benefit the CCCHFA saw in this system in particular was being exempted from trip and possession limits for cod and a release from the Georges Bank seasonal closure in May (Holland 2007). The CCCHFA only applied for an allocation for Georges Bank cod in its sector proposal so still had to fish under the DAS and other controls for the other species it caught (Holland 2007).

The sector developed binding operations plan allowed the CCCHFA to determine how it wanted to allocate the quota among its members. However, due to restrictions under Amendment 13 and the logistical restriction of being the only sector in existence, the Georges Bank cod hook sector could not transfer quota allocations outside of the sector and limitations on the catch of incidental species ultimately constrained the profitability gains seen by the sector and its members (Holland 2007). Transferability of allocations could be accomplished by yearly movements of vessels into different sectors under Amendment 13, however the limited development of sectors in the fishery preventing this (Holland 2007). Additionally, sector allocations were based on the sum of members catch histories which were collectively tied to each vessel's permit, individual species allowances could not be separated out from the multispecies catch history or accordingly from the allocation (Holland 2007).

Additionally, Amendment 13 prescribed that sectors could only be implemented through the formal Council channels via an amendment or framework adjustment to the groundfish FMP (Holland 2007). The second sector under the Amendment 13 provisions was the Georges Bank cod fixed-gear sector (GBCFGS) that was authorized under Framework Adjustment 42 in 2006 (Holland 2007). The sector also had a membership group based out of Cape Cod and fished for Georges Bank cod along with other species in the Multispecies complex with sink gillnet gear (Holland 2007). Similar to the GBCHGS, the GBCFGS only applied for an allocation of Georges Bank cod so was still subject to the input controls for catches of other species (Holland 2007). Operating partially under the input control system led to both sectors frequently only catching a portion (about 60%) of their annual cod allocations (Holland and Wiersma 2010).

The development of the Amendment 13 sector program and the collective experience of the development of the first two sectors in the New England groundfish fishery lent much guidance to the Council's later reinvention of the program in Amendment 16. Observing the progression of the first two sector implementations and their subsequent perceived successful operation gave credence to the notion of catch shares as a viable management option for the NEFMC (Meridian Institute and MRAG Americas 2010). The early success, despite the limited application of the potential breadth of a sector and the numerous obstacles to development, planted the seed for a rights-based system on a broader scale for New England's fisheries that increasingly built momentum (Meridian Institute and MRAG Americas 2010). Industry members, especially in the small boat component of the fleet, saw the potential for what sectors could do to protect their economic viability as a flexible community-based management strategy. Some industry members also saw the potential for how sectors could protect the cultural legacy so integral to the New England groundfish fishery (Meridian Institute and MRAG Americas 2010). The fleet saw how sectors could slow the race to fish that had led to poor product quality and therefore reduced revenues and could increase efficiencies to reduce operating costs (Holland 2007). The Council saw how sectors could help further the rebuilding of the suffering cod stocks especially (Meridian Institute and MRAG Americas 2010). Also, the capacity of sectors to bring regulatory flexibility to the fishery was seen as a viable solution for what had become a serious discard problem when catches of mixed species were constrained by small allocations of some individual stocks (Holland 2007). Perhaps one of the most important contributions the GBCHGS and GBCFGS made was to offer a working model of how sectors could be designed to meet both fishermen's and the fishery's needs, demonstrating elements that worked and those that did not (Meridian Institute and MRAG Americas 2010). This experience was essential to the learning process in developing Amendment 16 to the Northeast Multispecies FMP.

As the pioneer in the formation of sectors in the groundfish fishery, the CCCHFA was very vocal during the Amendment 16 learning process, offering advice to new sector organizers and the Council (Singer 2011). Learning lessons that the CCCHFA offered to prospective sectors included advice on meeting frequently, on including industry participants beyond just owners and captains in discussions because all would be affected by the sector's decisions, and on the importance of securing a financial commitment from prospective members to gain the actual momentum needed to complete the whole proposal process (Singer 2011). Sector management modeled by the CCCHFA helped collect necessary political support for the concept, NGOs got on board and brought with them funding to advocate for expanding sector management and also help cover the administrative needs of running a sector (Brewer

2011). As an effect of this, when the Amendment 16 program expanding the scope of the sector program rolled out, all of the new sectors that were developed (seventeen of them) used the operations plan that the CCCHFA had developed in the previous years as a model for their own (Singer 2011). The benefit was that the CCCHFA operations plan had already been approved by NMFS which increased each sector's confidence in gaining approval (Singer 2011).

The CCCHFA had also started to explore the idea of developing permit banks associated with its sectors; such banks would hold the sector's collective catch history and permits (Holland 2007). A permit bank would allow the sector to purchase member's catch history and keep it within the sector if a member desired to exit (Holland 2007). The CCCHFA felt that a permit bank also offered the opportunity for the sector to invest further in the fishery by purchasing more permits or catch history and also offered new entry opportunities by making available allocations to future members (Holland 2007). The permit bank idea gained significant traction in the formation of the Amendment 16 program. The Amendment 13 sector experience was also critical for NMFS in its role in the Amendment 16 learning process, the Cape Cod sectors helped NMFS have a baseline experience on how to carry out the rulemaking process on the sector operations plans, what kind of timeframe was involved, and also how to interpret what sectors needed to have in the plan to be in compliance (Singer 2011).

The allocation scheme for sectors adopted in Amendment 13 was based on a rolling timeframe from which catch history was calculated (Holland 2007). A sector's allocation was locked in as a TAC percentage based off of the ratio of the collective members' catches per species to the total commercial catch during some period of 5 years (Holland 2007). The CCCHFA then determined it would divide up its allocation into monthly quotas that members would competitively fish for and underages of the monthly TAC would be rolled over to the next month (Holland 2007). Underages were frequent for the sector as catches were constrained by the lowest common denominator, or small allowances for catches of incidental species under restricted DAS allocations, low cod catchability rates, and other bureaucratically-related delays (Holland 2007). Evaluating how the Amendment 13 provisions contributed to sector formation was also a step in the learning process for the Council. It was collectively agreed that the rolling system for catch history qualifying years was an unfavorable design prescription despite its original appeal in that it would allow sector formation to closely mirror the most recent catch history of vessels joining sectors (Holland 2007). The rolling baseline system had created regulatory uncertainty and perverse incentives like reducing the value of sector member's catch history for future allocations if allocations were redistributed within sectors and encouraging industry participants to maximize their catch outside of sectors to qualify for greater allocations upon later

joining sectors (Holland 2007). Additionally, allowing the formation of sectors with single species allocations led to members having to follow two different management systems for species that were caught often simultaneously in a multispecies fishery. Requiring sector vessels to also abide by DAS restrictions that were already constrained by weak stock resulted in a limited uptake of the sector option and many vessels already participating in one of the two existing sectors left them by 2007 (Holland 2007). If a sector program was going to be the preferred alternative for the Council to pursue, it realized that much of the major structure of the program would need to be reinvented to make it more effective (Holland and Wiersma 2010).

Other knowledge, information, and experience that contributed to the NEFMC's learning process in developing the adapted sector management program in the Northeast Multispecies FMP came as lessons learned in the design and use of catch shares from policy peers to the Council. The development and successful operation of a harvest cooperative in the Pacific whiting offshore fleet, the Pacific Whiting Conservation Cooperative (PWCC), lent valuable advice and encouragement to the NEFMC to pursue a program based on similar ideas (Holland and Wiersma 2010). The PWCC experience demonstrated that an exclusive quota allocation to a small and cohesive group of fishery participants could foster self-organization and management within the group to create a mutually favorable allocation method between group members (Holland and Wiersma 2010). The management scheme helped the group meet the management objectives and was supported both by management and the industry participants themselves. Members of the PTD were knowledgeable about the PWCC system and other similar programs like the AFA pollock cooperative program in Alaska (Singer 2011). The original development of the sector program in Amendment 13 was modeled after the PWCC approach with the central theme that members would self-enforce a hard TAC in exchange for release from some of the traditional effort control regulations (Singer 2011). In Amendment 13, the Council even recommended that prospective sectors should consult the contracts drawn up by both the PWCC and the AFA cooperatives to fashion the required binding operations plans for the groundfish fishery (NEFMC 2003).

To give industry members the opportunity to learn from others' experiences, meetings between New England groundfish fishermen and Alaskan and BC fishermen that had been through the shift to cooperative catch share management were facilitated by various NGOs in 2009 (Singer 2011). The direction interaction helped industry members learn about what the shift to broader catch share management would look like, what the effects would be, and how as individual fishermen they could adapt their businesses to take advantage of the opportunities in catch share management (Singer 2011). EDF also brought Alaskan fishermen experienced with the catch share transitions that had occurred

there to assist with the actual development of individual sectors and help fishermen prepare for a potential fishery-wide transition (Singer 2011). Trips were also organized by EDF in cooperation with the Sand County Foundation and the Alex C. Walker Foundation to take New England fishermen to BC and New Zealand to interact with other fishery participants who could lend insight from the fisherman's perspective of what transitioning to catch shares would mean (Singer 2011).

Other sources of insight for the actual individual sector operations plans came from the New Zealand QMS system. A major industry group, the Northeast Seafood Coalition (NSC) that helped to create several of the sectors proposed with Amendment 16 modeled components of its plan provisions on the methods by which New Zealand dealt with overages of the quota allocations (Holland and Wiersma 2010). NSC developed a 'deemed value' program that created quota reserves at the beginning of the fishing season that quota could be bought from for a predetermined value in the case of an overage by an individual vessel within the sector (Holland and Wiersma 2010). Sector members that had originally contributed to the quota reserve would receive the profits from the buying members (Holland and Wiersma 2010).

6.5 | Internal learning process variables

Problem severity

To say the problems in the New England groundfish fishery prior to the transition in Amendment 16 were numerous would be an understatement. The policy legacy of the Northeast Multispecies FMP had over three decades persistently failed to meet the primary objectives with which it was implemented, rebuilding and protecting both the groundfish stocks and the commercial fishing industry based on them (Macinko and Whitmore 2009). Nearly all populations and species in the stock complex were either still subject to overfishing or had been subject to it in the recent past (Macinko and Whitmore 2009). The list of healthy stocks was considerably shorter than the list of those that were not. Out of twenty recognized stocks prior to Amendment 16, twelve stocks within seven different species were experiencing overfishing: cod, yellowtail flounder, witch flounder, winter flounder, white hake, pollock, and windowpane flounder (NOAA Fisheries Service Office of Policy 2010). Of those twelve, ten were considered overfished along with three other stocks (ocean pout, Atlantic halibut, and Atlantic wolffish) (NOAA Fisheries Service Office of Policy 2010). The rebuilding plans for these species continually failed to meet the required standards under the MSFCMA and stock assessments continued to return bad news (Macinko and Whitmore 2009). The Council was cognizant of the dismal health of

the groundfish resources and predicted that most stocks in the complex would not rebuild to levels supporting maximum sustainable yield at any time in the near future (NEFMC 2008).

The adverse biological state of the fishery was accompanied by economic and social problems for the fleet. After years of increasingly restrictive regulations, the commercial groundfish fleet was near rock-bottom financially (Holland 2007). The groundfish fishery was prosecuted with a variety of gear types and a shrinking quota repeatedly left even less for each group to fight over. Conflict between industry participants operating different gear-types was a significant problem in the fishery for management (NEFMC 2003). Discord also arose between the inshore and offshore fleet components (NEFMC 2003). In addition to fighting among themselves, there were considerable trust issues between industry and management, especially the scientific component of management (NEFMC 2003). And as scientists continued to have to bear the news of low stock abundances, discord became further entrenched.

Institutional capacity

The institutional capacity of the NEFMC and specifically the policy legacy of the Northeast Multispecies FMP prior to the adoption of Amendment 16 played an important role in the Council's learning process and how it approached transitioning the groundfish fishery into sector management. When the original concept of sector management emerged in Amendment 13, many saw little chance of it succeeding or gaining momentum as an appropriate solution to the fishery's problems (Singer 2011). In general, both with the Council and associated stakeholders, there had long been rather vehement opposition to ITQs (Singer 2011). The Council was constantly wary of developing a management approach in Amendment 16 that would trigger an ITQ referendum (Holland 2007). For a brief time, though, an IFQ option was debated but ultimately dropped both out of referendum concerns but also concerns about keeping the Amendment development on schedule (Holland and Wiersma 2010). While under some common agreement on what should not be pursued, the Council otherwise struggled for much of the history of the FMP to determine what the long-term vision for the groundfish fishery should be (Singer 2011). The Council had never been able to come to any sort of agreement on what the socioeconomic goals of the management of the fishery should be and how the Council would measure them (Singer 2011). Lacking a clear vision of what the fishery should move forward to delayed development of how to move the fishery forward in general. This inertia slowed the development of Amendment 16 as the Council had to simultaneously accomplish tasks that it had struggled with for years (Singer 2011). Though official work on Amendment 16 had begun in 2006, it was not until 2008

that the Council came to a consensus on objectives (though considerably broad) that it sought to achieve with the management alternatives debated (Singer 2011).

Informational asymmetries also constrained institutional capacity necessary in the development of the expanded sector program for the groundfish fishery. Despite the fishery's experience with sectors under Amendment 13, there was a significant lack of understanding or a misunderstanding as to how sectors would work under the new alternative as well as to what the real costs and benefits were likely to be (Holland 2007). And similar to the state of affairs with Amendment 13, in the early development of the Amendment 16 plan there were few resources available to help guide industry members through the process of forming sectors, designing operations plans, and especially carrying out EAs (Holland 2007). Additionally, the hard TAC requirement under sector management caused considerable apprehension for the Council and stakeholders due to the fishery's previous experience with a hard TAC early in the FMPs history that was collectively determined to have been a significant failure (Singer 2011). The Council approached the idea of reverting back from its current practice of using TACs as targets cautiously (Singer 2011). The hard TAC provision became entwined with the expanded sector program alternative even though the Reauthorization of the MSFCMA required that the Council move in that direction regardless. The Council did agree that a hard TAC associated with sector management was preferable and offered more optimism for success than a stand-alone hard TAC measure through the Amendment (NEFMC 2009a).

The Council did agree that a new management direction needed to be pursued, and before the scoping for Amendment 16 began came together outside of the Council process through the efforts of a regional environmental NGO, the Gulf of Maine Research Institute (GMRI). In this 'FishTank', Council members came together with industry members to discuss potential changes to the groundfish fishery management (Singer 2011). General ideas supported in the discussions included investigating the potential for an output control system with a point system or allocation formula that could be incorporated in sector management or in a new area-based management strategy (Singer 2011). The GMRI played an integral role in the path the NEFMC took in developing Amendment 16 by facilitating dialogue to achieve mutual understanding of the problems and potential solutions (Holland 2007). NGOs as a whole were a key component of the stakeholder group intertwined with the Council in the development process. EDF had been a major player in New England fisheries management for several years, holding a seat on the NEFMC beginning in 1997 (Singer 2011). EDF was the only conservation representative to sit on any of the Regional Councils (Singer 2011). The NGO had also long been a vocal supporter of catch share management in fisheries (Singer 2011).

Significant capacity was built in the fishery and the NEFMC for Amendment 16 by the experience with Amendment 13. The same reasons that had led the Council to adopt the sector management measure in Amendment 13 still rang true. The Council saw sectors as an opportunity to simplify the regulations in the fishery, especially because many, including the DAS regulations, had caused significant friction between managers and fishermen (NEFMC 2009a). The idea of addressing the overcapitalization problem through industry self-governed consolidation was also seen favorably (NEFMC 2009a). Additionally, the Council felt the necessary capacity existed for organization and trust within the industry to transition to sector management (Holland and Wiersma 2010). Much of the industry was already self-organized into industry groups that played roles in the policy arena (Holland and Wiersma 2010). The concept of addressing fleet problems through the market rather than through regulations had also finally gained traction in New England (NEFMC 2009a).

The failed policy legacy of the New England groundfish fishery, though, still impacted the momentum behind Amendment 16 and the serious trust issues among managers, fishermen, and scientists needed to be addressed as the Council attempted to move forward in the development of the alternate management plan (Holland et al. 2010). Having Amendment 13 in place did give the Council a head start in transitioning to a catch share strategy, it needed to identify and address the problems with the current program instead of completely starting from scratch (Singer 2011). Components that needed attention included clarifying monitoring and reporting requirements, defining sector versus non-sector (common pool) vessel interactions, and tackling the contentious problem of the initial allocation scheme (Singer 2011). Devising a mutually supported allocation framework was an especially difficult problem for the Council in the development of Amendment 16 as it learned that frameworks needed well-defined TACs to build off of and the Council had only just begun tackling that management task to be concurrently implemented in the Amendment (Singer 2011).

Another critical detractor from building the institutional capacity to proceed through the fully vetted development of a catch share program for the New England groundfish fishery was external time restrictions on the Council. The process of analyzing alternative management strategies was packaged with developing the necessary management changes to comply with the new requirements in the Reauthorized MSFCMA such as ending overfishing. This task had a very aggressive timeline within which it needed to be developed and adopted (Singer 2011). The Council tried several times to move the consideration of changes to the status quo input control regulation system to a future amendment due to concerns about meeting the legal timeline for Amendment 16 (Singer 2011). Concerns about time restrictions played heavily into the narrowing down of management alternatives being considered and

eventually the Council was only considering the expansion of the sector program or modifications to the existing DAS system (Singer 2011).

The NEFMC created the Sector Omnibus Committee in 2007 to attempt to create consistency in the development of the sector management strategy across all of its fisheries (Singer 2011). The Council then approved the generalized Sector Policy and kicked the process to individual species committees to apply the general course of action to the needs of each fishery (Singer 2011). In 2008, the Council circulated a draft for public comment that conveyed its intention to transition the groundfish fishery management into an output-based system (NEFMC 2009b). Even with the concern for sticking with the timeline, the development of Amendment 16 got behind schedule and was not adopted in 2009 as originally intended. Instead, it was slated for implementation a year later (NEFMC 2009a). The learning process of the NEFMC in deciding on sector management as the preferred management strategy was significantly, if not completely, guided by the timeline the Council was tied to for the development of Amendment 16.

Industry buy-in

The role of industry in guiding and shaping the NEFMC's development of the Amendment 16 expanded sectors program cannot be underestimated. Frequently along the way industry members and groups took it upon themselves to seek out knowledge, information, and experience to inform the discussion of alternative management strategies to the input control system. Often in partnership with NGOs, they then acted as a conduit to the Council, driving the learning process forward to the eventual adoption of the Amendment 16 plan. The NEFMC too, though, sought the involvement of the industry in the policymaking process as it realized the importance of industry buy-in to management changes (NEFMC 2009c). Prior to the original schematic for sector management in Amendment 13, industry members were very vocal to the Council about their dissatisfaction with the regulatory complexity of the input control system and the DAS component especially (NEFMC 2003). The rapidity of management changes was also greatly frustrating for industry participants as they felt at the mercy of the frequent addition of layers of regulatory complexity by the Council (NEFMC 2003). Industry groups had long taken an active approach to groundfish management and frequently met to collaborate on management advocacy. In 2001, the Maine Fishermen's Forum convened a meeting of industry participants to discuss management possibilities alternative to the DAS system, even analyzing what the industry would advocate for if an IFQ option was pursued (Singer 2011). This marked a step in the realistic acceptance of the catch share movement that seemed to be knocking at their door. Maine fishermen had especially

been wary of the move to catch shares as they saw the associated consolidation concentrating control of the fishery into the hands of a few, large, and non-local corporations (Brewer 2011). Apprehension to the idea of catch shares still remained for some participants, and often support or criticism fell along classes in the industry. The managerial class of the industry such as representatives of industry organizations often supported the transition while rank and file fishermen were still underinformed about what the management alternatives would mean (Macinko and Whitmore 2009). Upon the development of sectors, many industry members still felt they lacked the information to make an educated decision to join or not join a sector (Holland et al. 2010).

Industry dissatisfaction with the DAS regulation of the fishery centered on how the industry perceived the program encouraging risky fishing and creating significant safety concerns in the fishery as participants did everything they could to maximize their catch within the input control restrictions (Holland 2007). Industry members were also extremely vocal in what they saw as a perverse implication of the input control system, that due to species-specific trip limits in a truly multispecies fishery, fishermen were forced to discard a significant amount of fish that were likely already dead (NEFMC 2003). They were also critical of generic restrictions that did not take into account the differences in fishing activity between small and large vessels and felt that many regulations such as minimum mesh sizes and minimum fish sizes were out of sync with each other (NEFMC 2003). Fishermen also criticized the input control system for lacking any incentive for individuals to be proactive about making gear choices and other fishing decisions that could positively impact the FMP's conservation impact (NEFMC 2003). Many industry participants saw sectors as the only escape from the misery they felt under the DAS regime (Macinko and Whitmore 2009). Many groundfish industry members had a more optimistic view of sectors, especially those that participated in a pilot sector development project for the Rhode Island state fluke fishery in 2005 (Singer 2011). The project was coordinated by NGO's and the Rhode Island Sea Grant who developed the Rhode Island Fluke Conservation Cooperative with a group of local fishermen (Singer 2011). The program was modeled based on the Amendment 13 sector requirements and therefore offered on-the-ground experience with sector management for many of the same fishermen that participated in the New England groundfish fishery (Singer 2011).

The groundfish fishery fleet had been disheartened by their experience with the development of Amendment 13 and they took the experience as a learning lesson to how they would interact with the Council through the development of Amendment 16. They saw how regulatory uncertainty had stalled real progress from being made in terms of management changes through Amendment 13 and took an approach to prevent this from repeating itself in the Amendment 16 development process (Singer 2011).

A significant impact of the industry's experience with Amendment 13 was less industry engagement in the official Council Amendment 16 development process (Singer 2011). Thus while industry groups debated novel management strategies for the fishery, at the same time many took steps to preemptively take advantage of the existing sector option if it remained the only viable option to move away from status quo (Singer 2011). Significant industry buy-in to the suitability of sector management as a direction that would be new to most of them was won by observing a pilot sector development project carried out through a partnership between GMRI and two industry organizations, the Associated Fisheries of Maine and the Midcoast Fishermen's Association (Singer 2011). Both groups started the project skeptical of its success but expressed that by participating, they had seen how a sector could be designed specifically to their needs (Singer 2011). And ultimately both organizations chose to develop official sector proposals for submission to the Council in 2007 (Singer 2011).

Other industry groups watching the pilot project jumped on board with the idea, including the NSC, which orchestrated the development and submission of twelve different sector proposals to the NEFMC (Singer 2011). Some industry members felt that sectors could more effectively protect the cultural heritage of New England fishing communities than other rights-based management such as IFQs (Holland and Wiersma 2010). In all, seventeen new sector proposals as well as proposed changes to expand the two existing sectors beyond just cod allocations were submitted to the Council in 2007 (Holland 2007). Sector proposals were facilitated by partnerships with NGOs that both provided funding for sector development and technical assistance in the development of the binding operations plans and EAs (Holland and Wiersma 2010). Key NGO players included The Island Foundation, The Penobscot East Resource Center, and the Gordon and Betty Moore Foundation (Holland and Wiersma 2010). The proposed sectors included representation accounting for the majority of the groundfish landings in the fishery (Holland 2007). Fishermen also worked with NGOs like GMRI in a Monitoring Working Group to submit recommendations to the Council for provisions for elements such as monitoring and to approach Congress with requests for funding for such program components (Singer 2011).

Much of the industry buy-in to the development of Amendment 16 was based on the plan that the Council would address the problems the industry perceived with the Amendment 13 sectors system. Industry members did see the potential benefits sectors could bring, especially increased profitability by allowing transfers of allocations to increase efficiency in fleet operations (Holland 2007). Therefore they saw the accumulation caps on sector holdings incorporated in the Amendment 13 design as being overly restrictive on sector operation and argued for the removal of such provisions in the Amendment 16 design (Singer 2011). The Council explicitly solicited industry input on management changes that should

be considered to the Amendment 13 system (Singer 2011). Concerns remained that with the decision to pursue expanding the sector management program, the Council had strategically side-stepped the IFQ referendum requirement under the Reauthorized MSFCMA (Brewer 2011). Trust issues were again a concern as industry perceived that the requirements of sectors to fish under both a hard TAC and DAS allocations signified that NMFS did not trust the fishermen to abide by the TAC (Meridian Institute and MRAG Americas 2010). Industry members argued that for sector management to be effective, the rules on approving sectors had to be eased so that sectors could be approved through less formal Council actions than amendments and framework adjustments (Holland 2007). The uncertainty that resulted from that requirement had deterred industry members from developing sectors because they were unsure if the time, effort, and money that would be required for development would actually lead to Council approval (Holland 2007).

This concern about Council inaction in spite of industry investment in addressing management changes was nearly borne out in the Council's frequent efforts to move the consideration of alternative management strategies to a later amendment process (Singer 2011). Industry members pushed back hard against this (Singer 2011). The possibility of an Amendment with more DAS restrictions and no alternatives to help keep the industry afloat won even more support for sectors by industry members (Singer 2011). Ultimately the submission of the seventeen new sector applications that sought approval for implementation with Amendment 16 pushed the Council to keep the adjustment of sector management provisions on the table for development with the Amendment's process (NMFS 2012). The collective voice of industry members supporting the move to sectors also garnered more support from NMFS in assisting prospective sectors in navigating the regulatory requirements like developing EAs (Singer 2011).

The development of the expanded sector management program under Amendment 16 continued to move forward, and industry weighed in on most steps along the development process. Some industry members were concerned with the allocation scheme that had begun to take shape (Holland et al. 2010). The design element being developed for the initial allocation framework was to be a calculation of potential sector contributions (PSC) based on the individual catch history of prospective sector members. When that individual did join a sector, the PSC would be pooled, resulting in the overall sector's allocation (Holland and Wiersma 2010). The issue of qualifying years from which catch history would be taken was especially contentious. The GMRI again brought together industry leaders to come to a mutual point of view to present to the Council (Singer 2011). The point of view brought was that the longest grouping of years possible should be used to create the allocation baseline (Singer 2011). Ideas

that had been floated through the Council like different qualifying years for the existing sectors versus the new sectors were controversial and invoked much debate (Meridian Institute and MRAG Americas 2010). Many industry participants addressed concerns during the development of the allocation framework that some fishermen would be unfairly impacted by recent permit purchases that carried little associated catch history (Meridian Institute and MRAG Americas 2010). Garnering industry support of an allocation framework was hampered by NMFS inability to forecast for participants what their catch history was relative to the rest of the fishery under various allocation schemes due to the late development of TAC information (Singer 2011).

Contextual attributes

The New England Multispecies Sectors program developed by the NEFMC was fundamentally influenced by the context of the fishery and its management. The design of the program had to account for the unique ecological, economic, and social features of the New England groundfish fishery. These characteristics included the nature of the multispecies fishery, the prior economic condition of the majority of the participants, and the unique cultural identity of the participants in the groundfish fishery.

Ecological context

Internal influences on how the NEFMC learned to apply catch share mechanisms to its needs in the New England groundfish fishery included unique contextual factors such as those stemming from the nature of the groundfish resource and how the fishery then was prosecuted. One of the most fundamental influences was the complexities associated with a multispecies fishery. In fact, other Councils such as the NPFMC that also managed multispecies groundfish fisheries ultimately decided not to pursue a wholesale transition to catch shares but rather took more of a single species approach because of the complexities of developing such a management program (Fina 2011). The difficulty of a multispecies fishery is often that catches are constrained by the stock with the lowest limit (NOAA Fisheries Service Office of Policy 2010). And there may be little certainty in determining which species will be brought in while harvesting since most can be caught in the same way.

Managing the fishery under the DAS allocations and the trip limits had allowed the reduction in fishing mortality for some of the stocks of concern within the complex, but resulted in excessive protections for other species such that the fleet was unable to catch the allowed sustainable yield of the healthier stocks (Holland 2007). Many of the stocks of concern generally were caught infrequently in the fishery but the catch was highly variable resulting in significant stochastic overages of the trip limits and

therefore considerable discards of harvested fish (Holland 2007). This feature may have argued for a catch system as opposed to an input regulation system because catch could be balanced with quota through trading mechanisms (NOAA Fisheries Service Office of Policy 2010). Further argument for tradable quotas stemmed from concerns about localized depletions if fishing effort were concentrated in a regional manner, and the abundances of groundfish had long reflected this pattern (Holland 2007). Additionally, trawling as the dominant mode of harvest in the New England groundfish fishery carried with it considerable concerns about bycatch (Macinko and Whitmore 2009). Industry members in the fishery saw the potential in sector management to trial different fishing practices or gear modifications to reduce bycatch (Holland 2007). Trawling also carries concerns about habitat damage and resulting impacts on essential fish habitat, which the NEFMC began addressing through area closures from trawling to assist rebuilding efforts beginning in 1989²⁹.

Economic context

Economic contextual features of the New England groundfish fishery and its associated management also helped shape the Council's learning process in developing the Amendment 16 Multispecies Sectors program. Significantly, the economic situation of the fleet at the time of the Amendment development was already suffering severely (Holland 2007). The accumulated years under the input control system had reduced the fleet's efficiency and reduced the sustainability of many of the industry participants' operations (Holland 2007). Therefore, there had already been considerable restructuring of the industry and consolidation in the fleet following a general path away from Maine in particular (Holland 2007). This threatened the highly dependent shoreside economy that included employment in wharves, stevedoring, and other supply industries for the fishery (NEFMC 2004). The economic situation of many of the participants also contributed to the reason why the Amendment 13 sector program had not taken off when it was implemented, the costs involved in forming a sector were insurmountable for many fishermen (Holland 2007).

The nature of the marketing of the product from the fishery also impacted management changes because all transactions were done through auctions acting as a middle man between harvesters and processors (Holland and Wiersma 2010). The market for groundfish products had suffered from an unstable inflow of fish to the processors as well as from quality issues that resulted from the race to fish (Holland and Wiersma 2010). The fleet was also highly heterogeneous with a mix of gear types from trawl to gillnet to hook and line and with some participants operating smaller daytrip

²⁹ Amendment 2 to the Northeast Multispecies FMP (54 C.F.R. 4798)

boats and others traveling farther offshore in large boats for multiday trips (Holland and Wiersma 2010). Additionally, the groundfish fishery had a large recreational component to it, putting additional pressure on the resource (NEFMC 2009a). The development of other fisheries in the area such as the lobster fishery, though, allowed the reduction of some of the fleet's pressure on the groundfish stocks (Acheson and Steneck 1997).

Social context

The social contextual factors that influenced the development of the expanded sectors program included community concerns and equity concerns that lingered from the status quo regulatory regime. A large contingent of the groundfish fleet was made up of small owner-operator boats that employed only 2-3 crewmembers each (Holland and Wiersma 2010). When the Council finally determined what it saw as the social goals of the Northeast Multispecies FMP, it included the objective of taking steps to maintain the small dayboat component of the fishery and to prevent a new regulatory scheme from allowing excessive consolidation (NEFMC 2009a). The Council saw that this protection could potentially be secured by allowing the creation of a small boat fleet sector (Macinko and Whitmore 2009). In the original development of Amendment 13, the Council also envisioned sectors as a method to help small communities, especially in the face of further reductions in allocations (NEFMC 2004). Other stakeholders in the fishery envisioned community-based sectors that could facilitate continued community participation and maintain access to the resource for new entrants (Holland 2007). Some communities had experience playing a management role already as some were active in shellfish fishery management in New England state tidal areas (Holland 2007). A specific program element that was discussed that could help communities take a leadership role in management was the idea of permit banks that could purchase permits and catch history for a sector (Holland 2007). A community-based permit bank could entice vessels to stay in communities and also perhaps facilitate further community economic development and investment in the fishery through the purchase of more permits (Holland 2007).

Fishing communities were wary of increasing consolidation as a threat to their historic participation in the groundfish fishery (Holland 2007). Stemming from this concern, more communities were in favor of sectors as a catch share option over IFQs because many feared the fishery would become a tradable asset for Wall Street investors who did not value the fishery as a way of life (Holland and Wiersma 2010). Fear of consolidation away from small boats and small communities was a thread that ran through the entirety of the development of Amendment 16 (Holland 2007). Consolidation

effects that could negative impact small boats had been prevented under the DAS regulatory structure (Holland 2007). The cultural fabric of the New England fishery was a critical component influencing the design of management alternatives, many sought to protect the legacy of family-run businesses that had almost in an against all odds way continued to operate in the fishery, if only barely (Holland and Wiersma 2010). A significant social concern that also had to be dealt with was the consolidation patterns that already existed in the fishery in which fishermen, landings, and revenue was methodically moving from Maine to Massachusetts (Holland 2007). The issue was made worse by Maine state marine fuel taxes, restrictions on groundfish vessels from landing lobsters in Maine, and the general desire of fishermen to be closer to the fishing grounds (Holland 2007). The loss of fishing activity threatened the viability of Maine's dominant auction operation, the Portland Fish Exchange, and as auction houses were integral to the marketing of groundfish, its suffering only led to more fishermen leaving the area (Holland 2007).

Perceived inequities in the policy legacy of the Northeast Multispecies FMP also contributed to the social context in which Amendment 16 was developed. There had long been a struggle in the development of regulations to balance rewarding of historic participation versus more recent participation (NEFMC 2003). Participants in the fishery also felt that DAS allocations were made unfairly because regulations were applied equally across all types of fleet participants and this resulted in the perceived differential punishment of some fishermen (NEFMC 2003). Yet the development of different regulations for different fleet components was also viewed as unfair (NEFMC 2003). Additionally, the sum of the groundfish fishery's management was somewhat disjointed because some parts of the regulation were specified to different components of the fleet based on gear while other regulations such as harvest allocations were not applied based on gear specifications (NEFMC 2003). And finally, there were conflicts between the commercial fleet and the growing recreational fleet that did not have to abide by many of the same spatial regulations such as closures as the commercial fleet did (NEFMC 2003).

6.6 | **The learning outcome**

The Amendment 16 outcome of the NEFMC's learning process in determining how to transition the New England groundfish fishery into catch share management is summarized below.

Table 4 | Amendment 16 Design of the New England Multispecies Sectors program

Specifications of privilege	Type of allocation	<ul style="list-style-type: none"> • Self-selecting sectors receive yearly pooled allocation of ACE³⁰ based on PSCs of members <ul style="list-style-type: none"> ○ Minimum of three distinct owners ○ No maximum restrictions on number of members, vessel types, gear types, or region
	Management unit	<ul style="list-style-type: none"> • Northeast Multispecies Complex (species and population designations) <ul style="list-style-type: none"> ○ Atlantic cod (<i>Gadus morhua</i>) <ul style="list-style-type: none"> • GB³¹ • GOM³² ○ Haddock (<i>Melanogrammus aeglefinus</i>) ○ Pollock (<i>Pollachius virens</i>) ○ Yellowtail flounder (<i>Limanda ferruginea</i>) <ul style="list-style-type: none"> • GB • SNE³³/MA³⁴ • CC³⁵/GOM ○ Witch flounder (<i>Glyptocephalus cynoglossus</i>) ○ Winter flounder (<i>Pseudopleuronectes americanus</i>) <ul style="list-style-type: none"> • GB • SNE/MA • GOM ○ Windowpane flounder (<i>Scophthalmus aquosus</i>) <ul style="list-style-type: none"> • GB/GOM • SNE/MA ○ American plaice (<i>Hippoglossoides platessoides</i>) <ul style="list-style-type: none"> • GB • GOM ○ Atlantic halibut (<i>Hippoglossus hippoglossus</i>) ○ Redfish (<i>Sebastes fasciatus</i>) ○ Ocean pout (<i>Zoarces americanus</i>) ○ White hake (<i>Urophycis tenuis</i>) ○ Silver hake (whiting) (<i>Merluccius bilinearis</i>) ○ Red hake (<i>Urophycis chuss</i>) ○ Offshore hake (<i>Merluccius albidus</i>)
	Transferability	<ul style="list-style-type: none"> • Sector can transfer ACE annually with other sectors without restriction • Permanent transfer of PSC between sectors cannot occur while a vessel is participating in a sector
Specifications of	Initial eligibility	<ul style="list-style-type: none"> • Voluntarily-formed group of at least three distinct owners

³⁰ Annual Catch Entitlement³¹ Georges Bank³² Gulf of Maine³³ Southern New England³⁴ Mid-Atlantic³⁵ Cape Cod

privilege holders		<p>that must submit legally binding operations plan (one year contract at least) and EA to be approved annually by NMFS</p> <ul style="list-style-type: none"> • Members must possess limited access Northeast multispecies permit • PSCs calculated for each permit for each stock for which catch history within qualifying period of 1996-2006 exists
	Subsequent eligibility	<ul style="list-style-type: none"> • No direct provisions
Specifications of program	Consolidation controls	<ul style="list-style-type: none"> • No cap on sector allocations
	Directed conservation elements	<ul style="list-style-type: none"> • Sectors must implement reserve system requiring members to put between 5 and 20% of ACE into a reserve only to be accessed later in year <ul style="list-style-type: none"> ○ Reduces likelihood of sector exceeding overall ACE allocation
	Social equity elements	<ul style="list-style-type: none"> • No direct provisions
	Administrative components	<ul style="list-style-type: none"> • Monitoring <ul style="list-style-type: none"> ○ NMFS funded 30% observer coverage for first year; calculate assumed discards for each sector based on observed trips from that sector ○ Sectors submit weekly and yearly catch reports including detailed landings and discards of all stocks ○ Mandatory contracts with third-party entities for dockside monitoring (50% coverage randomly assigned for the first year, 20% for subsequent years) and at-sea monitoring (hail system) ○ Vessels must submit VMS trip declarations and weekly VTRs³⁶ • Enforcement <ul style="list-style-type: none"> ○ If sector exceeds ACE during a year, allocation in subsequent year is reduced to account for overage • Program administration and review <ul style="list-style-type: none"> ○ Sector can carry up to 10% of unused ACE forward to next fishing year (NOAA Fisheries Service Office of Policy 2010)
Issues not addressed in original design	Major changes after implementation	<ul style="list-style-type: none"> • State permit banks (Maine)
	Unaddressed issues	<ul style="list-style-type: none"> • Amendment 17 supposed to further develop State-operated permit banks and streamline administrative requirements for banks to be able to lease ACE to sector

³⁶ Vessel trip report

Sources: Holland 2007, Holland and Wiersma 2010, NOAA Fisheries Service Office of Policy 2010, and NFMS 2012

6.7 | Correlating the learning process and outcome

The development of Amendment 16 by the NEFMC came at a time when the groundfish fishery was in significant upheaval and distress and had been for several decades. It had endured substantial changes in management since the mid 1990s and the economic viability of the fleet had suffered as a result (Holland 2007). The policy legacy prior to the implementation of the management direction in Amendment 16 was one in which an input control system told fishermen where to fish, when to do it, and how much they could take (Holland 2007). The combination of trip limits, gear restrictions, DAS limitations, and rolling, seasonal, and year-round closures did little to address the severe overexploitation of the groundfish resource and the overcapitalization of the fleet (Holland 2007). Both management and the industry were frustrated and the development of Amendment 16 was certainly contentious.

There were, however, some beneficial outcomes of the learning that occurred in the process of shifting the fishery to an expanded sector management program. One of those direct outcomes was that after observing the failure of the Amendment 13 rolling baseline catch history determination scheme and listening to industry opposition to it, the Council passed motions to proceed forward with an expanded sector program that created a consistent baseline for all catch history determinations to calculate PSC in a fishery (Holland 2007). Other components of Amendment 16 that resulted from lessons learned in the experience with Amendment 13 included the easing of restrictions on the transfer of ACE between sectors (Holland 2007). The Council realized that profitability gains to the industry were much more substantial without transferability limitations (Holland 2007). Additionally, some elements of Amendment 16 were key inclusions needed to win the industry buy-in to the retooled management approach. The easing of DAS restrictions on fishermen fishing under sector management was critical to selling the plan to industry (Meridian Institute and MRAG Americas 2010). The NEFMC also saw the benefit of the self-selecting style of sectors as a way to ease industry concern about management changes; participants did not have to join sectors and could also opt out of a sector without penalty even after being included in a proposal (Singer 2011). It was perceived that sectors felt like less of a top-down Council action forcing the industry into catch share management (Singer 2011). The Council and NMFS' experience with sector management through Amendment 13 was also an integral component influencing the Amendment 16 learning process, and NMFS especially was much better prepared to help

industry members develop sectors after going through the process with the first two sectors in 2004 and 2007 (Singer 2011).

Some parts of the learning process for the NEFMC in developing Amendment 16 focused attention on the concern by both Council members and industry participants about how consolidation could be a negative implication of the transition to catch shares if not addressed (Singer 2011). During the development process, the Council kicked that issue to the individual species committees to tackle (Singer 2011). The Amendment 16 outcome ultimately did not include any provisions on preventing excess quota holdings by sectors (Meridian Institute and MRAG Americas 2010). It will remain to be seen if after implementation, consolidation becomes an issue in the restructured fishery. Some issues left unaddressed by the Council, though, were ameliorated at least temporarily by sources external to the Council. The extraordinary cost of developing a sector and jumping through the regulatory hoops had been a problem since the Amendment 13 conceptualization of sectors. The Council did little besides change the requirement that sector proposals did not have to go through an FMP amendment or framework adjustment (Singer 2011). However, the resources both in funding and advice made available to industry participants from federal sources and NGOs were integral in supporting the industry bottom-up impetus of the expansion of sector management.

Ultimately in how the NEFMC learned about the applicability of catch shares to its needs with the New England groundfish fishery, it determined that sectors were the best option because it allowed for a diverse range of management systems to be applied individually in self-selecting sectors (Holland and Wiersma 2010). This was a closer fit to the diverse and heterogeneous nature of the groundfish fishery than a more centralized approach through an IFQ program, for example, and could aptly mirror and therefore protect local community identities. The Council also found that components in sector management such as yearly application requirements of members holding permits and requirements for sectors to be composed of multiple permit holders innately prevented the broad movement of permits out of the hands of fishermen and into those of investors (Holland and Wiersma 2010).

The external forcing of the Council development of the expanded share program has left some wondering about its longevity. The rushed nature of the program creation and its implementation has led to worries that some program details and elements were not adequately vetted before adoption and that this may spell doom for the program (Singer 2011). Others have speculated that the Amendment 16 program is just a temporary step in a transition to another management system (Holland et al. 2010). Many industry members still fear the transition to IFQs (Singer 2011). Immediately after the Council vote to approve Amendment 16, the Council showed general acceptance of the notion of catch share

management in fisheries by convening a Catch Share Workshop in 2009, the Fisheries Leadership and Sustainability Forum (Singer 2011). The workshop focused on creating a dialogue about the design and use of catch shares in New England fisheries and brought representatives from other regions that had catch share experience to share their successes and failures and any advice they had for the Council in its future actions (Singer 2011). The workshop attendees heard advice from representatives involved with the development of the West Coast Groundfish Trawl Rationalization under the PFMC as well as from those involved in Alaska catch share programs, the BC fisheries, and New Zealand's QMS (NEFMC 2009c). The West Coast groundfish fishery experience was a valuable analogue to New England's groundfish fishery and offered an interesting comparison of the directions in which catch share design could be taken (NEFMC 2009c). Presentations from West Coast representatives stressed the notion that catch share programs were works in progress that needed to keep evolving to stay effective in achieving the fishery's objectives (NEFMC 2009c). What the evolution of Amendment 16 will look like in the future will remain to be seen.

This research was undertaken to attempt to better understand the design and use of catch share programs as a fisheries management tool. There remains uncertainty as to the full implications (both positive and negative) of this instrument. Therefore, this research sought to understand whether Councils as a management entity are learning through the development of these programs as to how to adapt the basic model to the specific needs of an individual fishery. Additionally, if Councils were determined to be learning, this research sought to understand the influences on the process of learning that brought knowledge, information, and experience to the program development. The understanding of the learning process was then used to inform the learning outcome in the actual catch share program design. This methodological framework was chosen to allow for the tracing of innovation in the use of this policy instrument to effectively reach management objectives through time. Detailed below are brief analyses on whether policy and instrumental learning were occurring and then synopses organized by learning process variable summarizing how each category of influence manifested in each of the four cases. Additionally, there is a summation of broad changes over time in the program design, gathered by analyzing the learning outcome across the four cases. Finally, there is a discussion of what the results of this multiple case study may mean for the future of catch shares.

7.1 | Occurrence of policy learning

This work examines learning in relation to the preference for catch shares as a management tool to meet various policy objectives. Policy learning and instrumental learning have occurred concurrently with respect to catch share management. For the purposes of this work, policy learning was defined as judgments made on the preference of a current course of action relative to alternative courses of action (May 1992). The evidence for policy learning lies in the reauthorizations of the MSFCMA and how the requirements specific to catch shares changed from 1976 to 2006 in terms of the guidance to Councils on the design and use of the management tool to most effectively meet the National Standards and fishery-specific objectives. In the original 1976 Act, the FCMA, market-based mechanisms were an allowed management tool for a Council to employ if it saw fit, but were not employed widely. The FCMA stated that these limited access systems could be used to address overfishing, overcrowding, or overcapitalization problems in a fishery (FCMA 1976). When developing a limited access system, the Act required that the program directly address economic efficiency (MAFMC 1990). Additionally, the FCMA mandated that Councils take into consideration the past and present participation in the fishery, dependence on the fishery, and the economic, social, and cultural characteristics of the fishery (NPFMC 1992).

The reauthorization of the FCMA in 1996 to the SFA incorporated significant changes to the policy in regards to the prescriptions on catch shares. Primarily, the Act prohibited the development and implementation of new IFQ programs until the completion of the study it commissioned with the NAS to analyze the policy instrument (NPFMC 2004a). The SFA also dictated that after the moratorium ended, new catch share programs would have to include provisions for procedural reviews and revisions and that Councils had to consider allocations for crew members in the design. The Act also required that the findings and recommendations of the NAS study be taken into account by Councils in the future development of catch share programs. The second reauthorization of the Act in 2006 to the MSFCMA represented another significant change in policy guidance relative to catch share management. The MSFCMA promoted the voluntary use of market-based mechanisms, or LAPPs, by Councils (Singer 2011). If LAPPs were chosen, the Act mandated that programs promote social and economic benefits, assist in the reduction of capacity in overcapitalized fisheries, and included provisions for a range of entities to be considered eligible to participate in a program, with a notable inclusion of processors (MSFCMA 2006). The Act also incorporates provisions for Councils to meet in the program design, including preventing excessive share holdings and creating a Limited Access Privilege Assisted Purchase Program if needed (MSFCMA 2006). Additionally, the 2006 Act diverged on some of its guidance for different regions with the inclusion of a referendum requirement for IFQ programs developed by the NEFMC and GMFMC (Holland and Wiersma 2010).

These incrementally more detailed policy prescriptions for the development of catch share programs in the changes of the Act have affected the latitude that a Council has in determining how to craft a catch share program and the guidelines on what elements Councils must consider when pursuing this management option. While the guidance has become more detailed over time as experience with the management strategy has accumulated, much of the guidance remains as advice to the Councils rather than direct mandates. The conclusions of numerous official analyses of catch share programs at the national level such as the 1999 NRC study recommended that catch shares remain a policy instrument individual Councils may choose to pursue and develop with considerable autonomy. The evaluation of this information at the national level is reflected in later additions to the collective federal guidance on catch shares in the 2010 NOAA Catch Share Policy, for example, that offer advice Councils may choose to follow without binding regulations. Across the three versions of the Act, the general judgment on catch shares in terms of the overall course of action has moved between indifference, disallowance, and cautious support, but ultimately the policy guidance simply became more detailed over time and the evidence for why is extensive in the official analyses of the accumulated experience

with the instrument at the national level. Policy learning, therefore, was fundamentally intertwined with the instrumental learning relative to catch share management that occurred with each successive program development.

7.2 | Cross-case patterns of instrumental learning

For the purposes of this work, instrumental learning was defined as lessons on the viability of a tool to meet existing goals more effectively than other tools (May 1992). The four cases analyzed were representative cases from the U.S. federal catch share program data set. The four catch share cases were examined to assess the occurrence of instrumental learning; the Atlantic Surf Clam and Ocean Quahog ITQ program, the Alaska Halibut and Sablefish IFQ program, the Bering Sea King and Tanner Crab Rationalization program, and the New England Multispecies Sectors program all demonstrated the occurrence of significant instrumental learning in the design and use of catch share programs. Each case was unique in that each catch share development process was shaped by different sources of information, knowledge, and experience and therefore resulted in a unique program design outcome. The development of each program is inextricably intertwined with the unique context within which it arose. It is for this reason that a case study approach was most suitable for this research, the boundaries between the 'phenomenon' (the catch share program) and the context were not always clear (Yin 2009). The cases do not represent replicates that can be compared across the variables to offer an estimation of which learning process variables more strongly affect the learning outcome variables for catch share programs as a whole. The suitable analyses of this data also do not center on comparing the four programs based on the learning outcome, instead the analyses that were carried out within each case study focus on understanding whether the presence or absence of particular program elements was appropriate or not based on the learning process of each Council. The general conclusions that can be drawn are whether there were overall patterns in the manifestation of each variable across cases and if there are general patterns in how the design of catch share programs has changed over time.

All six of the learning process variables; vertical diffusion, horizontal diffusion, problem severity, institutional capacity, industry buy-in, and contextual factors; are independent variables in this study that all contributed to the learning outcome. The original catch share program design was the dependent variable. These variables and the way in which they have been operationalized here do not generate quantifiable results; rather they offer qualitative results. Given this, it is difficult to analyze the results in a way that would explain which independent variable weighed more heavily on the dependent variable result. All variables played a role in each catch share program development, in different ways

across cases. Broad findings can be drawn from the cases that examine how each variable played into each catch share program development.

External learning process variables

Vertical diffusion

Different results for the vertical diffusion variable based on a significant time pattern was an independent variable postulated *a priori* to have a significant influence on the catch share outcome. It was hypothesized that the case learning outcomes would differ due to specific differences in the nature of the vertical diffusion influencing the learning process in each case. This would pertain to the various reauthorizations of the MSFCMA and other major federal policies pertaining to catch shares that intervened between cases. Both the Atlantic Surf Clam and Ocean Quahog ITQ program and the Alaskan Halibut and Sablefish IFQ program were implemented under the guidance of the 1976 FCMA. The FCMA contained provisions that allowed Councils to use limited access systems and the allocation of fishing privileges as fishery management tools (FCMA 1976). The MAFMC ultimately decided to pursue a program combining the two options into an ITQ system based on the guidance from NMFS in its oversight role for the Councils under the FCMA (MAFMC 1990). NMFS helped the MAFMC develop a program that would meet the FCMA National Standards in a balanced way. The Alaska Halibut and Sablefish IFQ program was also shaped significantly by NMFS in its role of approving or disapproving FMPs. NMFS gave the NPFMC guidance on instruments it should pursue to meet the fishery's objectives. For both case 1 and case 2, NMFS' interpretation of the FCMA in determining if Council actions appropriately met the federal policy was a dominant influence on each Council's learning process and therefore on how each catch share program developed. The outcomes of cases 1 and 2, however, are fundamentally different from each other and the design of case 2 is considered significantly more complex than case 1 (Anderson and Holliday 2007). Both were developed under the guidance of the same federal policy thus this argues that other variables must explain the differences.

The nature of the federal fisheries policy under the vertical diffusion variable changed for the Bering Sea King and Tanner Crab Rationalization program because the FCMA was reauthorized as the SFA in 1996 and the development of IFQ programs was placed under a moratorium. The crab program was fundamentally shaped by the changes to the policy that were incorporated in the SFA, predominantly the 1999 NRC study completed during the moratorium on the development of new catch share programs. The NRC report was a comprehensive examination of both what had been learned in the few catch share programs already implemented in the U.S. and in programs implemented by other

countries. Fisheries managers were then required to consider the findings and recommendations of the report in the development of subsequent catch share programs. This source of information along with the SFA implementation bore directly on several of the program elements that came out of the NPFMC's learning process for the Crab Rationalization (NPFMC 2004a). These included the processor quota element and the numerous community protection provisions. Case 3 is considered to be one of the most complex adaptations of catch share management and the amount of federal guidance on designing and using catch shares that came out of the NRC report could help explain this status. The final case, the New England Multispecies Sectors program, came after another change in the federal fisheries policy under the vertical diffusion variable. The fourth case was developed after the 2006 Reauthorization of the MSFMCA. It appears to be less of a direct product of the federal policy than the other three cases. This is because the sector program that was developed was determined to be neither an IFQ nor a LAPP so it effectively side-stepped the referendum requirements of the former and the general requirements of the latter, each of which were significant changes in the federal law with regard to catch share programs. The confusion on the legal definition of a LAPP also applied retroactively to the Crab Rationalization program with legal clarification put forth rather innocuously in a Federal Register notice (50 CFR Part 680).

The operationalization of the vertical diffusion variable was not limited to the MSFMCA. Case law guidance that came out of judicial challenges to previous catch share programs was influential in both the Halibut and Sablefish program and the Crab Rationalization program. This characteristic exemplifies that each catch share program development was intertwined with the programs that had been developed before it. Each new development had to contend with the perceptions of previous adoptions. Program development surpassed the boundaries of the Councils and managers often had to contend with the issues and controversies coming out of previous implementations. Other ways in which vertical diffusion impacted the development of the catch share programs examined here included more of the 'carrot' side of centralized government influence on fisheries management. One of the most dominant vertical diffusion sources influencing the NEFMC as it transitioned to catch shares in the groundfish fishery seems to be the pressure from NOAA directly on the Council sweetened with considerable federal funding to aid the Council in the program's development.

Horizontal diffusion

The horizontal diffusion of knowledge and information was a significant component of Council deliberations in developing each of the catch share programs analyzed here. This argues that

considerable instrumental learning did occur based on the inclusion of new information because direct ties can be made between the learning outcome of a program with components of the development process that included the full examination of the experiences of others in designing and using catch share mechanisms to meet specific objectives. In each of the four cases analyzed, the learning process directly tied to program elements in the outcome that were fundamentally shaped by the knowledge gained through examining the experiences of other Councils and other countries employing catch shares programs as a fisheries management tool. For many Councils, significant learning also occurred by fully analyzing its own previous experiments with catch shares. This analysis shows that the diffusion of lessons learned across Councils and countries was significant. The pattern of diffusion as it relates to the learning process appears to follow no particular spatial path but rather is linked to the similarity between previously transitioned fisheries and the fishery being considered for transition. For example, in the development of the Halibut and Sablefish IFQ program, similarities in the fishery product and market led the NPFMC to look to Canada's experience with developing IVQ programs for its sablefish longline and pot fisheries and its halibut longline fishery (NRC 1999).

In regards to the diffusion of knowledge and information from international policy peers, Canada and New Zealand stood out as the most frequent sources of experience Councils analyzed in developing each program. The Canadian catch share experience was analyzed in all four cases examined here while New Zealand's experience was taken advantage of significantly in all but the Crab Rationalization program case. Canada shares many of the same fisheries with the U.S. due to geographic proximity which potentially explains the preoccupation with learning from Canada in relation to the amount of other countries that employ catch shares in managing fisheries. New Zealand's role as a source of guidance in the development of U.S. catch share programs may stem from the expansive and comprehensive nature of New Zealand's fishery management policy, the QMS, which pulled all national fisheries under catch share management.

Each Council saw the benefit of using the experience of others to preempt problems by design, to understand the implications of transitioning to catch shares, and to garner the support of the industry by helping them better understand how they would be affected by such a management change. The earlier experiences of others also showed the potential negative repercussions that could come out of catch shares, which helped Councils attempt to design program elements in newer adaptations to address those issues. However, the acknowledgement of negative repercussions in past catch share developments may have also increased resistance or apprehension to transitioning to catch share management by both managers and industry participants. Facilitated by horizontal diffusion, later

Councils may have benefited from the learning lessons of earlier experiments with catch shares in being able to develop more complex programs that built off of the design elements and adaptations trail-blazed in previous implementations. Councils were significantly proactive in driving the horizontal diffusion process by seeking the advice of others that had experience with the development of catch share programs by bringing such individuals in to Council meetings to facilitate direct learning. The learning process for the Councils examined in these four cases was often not passive.

Internal learning process variables

Problem severity

In accordance with the extant literature on policy innovation, Council decisions to pursue management changes and a catch share option in particular were fundamentally driven by the nature and extent of the management problems. Examining commonalities in the nature of the problem severity variable for each of the four cases shows that each shared an overcapitalization problem that persisted and worsened under other regulatory systems. All cases with limited entry controls in the FMP saw how that management system encouraged the accumulation of capacity in the fisheries as participants exploited uncontrolled effort provisions. Overcapacity in each of the four cases led to an increasingly competitive race to fish and many of the other problems plaguing the fisheries were symptoms of that underlying policy problem. The race to fish spawned many other problems; the cases had a few or all of the following problems: safety issues, gear loss, ghost fishing, low product quality, administrative inefficiencies, dissipated profits, and low economic stability. Resource health problems were also factors in the problem severity variable for the Crab Rationalization program and for the Multispecies Sectors program to a significant degree. Overcapacity hindered rebuilding programs for most of the stocks under the crab FMP. Stock overexploitation was a massive concern for the Multispecies Sectors program and New England's transition to catch shares had the task of addressing considerable overcapacity problems and overexploitation problems. The halibut and sablefish resources in the Halibut and Sablefish IFQ program had been well managed under a TAC system, and the surf clam resource had been rebuilt under TAC management after previous overexploitation.

Institutional capacity

The operationalization of the institutional capacity variable in regards to the management provisions most basic to catch share programs had the most considerable influence on the cases. Each of the cases was shaped significantly by whether the fishery was managed already with a TAC and limited

entry provisions. The surf clam and ocean quahog fishery and the crab fishery had both elements, the halibut and sablefish fishery had only TAC management under the guidance of the IPHC, and the multispecies fishery had only limited entry. Lacking one of the elements meant there was an additional hurdle the respective Council had to meet in transitioning the fishery to catch share management. These provisions also were elements of the policy legacy in each fishery that influenced the learning process. The NEFMC had an especially difficult task contending with the policy legacy of the groundfish fishery that included the abject failure of previous attempts at TAC management specifically. Not all policy legacies were hindrances to the Councils, however. Considerable institutional capacity for the Crab Rationalization was available due to a design element incorporated in the Halibut and Sablefish IFQ program, the creation of the RAM Division, which acted as a management legacy for the NPFMC as a whole. Having this separate entity available to orchestrate and operate the allocations under a catch share program offered significant help to the NPFMC by reducing a large component of the administrative burden in adopting a catch share program, the initial allocation. In general, the data collection practices that had occurred in the fishery prior to rationalization also greatly influenced the type of initial allocation framework that could be designed during the development process. For example, the NPFMC did not have adequate data on crewmember participation in the halibut and sablefish fishery to realistically address the industry request to include this segment of the fishery in the initial allocation scheme.

Industry buy-in

The role of industry in driving and shaping the development process of each of the catch share programs was considerable. This was perhaps a function of the participatory nature of fisheries management with numerous official and unofficial avenues incorporating stakeholders into the policymaking process. Major industry involvement also supports the theory on effective common pool resource management which highlights the importance of stakeholder participation to preempt problems and conflicts (Ostrom et al. 1992). The notable sway that industry members held with the development of each of these programs may also reflect the nature of catch shares as an optional management tool that managers and industry participants must evaluate on whether it is the right tool to implement to meet that fishery's unique needs (MAFMC 1990). The role of industry in fisheries management may demonstrate the importance of reinventing the catch share development process in each case as a critical component of learning, that both the Council and the relevant stakeholders must concurrently learn in regards to the preference for catch shares as a management alternative. Industry

concerns about how transitioning to catch shares would affect them most intensely played out in the development of the initial allocation framework for each case.

In all four cases, the development of the catch share program had to balance the often competing interests of different industry groups, especially between newer and more established participants. Most of the cases were also influenced by industry input that was born from dissatisfaction held by industry members in other fisheries that had previously transitioned to catch share programs. With these concerns made valid by the experiences of other fisheries, many industry members were proactive in influencing the policymaking process. In the Halibut and Sablefish IFQ program and the Multispecies Sectors program, industry representatives initiated certain components of the development process by bringing proposals for management alternatives to their respective Councils. The development of the Crab Rationalization program also included industry members designing potential management options to bring to the Council in the initiation of the consideration of management changes. The New England groundfish fishery program was dominantly guided by industry participation in the process of development; the industry often took matters into its own hands and ultimately drove the development process towards the expansion of the sector program by bringing a critical mass of industry members to agreement on the solution that would be sought.

Contextual factors

Each of the catch share programs examined in this analysis is fundamentally a function of its context in terms of the ecological, economic, and social characteristics of the fishery and its participants. The development process and outcome of each program is intertwined with the unique attributes of each case, and the characteristics vary significantly across cases. The fisheries examined here include a variety in the types of species harvested, the gear used to harvest, the type of participants, the type of vessels used, the interplay with other fisheries, and the cultural fabric of the fishery. Due to the nature of catch shares as a highly malleable management tool for the needs of different Councils, each program was developed to recognize the needs of each fishery and often to support the protection of much of the traditional features. Several of the cases examined had some type of community concern that played into the development process such as sensitive coastal Alaskan communities in the Crab Rationalization and the venerable cultural spirit of New England groundfish fishermen in the Multispecies Sectors program. How each Council addressed these matters in developing the programs varied, and each program reflects a different balance of goals specific to each fishery.

7.3 | Patterns in the learning outcome

By analyzing the program designs as catalogued in the learning outcomes for each of the cases, some general patterns in relation to program elements emerged. These patterns do not reflect a standardization of design over time such that learning has resulted in the zeroing in on one preferable catch share program design over another. Rather the general patterns relate to how the application of catch shares to fisheries has changed over time along with the complexity of the programs. In analyzing the results of the management unit variable in the learning outcome, it is seen that the first two cases, the Atlantic Surf Clam and Ocean Quahog ITQ program and the Alaska Halibut and Sablefish IFQ program, were developed for fisheries focusing on two species only. The Crab Rationalization program applied to a fishery focused on five different species of crab with several distinct populations. The New England Multispecies Sectors program applied to a fishery for a stock complex with fifteen species and many divided into multiple populations. While these results do not suggest that over time catch shares are always applied to multispecies fisheries, it demonstrates that the type of catch share programs developed over time has changed with programs now being adapted to more complex fisheries.

Additionally, by analyzing the initial eligibility and subsequent eligibility variables in the learning outcome across the four cases, it is observed that the type of entities that are able to receive or hold privileges and shares has diversified. The Surf Clam and Ocean Quahog program initially allocated privileges to only vessel owners, the Halibut and Sablefish program also initially allocated shares to only vessel owners, but also allowed shares to be held by communities through the CDQ program. The Crab Rationalization program design was an expansion of the allocation framework relative to those of the first two cases; it incorporated a share class for eligible skippers and crewmembers in the initial allocation framework and created a separate share type for processors. The New England Sectors program allowed states to hold privileges in a permit bank system. Observing this pattern of change across the four cases also demonstrates that over time catch share programs are as a whole incorporating a greater diversity of stakeholders in the privilege allocation framework. While the pattern is not cumulative in that each successive program does not incorporate allocations to all of the entities designated in the previous programs, the pattern shows that the pool of potential privilege holders or ‘winners’ in the allocation decision is diversifying and expanding over time.

A potential explanation for these patterns in program design is that the collective learning process of Councils developing the various catch share programs has occurred based on the concept of building blocks or the accumulation of learning lessons. This theory would argue that the earlier program developments provided necessary building blocks by designing simple programs that later

Councils could adapt and expand. Each catch share program development added new building blocks or learning lessons with unique program design provisions to the collective pool of experience. These building blocks in design could have allowed later Councils to innovate in increasingly more complex ways because overall there was more from which to learn.

An interesting find in analyzing the learning outcomes across cases was that one variable in the learning outcome of each of the cases, consolidation controls, failed to show a discernible pattern and remains a difficult component of the program design for Councils to develop. Consolidation in general has long been one of the most contentious and criticized implications of catch share programs (NRC 1999). The consolidation control variable partially represents the fundamental balance in program design Councils must find between economic efficiency and social equity. The balance has resulted in a different collection of transferability provisions, community protection elements, ownership caps, and other program elements between each of the four cases. The Alaska Halibut and Sablefish IFQ program and the Bering Sea Crab Rationalization program included considerable program controls that limited transferability and capped ownership to prevent excess consolidation as well as other program elements to help protect social equity. Both the Atlantic Surf Clam and Ocean Quahog ITQ program and the New England Multispecies Sectors program had no tangible controls on consolidation in the program outcome, arguably best facilitating gains in efficiency as a primary objective. The MAFMC has struggled with retroactively addressing the issue of consolidation and balancing efficiency and equity in the Surf Clam and Ocean Quahog program for several years (NOAA Fisheries Service Office of Policy 2009a). The implications of the lack of consolidation provisions in the New England groundfish fishery program may or may not be seen in the coming years as the program continues to settle in. Ultimately though, each program design can only be measured against its effectiveness in achieving the objectives of each fishery, which may reflect different priorities.

7.4 | **Conclusions**

This research aims to address a void in the understanding of the use of catch shares as a management tool in fisheries management. Significant information exists on the make-up of individual programs and the post-implementation effects, put forth by Councils and others. However, this only represents a portion of the knowledge that can be gained from these programs. A Council considering transitioning a fishery to catch share management must understand why a previous Council arrived at the design it did and why certain program elements were designed as they were to understand the applicability of components of existing programs to its own needs. Shortcuts in the design process

cannot be taken if the program is to be successful in meeting the management objectives. The adoption of innovations in one fishery that were developed in the context of another fishery may be misaligned if the adopting Council lacks knowledge of the previous context (Neustadt and May 1986). This issue is problematic in all public policy innovation and diffusion, but is especially problematic in fisheries due to the highly integrated nature of catch share programs within the context of the fishery. Without this understanding, Councils may unwisely develop a program that is not best suited to the fishery's needs or perpetuate mistaken management decisions.

This analysis has demonstrated the significant extent of the horizontal diffusion of knowledge and experience that has helped guide Councils in developing catch share programs. A detailed analysis of previous learning processes can help make certain that subsequent applications of this management tool are effective. There has been significant interest in facilitating the diffusion of learning lessons based on experiences with the design and use of catch shares as evidenced by the numerous case study compilations of various existing programs (i.e. the 1999 NRC report, 2007 NOAA Technical Memorandum, and numerous NGO publications³⁷). Additionally, the NOAA Catch Share Task Force that was created to draft the 2010 NOAA Catch Share Policy created a "catch shares" website linked to the NMFS home page that it sought to use as a clearinghouse for information on the management tool. This portal could be potentially expanded with the inclusion of direct information from each Council relaying its experiences in the development of these program adaptations.

If it is true that to know the future, the past must be understood then insight into the history of catch shares in federal fisheries management can help fisheries managers better understand the applicability of this management tool to the needs of various fisheries. Additionally, comprehending how and why the existing catch share programs were developed offers advice on how to best design program elements to meet specific fishery objectives. The decision is not just one to choose catch shares as the preferable tool but is also how to structure the program, a process that must be fully vetted in each potential fishery and adapted to that fishery's context. As a management tool, catch shares are not one size fits all (NEFMC 2009c). And design matters considerably. The generalizability of whole catch share programs may be low, but there is a strong potential to adapt specific program elements to subsequent fisheries, which demands a solid understanding of why individual elements were developed in the first place, what ends they were intended to meet, and what their success in doing so has been.

³⁷ Including the 2007 Ecotrust report, "Market Design for Limited Access Privilege Programs in U.S. Fisheries"; and the 2010 EDF report, "Catch Share Design Manual: A Guide for Managers and Fishermen"

The benefits and costs of catch shares are still being weighed in the debate over the design of individual programs. In looking at the four cases examined here along a temporal trajectory, learning in many different manners can be documented rather extensively. Each catch share program adoption is a milestone and it can be seen that the nature of the fisheries that catch share tools are being applied to is diversifying over time. Macinko and Whitmore (2009) contend that the movement towards catch share management is reaching a crescendo. For example, during the time of the development of the Halibut and Sablefish program, crafting a catch share program for a multispecies fishery was considered a daunting task that at the time was insurmountable (Pautzke and Oliver 1997). Developing comprehensive multispecies catch share programs added significant controversy to the national debate on the merits of catch share programs (Fina 2011). However, two decades after the first U.S. experiment with catch share management in federal fisheries, a catch share program was implemented for the New England multispecies groundfish fishery and the West Coast groundfish fishery.

It is possible that early program implementations provided the building blocks necessary for later Councils to be able to develop more complex adaptations, especially within the tightening restrictions of time and money each Council now feels. Taking full advantage of learning opportunities from previous catch share program experiments may have allowed Councils to continue to innovate in the design of catch share programs and locally adapt them. Two decades has seen six out of the eight Regional Councils adopt a catch share program in at least one of its fisheries. On the national stage, four catch share programs were implemented from 1990-1995 while nine were adopted from 2005-2011. Additionally, while catch share programs began in the U.S. as policy experiments by individual Councils, nationally NOAA has since developed the Catch Share Task Force that created the NOAA Catch Share Policy released in 2010. Budget requests for FY2012 include funding requests for a potential new budget line, the National Catch Share Program (NOAA FY 2012 President's Budget).

Catch share programs should not be the product of a black box. Fisheries policy, as with most fields of public policy, is constantly changing and hopefully adapting to best facilitate the achievement of the policy objectives. Catch shares are a tool in the toolbox of instruments in fisheries management that may be appropriate for some fisheries, but not all. A solid understanding of how individual programs develop can lend insight into why programs look the way they do and therefore help inform the development of later programs. The four programs examined here are not static, each has changed since implementation and must continue to change and adapt to the fishery it manages to stay effective. Therefore, the learning process for each Council in understanding how best to utilize catch share mechanisms for its needs does not end with the implementation of a program, each Council will

continue to evaluate the program's operation to ensure that the program continues to be the most favorable plan of action to meet the fishery's objectives.

The development of a catch share program is not an easy process for an individual Council. The controversy-laden task takes Councils several years and significant investments of time and money. Each later adopting Council must not only address the unique needs of the fishery selected for transition but also contend with the contribution of previous adoptions to the national dialogue about the management tool. The spread of catch share program management has created an effect in many other fisheries of a speculative value for catch history for example (Hartley and Fina 2001). Additionally, even the choice to consider developing a catch share program for a fishery can make the existing problems worse due to speculative behavior (Pautzke and Oliver 1997). Experience with earlier programs led to national concerns about the distributional implications of catch share management and later rationalization attempts have continuously had to overcome these obstacles (Matulich and Clark 2001). New problems have also surfaced that catch share programs must contend with, such as how program elements including ownership caps can be undermined by the creative business arrangements of industry participants (Bromley and Macinko 2007).

The stakes are high. Increasing attention on the health of our oceans and its resources is being brought on the national stage; the long-term sustainability of key fish stocks and the way of life dependent on them remain issues fisheries managers must continually attempt to tackle. Catch shares are a management tool that may be suited to address some fisheries management problems, but are not a silver bullet for all fisheries. Understanding where and when catch shares may be the most appropriate management alternative is critical to achieving management success. Significant learning has occurred on the appropriateness of this management tool and on how best to design individual programs to effectively meet management objectives. Learning must continue as each program is not static and must adapt alongside the fishery to which it is applied. Additionally, learning must continue as managers determine the full potential of catch shares as an effective management tool in the fisheries management toolbox. Continuing this research by expanding the analysis to all fifteen of the existing federal catch share programs could inform this task. Each offers something unique to the national clearinghouse of catch share programs, the four cases analyzed here have offered significant insight but only encompass a few pieces of the puzzle. Understanding the collective experience of all federal catch share programs would give fisheries managers valuable information and knowledge as the management toolbox continues to be refined.

References

- Abott, J.K., B. Garber-Yonts, & J.E. Wilen. 2010. Employment and Remuneration Effects of IFQs in the Bering Sea/Aleutian Islands Crab Fisheries. *Marine Resource Economics* **25**(4): 333-354.
- Acheson, J.M. & R.S. Steneck. 1997. Bust and Then Boom in the Maine Lobster Industry: Perspectives of Fishers and Biologists. *North American Journal of Fisheries Management* **17**: 826-847.
- Alcock, F. 2002. Bargaining, Uncertainty, and Property Rights in Fisheries. *World Politics* **54**(4): 437-461.
- Allen, R.B. 2005. How Legislated Criteria for Individual Transferable Quotas Could Defeat the Purpose of Transforming Fishermen from the Fox Raiding the Henhouse into the Farmer Guarding the Henhouse. In Managing Our Nation's Fisheries II: Focus on the Future. Proceedings on a Conference on Fisheries Management in the United States. Washington, D.C.
- Alliance Against IFQs v. Brown, 84 F.3d 343 (1996).
- Anderson, L.G. & M.C. Holliday (Eds.). 2007. The Design and Use of Limited Access Privilege Programs. NOAA Technical Memorandum. NOAA Fisheries Service Office of Policy. Silver Spring, MD.
- Arnason, R., R. Hannesson, & W.E. Schrank. 2000. Costs of Fisheries Management: the Cases of Iceland, Norway, and Newfoundland. *Marine Policy* **24**(3): 233-243.
- Bacot, A. H. & R.A. Dawes. 1996. Responses to Federal Devolution: Measuring State Environmental Efforts. *State and Local Government Review* **28**: 124-135.
- Barrow, J., G.E. Jefferson, M.D. Eagles, & G.J. Stevens. 2003. Allocation of Harvesting Rights in Three Atlantic Canada Marine Fisheries. In R. Shotton (Ed.), Case Studies on the Allocation of Transferable Quota Rights in Fisheries. *FAO Fisheries Technical Paper*. No. 411. Pp. 32-58. Rome, FAO.
- Beddington, J.R., D.J. Agnew, & C.W. Clark. 2007. Current Problems in the Management of Marine Fisheries. *Science* **316**: 1713-1716.
- Beem, B.E. 2005. Fisheries Policy Learning: The Interplay of Institutions, Interests, and Information. Doctoral dissertation, Department of Political Science, University of Washington.
- Beem, B.E. 2006. Planning to Learn: Blue Crab Policymaking in the Chesapeake Bay. *Coastal Management* **34**: 167-182.
- Bennett, C.J. & M. Howlett. 1992. The Lessons of Learning: Reconciling Theories of Policy Learning and Policy Change. *Policy Sciences* **25**: 275-294.
- Bess, R. 2004. Expanding New Zealand's Quota Management System. *Marine Policy* **29**: 339-347.
- Berkes, F., T.P. Hughes, R.S. Steneck, J.A. Wilson, D.R. Bellwood, B. Crona, C. Folke, L.H. Gunderson, H.M. Leslie, J. Norberg, M. Nyström, P. Olsson, H. Österblom, M. Scheffer, & B. Worm. 2006. Globalization, Roving Bandits, and Marine Resources. *Science* **311**: 1557-1560.

- Black, N.D. 1996. Balancing the Advantage of Individual Transferable Quotas Against Their Redistributive Effects: The Case of *Alliance Against IFQs v. Brown*. *The Georgetown International Environmental Law Review* **9**: 727-746.
- Boehmke, F. J. & R. Witmer. 2004. Disentangling Diffusion: The Effects of Social Learning and Economic Competition on State Policy Innovation and Expansion. *Political Research Quarterly* **57**: 39-51.
- Bonzon, K., K. McIlwain, C.K. Strauss, & T.V. Leuvan. 2010. Catch Share Design Manual: A Guide for Managers and Fishermen. Environmental Defense Fund. New York, NY.
- Boyd, R.O. & C.M. Dewees. 1992. Putting Theory into Practice: Individual Transferable Quotas in New Zealand's Fisheries. *Society and Natural Resources* **5**: 179-198.
- Brewer, J.F. 2011. Paper Fish and Policy Conflict: Catch Shares and Ecosystem-Based Management in Maine's Groundfishery. *Ecology and Society* **16**(1): 15-39.
- Brody, S.D., S. Zahran, W.E. Highfield, S.P. Bernhardt, & A. Vedlitz. 2009. Policy Learning for Flood Mitigation: A Longitudinal Assessment of the Community Rating System in Florida. *Risk Analysis* **29**(6): 912-930.
- Bromley, D.W. & S. Macinko. 2007. Rethinking Fisheries Policy in Alaska: Options for the Future. Prepared at the request of the Alaska Department of Fish and Game. Juneau, AK.
- Brooks, S.M. 2005. Interdependent and Domestic Foundations of Policy Change: The Diffusion of Pension Privatization around the World. *International Studies Quarterly* **49**: 273-294.
- Brown, G.M. 2000. Renewable Natural Resource Management and Use Without Markets. *Journal of Economic Literature* **XXXVIII**: 875-914.
- Busenberg, G.J. 2000. Innovation, Learning, and Policy Evolution in Hazardous Systems. *American Behavioral Scientist* **44**: 679-693.
- Busenberg, G.J. 2001. Learning in Organizations and Public Policy. *Journal of Public Policy* **21**(2): 173-189.
- Copes, P. 1986. A Critical Review of the Individual Quota as a Device in Fisheries Management. *Land Economics* **62**(3): 278-291.
- Copes, P. & A. Charles. 2004. Socioeconomics of Individual Transferable Quotas and Community-Based Fishery Management. *Agricultural and Resource Economics* **33**(2): 171-181.
- Costello, C., S.D. Gaines, & J. Lynham. 2008. Can Catch Shares Prevent Fisheries Collapse? *Science* **321**: 1678-1683.
- Creed, C.F. 1991. Cutting Up the Pie: Private Moves and Public Debates in the Social Construction of a Fishery. Doctoral dissertation, Department of Anthropology, Rutgers the State University of New Jersey.
- Criddle, K.R., & S. Macinko. 2000. A Requiem for the IFQ in US Fisheries? *Marine Policy* **24**: 461-469.

- Daley, D. M. & J.C. Garand. 2005. Horizontal Diffusion, Vertical Diffusion, and Internal Pressure in State Environmental Policymaking, 1989-1998. *American Politics Research* **33**: 615-644.
- Davidse, W.P. 2001. The Effects of Transferable Property Rights on the Fleet Capacity and Ownership of Harvesting Rights in the Dutch Demersal North Sea Fisheries. In R. Shotton (Ed.). Case Studies on the Effects of Transferable Fishing Rights on Fleet Capacity and Concentration of Quota Ownership. *FAO Fisheries Technical Paper*. No. 412. Pp. 15-61. Rome, FAO.
- Dawson, R. 2006. Vertical Integration in the Post-IFQ Halibut Fishery. *Marine Policy* **30**(4): 341-346.
- Dolšak, N. 2007. Tradable Permits for Common-Pool Resources: An Assessment. *Review of Policy Research* **24**(6): 541- 565.
- Dolšak, N. & K. Sampson. 2011. Diffusion of Market Instruments: The Case of Air Pollution. *Administration and Society*. DOI: 10.1177/0095399711400047.
- Ecotrust. 2007. Market Design for Limited Access Privileges Programs in U.S. Fisheries. Proceedings of a workshop organized by Ecotrust. Ecotrust Working Paper Series No. 4. Portland, OR.
- Exec. Order No. 12291, 3 C.F.R. 1981 (1981).
- Eythórsson, E. 2003. Stakeholders, Courts, and Communities: Individual Transferable Quotas in Icelandic Fisheries, 1991-2001. In N. Dolšak & E. Ostrom (Eds.). The Commons in the New Millennium: Challenges and Adaptation. Cambridge, MA: The MIT Press.
- Fina, M. 2003. Development of Rationalization Programs in the North Pacific Groundfish and Crab Fisheries. Paper prepared for presentation at the National Fishery Law Symposium, University of Washington School of Law, Seattle, WA. Oct. 23-24, 2003.
- . 2005. Rationalization of the Bering Sea and Aleutian Islands Crab Fisheries. *Marine Policy* **29**(4): 311-322.
- . 2011. Evolution of Catch Share Management: Lessons from Catch Share Management in the North Pacific. *Fisheries* **36**(4): 164-177.
- Fisheries Conservation and Management Act of 1976, Pub. L. No. 94-265, 16 U.S.C. 1831 (1976).
- Floharty, D. 1995. Magnuson Fishery Management and Conservation Act Reauthorization and Fishery Management Needs in the North Pacific Region. *Tulane Environmental Law Journal* **9**: 301-328.
- Ginter, J.J.C. & B. Muse. 2002. Rights-Based Fishery Management Systems in Marine Fisheries off Alaska. In Proceedings of the Eleventh Biennial Conference of the International Institute of Fisheries Economics & Trade: Fisheries in the Global Economy, Theme H: Future Paths for Rights Based Fisheries Management. Wellington, NZ. August 19-22, 2002.
- Gordon, H.S. 1954. The Economic Theory of a Common-Property Resource: the Fishery. *The Journal of Political Economy* **62**(2): 124-142.

- Grossback, L.J., S. Nicholson-Crotty, & D.A.M. Peterson. 2004. Ideology and Learning in Policy Diffusion. *American Politics Research* **32**: 521-547.
- Guyader, O. & O. Thébaud. 2001. Distributional Issues in the Operation of Rights-Based Fisheries Management Systems. *Marine Policy* **25**: 103-112.
- Hakim, C. 2000. Research Design: Successful Designs for Social and Economic Research. New York, NY: Routledge.
- Hardin, G. 1968. The Tragedy of the Commons. *Science* **162**: 1243-1248.
- Hartley, M. & M. Fina. 2001. Allocation of Individual Vessel Quota in the Alaskan Pacific Halibut and Sablefish Fisheries. In R. Shotton (Ed.). Case Studies on the Allocation of Transferable Quota Rights in Fisheries. *FAO Fisheries Technical Paper*. No. 411. Pp. 251-265. Rome, FAO.
- Hilborn, R., A.E. Punt, & J. Orensanz. 2004. Beyond Band-Aids in Fisheries Management: Fixing World Fisheries. *Bulletin of Marine Science* **74**(3): 493-507.
- Holland, D.S. 2007. Community-Based Sectors for the New England Groundfish Fishery. Final Report Submitted to NEFSC. Gulf of Maine Research Institute, Portland, ME.
- Holland, D.S. & J.J.C. Ginter. 2001. Common Property Institutions in the Alaskan Groundfish Fisheries. *Marine Policy* **25**: 33-42.
- Holland, D.S. & J. Wiersma. 2010. Free Form Property Rights for Fisheries: the Decentralized Design of Rights-Based Management through Groundfish "Sectors" in New England. *Marine Policy* **34**: 1076-1081.
- Holland, D.S., P. Pinto da Silva, & J. Wiersma. 2010. A Survey of Social Capital and Attitudes toward Management in the New England Groundfish Fishery. NEFSC Reference Document 10-12. NMFS, Woods Hole, MA.
- Huppert, D. 2005. An Overview of Fishing Rights. *Reviews in Fish Biology and Fisheries* **15**: 201-215.
- Kirman, A. & M. Salmon (Eds.). 1995. Learning and Rationality in Economics. Oxford: Blackwell.
- Kitts, A.W. & S.F. Edwards. 2003. Cooperatives in US Fisheries: Realizing the Potential of the Fishermen's Collective Marketing Act. *Marine Policy* **27**(5): 357-366.
- Larkin, S.L. & J.W. Milon. 2000. Tradable Effort Permits: A Case Study of the Florida Spiny Lobster Trap Certificate Program. IIFET Microbehavior and Macroresults, Oregon State University, Corvallis, OR.
- Litz, F.T. 1994. Harnessing Market Forces in Natural Resources Management: Lessons from the Surf Clam Fishery. *Boston College Environmental Affairs Law Review* **21**(2): 335-361.
- Lovrich, G.A. & B. Sainte-Marie. 1997. Cannibalism in the Snow Crab, *Chionoecetes opilio* (O. Fabricius) (Brachyura: Majoidae), and Its Potential Importance to Recruitment. *Journal of Experimental Marine Biology and Ecology* **211**: 225-245.

- Macinko, S. 2005. In Search of Transition, Community, and a New Federalism: Six Questions to Confront on the Road towards a National Policy on Dedicated Access Privileges. In Managing Our Nation's Fisheries II: Focus on the Future. Proceedings on a Conference on Fisheries Management in the United States. Washington, D.C.
- Macinko, S. & W. Whitmore. 2009. A New England Dilemma: Thinking Sectors Through. Final Report to Massachusetts Division of Marine Fisheries. Boston, MA.
- Magnuson-Stevens Fishery Conservation and Management Act of 1976, 16 U.S.C. 1801 (2006).
- Mansfield, B. 2004. Neoliberalism in the Oceans: "Rationalization," Property Rights, and the Commons Question. *Geoforum* **35**: 313-326.
- Marvin, K.A. 1992. Protecting Common Property Resources through the Marketplace: Individual Transferable Quotas for Surf Clams and Ocean Quahogs. *Vermont Law Review* **16**: 1127-1170.
- May, P.J. 1992. Policy Learning and Failure. *Journal of Public Policy* **12**(4): 331-354.
- McCay, B.J. 2001. Initial Allocation of Individual Transferable Quotas in the US Surf Clam and Ocean Quahog Fishery. In R. Shotton (Ed.). Case Studies on the Allocation of Transferable Quota Rights in Fisheries. *FAO Fisheries Technical Paper*. No. 411. Pp. 86-90. Rome, FAO.
- McCay, B.J. & S. Brandt. 2001. Changes in Fleet Capacity and Ownership of Harvesting Rights in the United States Surf Clam and Ocean Quahog Fishery. In R. Shotton (Ed.). Case Studies on the Effects of Transferable Fishing Rights on Fleet Capacity and Concentration of Quota Ownership. *FAO Fisheries Technical Paper*. No. 412. Pp. 44-60. Rome, FAO.
- McCracken, J., M. Fina, & K. Roberts. 2005. Establishing Criteria for IFQ Programs. In Managing Our Nation's Fisheries II: Focus on the Future. Proceedings on a Conference on Fisheries Management in the United States. Washington, D.C.
- Melnychuk, M.C., T.E. Essington, T.A. Branch, S.S. Heppell, O.P. Jensen, J.S. Link, S.J.D. Martell, A.M. Parma, J.G. Pope, & A.D.M. Smith. 2011. Can Catch Share Fisheries Better Track Management Targets? *Fish and Fisheries*. DOI: 10.1111/j.1467-2979.2011.00429.x
- Meridian Institute & MRAG Americas, Inc. 2010. Catch Shares in New England: Key Questions and Lessons Learned from Existing Programs. Essex, MA.
- MAFMC (Mid-Atlantic Fishery Management Council) in cooperation with the National Marine Fisheries Service and the New England Fisheries Management Council. 1990. Amendment 8 Fishery Management Plan for the Atlantic Surf Clam and Ocean Quahog Fishery. Dover, DE.
- . 2010. Overview of the Surfclam and Ocean Quahog Fisheries and Quota Considerations for 2011, 2012, 2013. Dover, DE.
- NMFS (National Marine Fisheries Service). 1996. The Surf Clam ITQ Management: An Evaluation. Northeast Spotlight Article. In A. Gautam, M. Holliday, & R. Lent (Eds.). Our Living Oceans: the Economic Status of U.S. Fisheries. Pp. 125-128. Silver Spring, MD.

NMFS in cooperation with Restricted Access Management. 2011. Bering Sea and Aleutian Islands Crab Rationalization Report: Fishing Year 2010/11. NMFS, Alaska Region.

----- . 2012. Fishing Year 2012 Northeast Multispecies Sector Operations Plans and Contracts Draft Environmental Assessment. NOAA Fisheries Service: Northeast Regional Office, Gloucester, MA.

NOAA (National Oceanic and Atmospheric Administration). 2010. NOAA Catch Share Policy. Silver Spring, MD.

----- . FY 2012 President's Budget. Budget Activity: National Marine Fisheries Service.
http://www.corporateservices.noaa.gov/~nbo/12bluebook_highlights.html

NOAA Fisheries Service. 2011. Status of Stocks: 2010 Report on the Status of U.S. Fisheries. Silver Spring, MD.

NOAA Fisheries Service Office of Policy. 2009a. Catch Share Spotlight No. 8. Surf Clam and Ocean Quahog ITQ.

----- . 2009b. Catch Share Spotlight No. 1. Alaska IFQ halibut and sablefish program.

----- . 2009c. Catch Share Spotlight No. 4. Bering Sea & Aleutian Islands (BSAI) Crab (King & Tanner) Rationalization Program.

----- . 2010. Catch Share Spotlight No. 16. Northeast Multispecies Sectors.

NRC (National Research Council). 1999. Sharing the Fish: Toward a National Policy on Individual Fishing Quotas. Washington, D.C: National Academy Press.

NEFMC (New England Fishery Management Council). 1994. Amendment 5 to the Northeast Multispecies FMP. Newburyport, MA.

----- . 2009a. Amendment 16 to the Northeast Multispecies FMP. Newburyport, MA.

----- . 2009b. Public Hearing Document: Draft Amendment 16 to the Northeast Multispecies Fishery Management Plan. Newburyport, MA.

----- . 2009c. New England Catch Shares Workshop Summary Report. Fisheries Leadership and Sustainability Forum. Bretton Woods, NH.

NEFMC in cooperation with the National Marine Fisheries Service. 2003. Supplemental Environmental Impact Statement for Amendment 13 to the Northeast Multispecies FMP. Newburyport, MA.

----- . 2004. Results of the FRFA for Amendment 13 to the New England Multispecies Fishery. Newburyport, MA.

----- . 2008. Amendment 16 to the Northeast Multispecies Fishery Management Plan Draft Environmental Impact Statement. Newburyport, MA.

- Neustadt, R.E. & E. May. 1986. Thinking in Time, the Uses of History for Decision Makers. New York, NY: Free Press.
- NPFMC. 2003. Appendix 2-6: Review of Rationalization Programs. In Regulatory Impact Review Appendix 1: Summary of Ad Hoc Committee, Crab Rationalization Committee, Advisory Panel, and Council Efforts on Crab Rationalization. Anchorage, AK.
- . 2011a. Fishery Management Plan for Groundfish of the Bering Sea and Aleutian Islands Management Area. Anchorage, AK.
- . 2011b. Fishery Management Plan for the Bering Sea/Aleutian Islands King and Tanner Crabs. Anchorage, AK.
- NPFMC (North Pacific Fishery Management Council) in cooperation with the National Marine Fisheries Service. 1992. Final Supplemental Environmental Impact Statement/Environmental Impact Statement for the Individual Fishing Quota Management Alternative for Fixed Gear Sablefish and Halibut Fisheries: Gulf of Alaska and Bering Sea/Aleutian Islands. Anchorage, AK.
- . 2004a. Final Environmental Impact Statement for the Bering Sea/Aleutian Islands Crab Fisheries. Anchorage, AK.
- . 2004b. Regulatory Impact Review/Initial Regulatory Flexibility Analysis: Voluntary Three-Pie Cooperative Program for the Bering Sea and Aleutian Islands Crab Fisheries. Appendix 1. Anchorage, AK.
- . 2005. Final Regulatory Flexibility Analysis for the Crab Rationalization Program for the Bering Sea and Aleutian Islands King and Tanner Crabs. Anchorage, AK.
- North Pacific Halibut Act of 1924, Pub. L. No. 97-176, 16 U.S.C. 773 (1982).
- Ohashi, T. 2010. Challenges Faced by the U.S. Fishery Policy in Overcoming Overfishing in Federally Managed Waters: Shifting from Traditional to Responsible Fishery Management for Sustainable Seafood. *The Japanese Journal of American Studies* **21**: 189-210.
- Okey, T.A. 2003. Membership of the Eight Regional Fishery Management Councils in the United States: Are Special Interests Over-Represented? *Marine Policy* **27**: 193-206.
- Ostrom, E. 1992. The Rudiments of a Theory of the Origins, Survival, and Performance of Common-Property Institutions. In D.W. Bromley (Ed.). Making the Commons Work: Theory, Practice, and Policy. pp 293-318. San Francisco, CA: ICS Press.
- Ostrom, E., J. Burger, C.B. Field, R.B. Norgaard, & D. Policansky. 1999. Revisiting the Commons: Local Lessons, Global Challenges. *Science* **284**(4512): 278-282.
- Ostrom, E., J. Walker, & R. Gardner. 1992. Covenants With and Without a Sword: Self-Governance is Possible. *The American Political Science Review* **86**(2): 404-417.

- Pautzke, C.G. & C.W. Oliver. 1997. Development of the Individual Fishing Quota Program for Sablefish and Halibut Longline Fisheries off Alaska. Presented to the National Research Council's Committee to Review Individual Fishing Quotas. September 4, 1997. Anchorage, Alaska.
- Pooley, S.G. 1998. Issues and Options in Designing and Implementing Limited Access Programs in Marine Fisheries. NOAA Technical Memorandum. In collaboration with the NMFS Limited Access Working Group. Silver Spring, MD.
- Potoski, M., & A. Prakash. 2004. The Regulation Dilemma: Cooperation and Conflict in Environmental Governance. *Public Administration Review* **64**: 137-148.
- Ragin, C.C. 2004. Turning the Tables: How Case-Oriented Research Challenges Variable-Oriented Research. In H. E. Brady & D. Collier (Eds.). Rethinking Social Inquiry: Diverse Tools, Shared Standards. pp. 123-138. Lanham, MD: Rowman & Littlefield Publishers, Inc.
- Rincke, J. 2004. Neighborhood Effects in the Diffusion of Policy Innovations- Evidence from Charter School Legislation in the U.S. Manuscript retrieved online at: http://cournot2.u-strasbg.fr/sew/papers_sew/Johannes_Rincke.pdf.
- Rogers, E. M. 1995. Diffusion of innovations (4th ed.). New York, NY: Free Press.
- Rose, R. 1991. What is Lesson-Drawing? *Journal of Public Policy* **11**: 3-30.
- Sabatier, P.A. 1988. An Advocacy Coalition Framework of Policy Change and the Role of Policy-Oriented Learning Therein. *Policy Science* **21**: 129-168.
- Sanchirico, J.N., D. Holland, K. Quigley, & M. Fina. 2005. Catch-Quota Balancing in Multispecies Individual Fishing Quotas. Resources for the Future. Discussion Paper 05-54. Washington, D.C.
- Sapat, A. 2004. Devolution and Innovation: The Adoption of State Environmental Policy Innovations by Administrative Agencies. *Public Administration Review* **64**(2): 141-151.
- Schikler, P. 2008. Has Congress Made it Harder to Save the Fish? An Analysis of the Limited Access Provisions of the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006. *New York University of Environmental Law Journal* **17**: 908-935.
- Singer, L.T. 2011. The Development of Catch Shares: Lessons Learned from New England. Gulf of Maine Research Institute. Portland, ME.
- Stafford, S.L. 2006. State Adoption of Environmental Audit Initiatives. *Contemporary Economic Policy* **24**: 171-189.
- Standal, D. & B. Aarset. 2008. The IVQ Regime in Norway: A Stable Alternative to an ITQ regime? *Marine Policy* **32**: 663-668.
- Stavins, R.N. 2001. Experience with Market-Based Environmental Policy Instruments. In K.G. Mäler & J. Vincent (Eds.). The Handbook of Environmental Economics. Malden, MA: Blackwell Publishers Ltd.

- Sullivan, J. 2001. Harvesting Cooperatives and U.S. Antitrust Law: Recent Developments and Implications. Paper presented at IIFET Conference. Corvallis, OR.
- Sutinen, J.G. & K. Kuperan. 1999. A Socio-Economic Theory of Regulatory Compliance. *International Journal of Social Economics* **26**: 174-193.
- Tipton, C.A. 1994. Protecting Tomorrow's Harvest: Developing A National System of Individual Transferable Quotas to Conserve Ocean Resources. *Virginia Environmental Law Journal* **14**: 381-421.
- Turnipseed, M., S.E. Roady, R. Sagarin, & L.B. Crowder. 2009. The Silver Anniversary of the United States' Exclusive Economic Zone: Twenty-Five Years of Ocean Use and Abuse, and the Possibility of a Blue Water Public Trust Doctrine. *Ecology Law Quarterly* **36**: 1-70.
- U.S. Commission on Ocean Policy. 2004. An Ocean Blueprint for the 21st Century: Final Report. Washington, D.C.
- U.S. Cong. House. 1994. Transferable Quotas Under the Magnuson Act. Fisheries Management Subcommittee of the Committee on Merchant Marine and Fisheries. *Hearing, The Use of Individual Transferable Quotas in which Individual Fishermen are Allocated Fixed Quota Shares Which Entitle Them to Catch a Percentage of the Total Allowable Catch*. 103rd Cong., 1st sess. Washington: GPO, 1994.
- Walker, J.L. 1969. The Diffusion of Innovations among the American States. *The American Political Science Review* **63**(3): 880-899.
- Wang, S.D.H. & A.A. Rosenberg. 1997. U.S. New England Groundfish Management Under the Manuson-Stevens Fishery Conservation and Management Act. *Marine Resource Economics* **12**: 361-366.
- Weimer, D.L. & A.R. Vining. 2011. Policy Analysis (5th ed). U.S.: Pearson Education, Inc.
- Weniger, Q. 1998. Assessing Efficiency Gains from Individual Transferable Quotas: an Application to the Mid-Atlantic Surf Clam and Ocean Quahog Fishery. *American Journal of Agricultural Economics* **80**(4): 750-764.
- Witherell, D., M. Fey, & M. Fina. 2012. Fishing Fleet Profiles. NPFMC. Anchorage, AK.
- Yin, R.K. 2009. Case Study Research: Design and Methods. Thousand Oaks, CA: Sage, Inc.



= case analysis programs

Source: http://www.nmfs.noaa.gov/sfa/domes_fish/catchshare/index.htm

ABC: Allowable Biological Catch
ACE: Annual Catch Entitlement
ACL: Annual Catch Limit
ADF&G: Alaska Department of Fish and Game
AFA: American Fisheries Act
AI: Aleutian Islands
AP: Advisory Panel
BS: Bering Sea
BSAI: Bering Sea/Aleutian Islands
CCCHFA: Cape Cod Commercial Hook Fishermen's Association
CDQ: Community Development Quota
CP: Catcher-Processor
CPUE: Catch-Per-Unit-Effort
CPR: Common Pool Resources
CV: Catcher-Vessel
DAP: Dedicated Access Privileges
DAS: Days at Sea
EA: Environmental Assessment
ECC: Eligible Crab Community
EDF: Environmental Defense Fund
EEZ: Exclusive Economic Zone
EIS: Environmental Impact Statement
FCMA: Fishery Conservation and Management Act
FCZ: Fishery Conservation Zone
FMP: Fishery Management Plane
GAO: General Accounting Office
GBCHGS: Georges Bank Cod Hook Gear Sector
GBCFGS: Georges Bank Cod Fixed Gear Sector
GC: General Council (NOAA)
GMFMC: Gulf of Mexico Fishery Management Council
GMRI: Gulf of Maine Research Institute
GHL: Guideline Harvest Level
GOA: Gulf of Alaska
IFC: International Fisheries Commission
IFQ: Individual Fishing Quota
IQ: Individual Quota
IPHC: International Pacific Halibut Commission
ITQ: Individual Transferable Quota
IPQ: Individual Processor Quota
LAPP: Limited Access Privilege Program
LOA: Length Overall
MAFMC: Mid-Atlantic Fishery Management Council

NAS: National Academy of Sciences
NGO: Non-Governmental Organization
NMFS: National Marine Fisheries Service
NOAA: National Oceanic and Atmospheric Administration
NEFMC: New England Fishery Management Council
NEPA: National Environmental Policy Act
NPFMC: North Pacific Fishery Management Council
NRC: National Research Council
NSC: Northeast Seafood Coalition
ODFW: Oregon Department of Fish and Wildlife
OFL: Overfishing Limit
OMB: Office of Management and Budget
OQ: Ocean Quahog
PFMC: Pacific Fishery Management Council
PQ: Processor Quota
PQS: Processor Quota Shares
PSC: Potential Sector Contributions
PTD: Groundfish Plan Development Team
PWCC: Pacific Whiting Conservation Cooperative
QMS: Quota Management System
QS: Quota Share
RAM: Restricted Access Management
RCR: Registered Crab Receiver
ROFR: Right of First Refusal
SAFMC: South Atlantic Fishery Management Council
SC: Surf Clam
SEIS: Supplemental Environmental Impact Statement
SFA: Sustainable Fisheries Act
SSC: Science and Statistical Committee
TAC: Total Allowable Catch
UQ: Unit Quota
VTR: Vessel Trip Reports
WDFW: Washington Department of Fish and Wildlife