Governing fisheries in the face of change: Social responses to long-term geographic shifts in a U.S. fishery

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ARTICLE INFO

Keywords:
Social-ecological systems
Climate change
Fisheries
Natural resource management
Adaptation
Policy narratives

ABSTRACT

Change, adaptation, and resilience have emerged as central concerns in the study of natural resource governance. The mobility of fisheries makes them particularly dynamic and susceptible to long term drivers of movement, such as changing climatic conditions and human pressures. To explore how movement impacts resource systems, this paper presents a mixed-method empirical analysis of long-term geographic shifts and social response in the Northeast U.S. summer flounder fishery from 1996 to 2014. First, the paper describes changes in the distribution of summer flounder and the catch location of commercial fishing trips landing summer flounder. This is followed by a description of the institutional context of summer flounder fishery management and a narrative policy analysis of the ongoing regulatory process. Results indicate significant northward movement of both resource and resource users. Fisheries movement patterns are a result of both ecological change, and an institutional context that allows for some types of fishery mobility while constraining others. Significant conflict has emerged over the distribution of resource access and benefits as these fishery shifts occur within a spatially allocative, and relatively static management context. The analysis identifies competing policy narratives that have emerged to advocate for different forms of adaptation. Narratives offer contesting constructions of the nature and extent of locational shifts, and the fundamental goals of allocation. The differences in these narratives highlight how policy history shapes contemporary disagreements about appropriate response. This fishery serves as a case study for exploring human response to large scale, long-term movements of a natural resource.

1. Introduction

1.1. Background

Adaptation and resilience to environmental change have emerged as central concerns in natural resource governance [1,2]. A growing array of scholarship has focused on change, unpredictability, and adaptation in resource systems generally, and fisheries specifically [3–5]. Fisheries are a spatially dynamic natural resource system relative to terrestrial systems [6] and therefore frequently serve as a model resource system for questions of adaptation in natural resource governance. Challenges caused by the dynamic nature of fisheries are of particular interest given the current context of natural and anthropogenic changes such as decadal variability, climate change, ocean acidification, and anthropogenic resource depletions and recoveries. Fisheries have been modeled as a pairing of a “governance system” and a “thing to be governed” with a chief challenge of governance being to establish compatibility between these two elements [5]. This paper explores explore efforts to maintain compatibility between these two elements in the face of long term locational shift of both fish and fishers (together, the thing to be governed) and the intersection of this change with a governance system based on an allocation of resources to static, land based territorial units.

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https://doi.org/10.1016/j.marpol.2018.10.032

Received 20 July 2018; Received in revised form 10 September 2018; Accepted 12 October 2018

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Many U.S. federal fisheries allocate quota on a state by state basis, distributing resource access rights according to historical participation in the fishery over a given time-period.

Climate-related changes in spatial distribution and abundance of fish species, including poleward shifts, have been documented in and predicted for a range of commercially important fish stocks including summer flounder (*Paralichthys dentatus*) [7–10]. In addition, a range of other processes can drive or contribute to shifts in geographic distribution, including changes in abundance, fishing, interactions with other species, and alterations in ocean currents [11,12]. Whatever the cause, however, these changes in geographic distribution of resources have important implications for the fishing communities, coastal economies, and seafood consumers that depend on marine fisheries.

Extensive work has discussed the vulnerability of fisheries to disruption by long-term environmental change [13–18]. There are a variety of potential responses to a locational shift of target species, such as changing target species, reducing trips, or exiting the fishery [19]. These responses can occur simultaneously and are influenced by a multitude of factors, including adaptation costs, market trends, and regulatory change [20]. The potential spatial responses of fishing activity to geographic shifts in target stocks have been explored through modelling studies that simulate future change scenarios [18,21]. However, these models have not explored potential interactions with management boundaries (i.e. the borders between nations and sub-national management jurisdictions) [18], and there are few empirical analyses linking species distribution shifts to spatial changes in fishing patterns [22].

1.2. Case study: Northwest Atlantic summer flounder fishery

This study examines spatial changes in commercial fishing activity in the governance context of the northwest Atlantic. This region is warming rapidly [23–25], and is home to a wide range of marine species, including fish stocks of substantial commercial importance that have demonstrated significant poleward shifts in distribution [8,9]. Recent empirical work conducted along the east coast of the U.S. has begun to examine the community-level implications of changes in fish distribution in terms of landing patterns and change at the community level [26]. However, for many U.S. fisheries the scale of management does not neatly map onto the community level, with fisheries managed at the federal, regional, or state level, and authority often distributed across these management scales.

Like many fisheries management systems, the U.S. framework is often based on allocation among static governance units corresponding to land-based jurisdictions such as states and regions. In this institutional context, fishing activity is mediated by spatially explicit regulations and the incentives they generate. Therefore, geographic movement of resources across political boundaries has important implications for whether and how fishers “follow the fish,” the potential social impacts of fish and fishery shifts, and governance response. For example, Pinsky and Fogarty [22] hypothesized that the lag they observed in landings shift relative to stock shift could be due to large-scale regulatory or infrastructural inertia slowing the social response to the ecological change. Although adaptive governance has been studied in the context of spatial mobility and dynamic fluctuations of marine resources generally, social science research has only begun to investigate institutional responses to long-term geographic shifts in fisheries, and empirical evaluations are scarce [27–29]. This gap limits understanding of linkages between long-term environmental and social change in fisheries, and the ramifications of distributional shifts for fisheries management and governance regimes remain unknown.

To investigate these issues, this study focuses on the U.S. summer flounder fishery, a case that has seen dramatic geographic range shifts in the fish species, complex spatial changes in associated fishing activities, friction with static spatial management measures, and associated proposals for management response. The summer flounder fishery constrains the landing location of vessels to states where they hold a landing license, while allowing relative freedom of movement within the US EEZ. Vessels may hold landing licenses in multiple states, but must follow regulations in those states and any landed fish count against the quota of the license granting state. As such, resource users can follow fish without regulatory constraint on the water, but movements may be limited by logistical and economic ties to the ports they land in. This context contrasts with studies of fishing activity movement focused on transboundary issues around spatial management tools including marine protected areas (MPAs) [30], exclusive economic zones (EEZs), or among multinational bodies such as the EU, where the central issue is the actors’ inability to move across boundaries to access shifting resources [31,32]. In this case, mobility is possible, but specific patterns of movement emerge as an outcome of ecological, institutional, and economic influences on fisher activity.

While both warming temperatures and fishing activity have likely contributed to changes in summer flounder distribution, existing evidence suggests that recovery from historical overfishing has played an especially important role in recent years [33]. Going forward, warming temperatures are expected to drive further northward shifts in summer flounder [34].

The case study explores how summer flounder management is shaping the spatial response of fishers to fish stock shifts and how the fish-fisher movements are generating social conflict and catalyzing the emergence of policy narratives to influence change through ongoing policy processes. A policy narrative is a form of story that actors use to apprehend a given policy problem. Policy narratives simplify policy problems by constructing terms of reference, suggesting outcomes, and contesting alternative narratives [35,36]. The relative simplicity of policy narratives leads to resilient stories that can shape the way actors conceptualize issues throughout the social processes of policymaking [37,38]. As such, narratives are more than just inert stories, they are strategic simplifications adopted to make consensus and decision-making more possible in the face of complexity, uncertainty, and conflict [35]. Through narrative analysis, these stories are deconstructed to “identify ‘protagonists’ and ‘antagonists’, the metaphors that describe the relationships between them, and the anticipated or desired transformations in them or in the policy situation” [38]. Analysis of policy narratives in the summer flounder case allows for consideration of how complex factors such as institutional history, ecological change, and the policy actors’ relationship to the resource converge to shape the current terms of debate, and the ways in which change in the resource system is interpreted and communicated.

1.3. Institutional context

The federal summer flounder fishery is managed through the Summer Flounder, Scup and Black Sea Bass Fishery Management Plan (FMP) implemented by the Mid-Atlantic Fishery Management Council (MAFMC). Table 1 provides a timeline of key changes to the FMP. The state quota system specifies fixed proportional allocations of commercial summer flounder landings among coastal states (Fig. 1C). In this system, vessels with a commercial summer flounder license (also referred to as a moratorium permit) must land any summer flounder catch in the state in which they are licensed, and states are responsible for implementing measures (i.e. trip limits, individual quotas, etc.) to ensure landings in that state do not exceed its allocation. All commercial landings in a state count towards that state’s quota. Temporary quota transfers are permitted, requiring inter-state agreement and National Oceanic and Atmospheric Administration National Marine Fisheries Service (NOAA-NMFS) approval. Despite these mechanisms, transfers infrequently occur in practice.

State quota allocations were established in the early 1990s during the initial stages of the FMP development. Because summer flounder stocks migrate seasonally, it was thought that introducing a coastwide landings limit without state-specific allocations could allow fishermen
Table 1
Timeline of key management changes for the commercial summer flounder fishery.

<table>
<thead>
<tr>
<th>Year</th>
<th>Management changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1982</td>
<td>The Atlantic States Marine Fisheries Commission (ASMF) developed a Summer Flounder Fishery Management Plan (FMP).</td>
</tr>
<tr>
<td>1988</td>
<td>The MAFMC implemented a Summer Flounder FMP based on the ASMF’s plan [41].</td>
</tr>
<tr>
<td>1992</td>
<td>Amendment 2 implemented the Total Allowable Landing system (60% commercial, 40% recreational) and set initial state-by-state quota allocations based on 1980–1989 commercial landings by northeastern states [38].</td>
</tr>
<tr>
<td>1993</td>
<td>Amendment 4 made minor adjustments to the state quota allocation percentages [42].</td>
</tr>
<tr>
<td>1993</td>
<td>Amendment 5 permitted quota transfer between states [43].</td>
</tr>
<tr>
<td>2004</td>
<td>NOAA Fisheries implemented a Turtle Exclusion Device (TED) requirement for “any summer flounder trawler that operates within the Summer Flounder Fishery-Sea Turtle Protection Area” in VA and NC waters, exempting the zone north of Oregon Inlet from January 15 – March 15 [44].</td>
</tr>
<tr>
<td>2010</td>
<td>Summer Flounder stock declared rebuilt by NOAA Fisheries [45].</td>
</tr>
<tr>
<td>2011</td>
<td>Amendment 15 established Annual Catch Limits (ACLs) and Accountability Measures (AMs) [46].</td>
</tr>
<tr>
<td>2014</td>
<td>ASMFC voted to enact regional adaptive management to address access issues for summer flounder [47].</td>
</tr>
</tbody>
</table>

from one state or region to take the entire season’s quota before fishers in other states had the opportunity to participate. To avoid the potential access disparities in such a scenario, the Council allocated total catch proportionally based on each state’s share of landings during the 1980–1989 period [39]. Notably, neither fish stock distribution nor catch locations were mentioned in FMP documents as factors affecting quota allocation decisions.

To address interactions with sea turtles in southern waters, in 1996 NOAA Fisheries introduced a requirement that summer flounder trawlers operate with a turtle exclusion device (TED) when fishing south of the “TED line” at 37°05′ N. latitude [40]. This measure introduces a spatial restriction that may increase the costs of fishing in VA and NC waters.

2. Methods

The research employs quantitative and qualitative methods in a three-part analysis, detailed in the following subsections. Section 2.1 describes the quantitative analyses of the distribution of summer flounder and the catch location of commercial fishing trips landing summer flounder. Section 2.2 outlines the approach to describing the institutional context of summer flounder fishery management and conducting a narrative analysis of the ongoing policy reform process.

2.1. Examining change in fish and fishing location

Annual population centers for summer flounder from 1967 to 2014 calculated by the Ocean Adapt data portal were used to examine fish location (downloaded from oceanaadapt.rutgers.edu 5/10/17) [9]. These annual population centers are biomass-weighted average latitude and longitude values created using the National Marine Fisheries Service (NMFS) Northeast Fisheries Science Center (NEFSC) fall bottom trawl survey data. Two linear regressions of biomass-weighted latitude vs. year were fit to assess the change in location of summer flounder over time (Fig. 1a): one for the entire time frame of the data set (1967–2014) and one for the time frame of the data set that matched the fishing data described below (1996–2014).

Vessel trip report (VTR, also known as logbook) data from NEFSC from 1996 to 2014 were used to determine fishing location. NEFSC collects VTRs for fishing trips conducted by vessels that hold a commercial federal fishing permit from Maine to North Carolina (unless the vessel holds a federal lobster permit but no other federal permits). Each VTR includes self-reported trip dates, landing port, type of fishing gear (s) deployed, geographic coordinates of gear deployment, and cumulative weight of each species caught [48].

VTR data were analyzed from commercial trips that reported catching any summer flounder and landing their catch in Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Maryland, Virginia, and North Carolina. VTR data were not included from trips that landed summer flounder in Maine, New Hampshire, Pennsylvania or Delaware because landings in those four states totaled less than 0.2% of all trips and less than 0.5% of catch each year and were too sparse to discern patterns. Less than 2% of the trips analyzed included summer flounder caught with more than one gear; each gear-catch was analyzed as a separate trip to allow for gear-based disaggregation.

Although recreational catch comprises a substantial portion of summer flounder catch in the northeastern US, this paper analyzed only commercial fishing trips as the research team and policy audience were specifically interested in how the policy process addresses locational shift in commercial operations. Though lobster pots have summer flounder bycatch, the analysis excludes commercial trips that reported using lobster pots because vessels holding only a federal lobster permit are not required to submit VTRs and so VTR lobster pot data are likely incomplete.

An annual geographic catch-weighted centroid of fishing location was estimated for each of the eight states above, and for those eight states aggregated. Centroids were weighted by catch (lbs) to emphasize fishing activity focused on summer flounder relative to other target species, but centroids weighted by effort (crew times trip length) produced similar results.

To account for locational uncertainty in VTR location data, this analysis employs a bootstrapping approach in the centroid calculations. VTR data are self-reported, which results in small but frequent inconsistencies in location (primarily due to rounding errors, not systematic biases) [49]. To account for these inconsistencies, this analysis uses DePiper’s [50] model to calculate a 90% confidence interval for each individual fishing trip. That confidence interval was used as a radius around the reported trip location and (assuming a uniform distribution) a random point was chosen within that area to represent the trip location. All estimated trip locations were used to calculate a geographic centroid for each year, weighted by pounds of summer flounder caught. This process was repeated 1000 times to generate a distribution of centroids for each year. Fig. 1 plots the geographic mean of those 1000 centroids.

To assess the change in fishing location over time, for each of the eight states analyzed, and for the fishery as a whole, the analysis employs an inverse weighted regression analysis. A linear regression of latitude vs. year was fit for each set of bootstrap-replicated centroids described above, weighting each centroid by the inverse variance of the trip latitudes used to calculate that centroid. This approach results in a centroid with tightly clustered trips being weighed more heavily than one with more dispersed trips. The mean effect strength from those 1000 regressions was calculated and that value was used as the rate of change in latitude. These analyses were completed in R 3.3 [51].

2.2. Institutional context and policy reform

To situate the shifts of fish and fishing activity within their political and policy contexts, the qualitative analysis describes the institutional framework and identifies policy narratives through narrative analysis of policy documents, public comments on proposed management changes
and targeted interviews. These analyses establish which aspects of the existing management structure are interacting with the geographic fishery changes, how and why those institutions were created, and how and why those institutions are currently being re-negotiated.

The research team conducted a broad literature review of the summer flounder fishery's governance and spatial shifts in fish and fishing patterns; these secondary data included websites and policy documentation from state and federal fishery management agencies, journalism and academic literature. The analysis identified elements of the management structure that were affecting (i.e., by facilitating or hindering) the observed geographic shifts in fishing locations. These data were compiled into a historical timeline of the origins and changes to relevant components of the Summer Flounder, Scup and Black Sea Bass Fishery FMP and its Amendments (Table 1). The document analysis was supplemented with interviews of key individuals involved in summer flounder fishery management. Questions focused on the governance structure of the fisheries, perceptions of range shifts in the fish stocks, perceptions of spatial responses in fishing activity, and management challenges and responses.

To understand institutional response to the emerging conflict around summer flounder, the researchers reviewed policy documentation related to ongoing development of a Comprehensive Summer Flounder Amendment (hereafter “the Amendment”). Discussions surrounding this potential amendment address the challenges caused by spatial fisheries shifts, and potential responses to these shifts. Data sources included reports, memoranda, white papers, meeting summaries, records of public comments submitted in writing and at public hearings, the Fluke Fairness Act [52,53] and related publicly-available documentation from the U.S. legislature, and other materials published by the MAFMC and ASMFC. These data were analyzed using qualitative coding to identify policy narratives and interest groups surrounding distributional shift and the proposed management changes [54]. The analysis outlines narratives surrounding two major policy proposals, and presents the themes and contents of these narratives through a descriptive table and examples drawn from publicly available comments surrounding the policy process. These narratives contextualize how actors understand and react to change in the fishery within the context of governance processes.

3. Results

3.1. Changes in fish and fishing location

Both summer flounder and commercial fishing trips targeting summer flounder demonstrated a significant shift northward. Summer flounder shifted significantly northward both between 1967 and 2014 ($y = 0.05x - 0.56$, $R^2 = 0.25$, $F(1,16932) = 5592$, $p < 0.01$) and between 1996 and 2014 ($y = 0.02x - 4.7$, $R^2 = 0.01$, $F(1,8689) = 106.8$, $p < 0.01$).

Results indicate a significant shift northward in commercial fishing trips that caught summer flounder between 1996 and 2014 ($y = 0.09x - 0.01$, $R^2 = 0.84$, $F(1,18998) = 99570$, $p < 0.01$). The overall shift was 9.7 km/year. The most dramatic and significant shifts were seen in vessels landing in more southern states (North Carolina: 24.0 km/year, Virginia: 13.7 km/year, and Maryland: 4.8 km/year), while smaller but still significant shifts were seen in northern Mid-Atlantic states (New Jersey: 2.6 km/year, New York: 1.3 km/year), and New England states showed less or non-significant latitudinal shifts by year (Fig. 1a, b, Table S1). To illustrate this point: trips landing summer flounder in North Carolina were on average fishing off the coast of North Carolina in the mid-1990’s, but off the coast of New Jersey by 2014: a difference of more than 350 km.

![Fig. 1.](image-url)
3.2. Policy narratives and conflict

In 2014, federal agencies (the Mid-Atlantic Fisheries Management Council (MAFMC), Atlantic States Marine Fisheries Commission (ASMFC), and National Marine Fisheries Service (NMFS)) initiated scoping processes to develop a Comprehensive Amendment to the Summer Flounder FMP, which are ongoing at the time of publication. Two main proposals to change the existing quota system have emerged: (a) quota reallocation, and (b) landings flexibility. Each option offers a unique set of costs and benefits, and although the two are not mutually exclusive, they are often adopted as alternative approaches by fishers in different geographic regions. These two alternatives form the core components of distinct policy narratives about appropriate action in the FMP amendment process, which are rooted in conflicting interpretations of ecological history and the equity of past management decisions. Table 2 matches these two alternatives with associated policy narratives, highlighting proponents of the narratives, themes, and structures. Quotes from scoping meetings and written public comments support the table and serve to illustrate how resource users express these narratives to apprehend and influence the policy process.

3.2.1. Quota reallocation

The question of reallocating quota to northern states is the most commonly referenced policy conflict associated with distributional shifts. Public comments were evenly split on the issue, with New York and Massachusetts fishers advocating for a reallocation and Southern state fishers defending the status quo. Underpinning this difference are fundamental conflicts about the equity of the initial allocation in the summer flounder fishery, the nature of shift in the summer flounder population (or the existence of shift at all), and who stands to benefit from reallocating quota.

The legitimacy and fairness of the initial allocation in 1989 is hotly contested among fishers. For example, some fishers from New York expressed that this allocation was the result of poor record keeping practices by management officials, which undercounted New York landings. Such a stance reframes the issue of quota allocation as a response to an initial injustice, rather than a response to environmental change. Fishers from southern states counter that the quota reflects their investment in developing the fishery and is an accurate representation of historical landings. Southern fishers argue that New York fishermen are erroneously considering landings from North Carolina fishers who operated in New York in the 1980s as evidence of New York participation that did not occur. Rhode Island fishery stakeholders positioned their strong record keeping and participation in the “rebuilding of the fishery” as “earning their existing piece of the pie” and reallocation should “protect their historical fishery”. Broadly, the current amendment process resurrected old distributional conflicts, which serve as the starting points of conflicting narratives in contemporary debate.

In questioning who stands to benefit from quota reallocation, Southern states characterize New York’s pursuit of reallocation as “stealing” the quota. Many southern state stakeholders defended their quota allocation based on “hard work” in the fishery at the time of allocation or over the rebuilding period. In these arguments, allocation is re-cast as an issue of preserving fairly earned access rather than of maximizing efficiency:

The commercial state-by-state allocation should also remain intact. In New York, fishermen were selling out of the back of trucks in cash so they didn’t have to pay the IRS money. There were about 10 boats in the 70s and 80s working the south side of Long Island for fluke – that’s it. They got the allocation they earned. They shouldn’t come back later and say they got fewer fish than they deserve

North Carolina and Virginia don’t need to lose quota to northern states, because southern states helped make the northern states what they are now.

On the other hand, northern states characterize southern states reluctance to give up quota as “hoarding” quota despite unfair initial allocation and clear changes in the distribution of fish. This narrative includes a component of equity, but also makes major arguments based on the inefficiency of current allocations:

Being from NY and fishing in federal waters, we should not be discriminated against because of our state. Before this arbitrary state-by-

<table>
<thead>
<tr>
<th>Proposal</th>
<th>Position</th>
<th>Proponents</th>
<th>Main theme</th>
<th>Narrative composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quota re-allocation</td>
<td>Support</td>
<td>Northern states who stand to gain quota</td>
<td>Equity</td>
<td>Initial allocation was unfair; more equitable access rights should be pursued</td>
</tr>
<tr>
<td></td>
<td>Opposition</td>
<td>Southern states who stand to lose quota</td>
<td>Preservation of historical access</td>
<td>The fish stock is clearly shifting. Southern states are “hoarding” quota. Initial allocation fairly earned through historical effort; existing access rights should be preserved. The fish stock is not clearly shifting; may be expanding. Northern states are “stealing” quota.</td>
</tr>
<tr>
<td>Change quota system</td>
<td></td>
<td>Various commenters, generally but not exclusively in Northern States</td>
<td>Adaptability</td>
<td>Initial allocation creates inflexibility, locks in regional participation differences Propose seasonal or coast wide quotas instead of state-by-state allocations. Shifts in the fish stock can be better addressed using a new system.</td>
</tr>
<tr>
<td>Landings flexibility</td>
<td>Support</td>
<td>Majority of fishermen across regions</td>
<td>Efficiency</td>
<td>The current landings system is inflexible, and places unnecessary costs and hardship on fishers. Landings flexibility would decrease fuel costs, travel time, and environmental impact while improving safety.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Processors and shore side businesses in northern States</td>
<td>Efficiency, Impact on local economies</td>
<td>Shore side businesses in Northern States are closer to the fish. Landing in Southern states does not make sense. Landings flexibility would improve conditions for fishers, while also allowing product to reach market in a more efficient way. Processors and businesses in Southern states were key to developing the fishery. Shore-side sectors in Southern states may lose business Northern competitors. Historical role in fishery necessitates more consideration.</td>
</tr>
<tr>
<td></td>
<td>Opposition</td>
<td>Processors and shore side businesses in southern States</td>
<td>Impact on local economies</td>
<td>Fishers in Northern States have developed relationships with shore side businesses. Influx of landings in Northern states by Southern boats would affect prices and relationships with processors.</td>
</tr>
</tbody>
</table>

Table 2
Two primary proposals to change existing summer flounder quota system: positions, proponents, themes, and narrative composition.
state quota allocation for fish harvested in the EEZ, most of the boats would travel up and down the coast catching fluke and unloading in any state the captain chose. Now, it has gotten to an unrealistic point of wasting fuel, wasting time, and sacrificing product quality.

In those comments that acknowledged shifted fish stocks, the nature of the shift itself was contested, with some commenters arguing that expansion rather than shift has occurred:

“There has been much talk of a “shift” in the center of biomass, and several miss-leading graphs have been distributed. The data actually reflect an expansion of the stocks.”

The implicit argument is that if data reflect an expansion to new range areas, rather than a shift from existing ranges, a corrective re-allocation is not necessarily needed. Others contested this claim, agreeing with management assessments of a Northward shift, highlighting how their own fishing experiences reflected this movement.

A significant group of commenters opted for a fundamentally different system, such as using two seasons with different quota schemes in each season, or opting for a coast-wide quota rather than a state-by-state allocation. The specific form of the suggested new quota system varies, but these proposals are rooted in the belief that the current system must fundamentally change to deal with emerging management challenges.

3.2.2. Landings flexibility

The most commonly expressed landings flexibility proposal would allow summer flounder fishermen to land their catch in any state, while still having it count against their permitting state’s quota. This proposal would therefore reduce the length of fishing trips for vessels permitted in southern states as illustrated in Figure B, while maintaining the status quo in terms of quota allocation. Supporters frequently cite increasing fuel costs and potential improvements in efficiency, safety, and environmental impact through reduced trip length as reasons for landings flexibility. The majority of commenters who mention landings flexibility in written comments support it, regardless of permit state, but may also advocate for quota reallocation in addition to flexible landings measures.

One commenter summarizes the efficiency-based argument put forward by the majority of fishermen:

“In a day with fuel prices driving the industry it is not economically feasible for a fisherman to drive fish hundreds of miles in the direction of their mandatory landing port only to have them trucked back in the direction they came from…There are enough tools in place (ex. VMS) to properly manage the stocks regardless of where they are landed.”

Despite general support for the measure, the debate over landings flexibility highlights the potential impacts of distributional shift on shore side infrastructure and businesses. Broadly speaking, such a proposal would likely increase landings in New Jersey and New York, and decrease landings in Maryland, Virginia, North Carolina. As a result, Southern processors and other shore side businesses expressed strong opinions about the effects of this proposal on local economies:

“The landing of summer flounder represents a larger industry…. The fish cutter, salesman, packers, truck drivers, grocery clerks, fuel companies, ice suppliers, etc. When you mention landings flexibility you put all those jobs in question.”

Conversely, some fishers in Northern states express concerns about flooding their markets with out of state permitted vessels:

“Landing big out-of-state fluke trip limits in New York in the winter will only make it harder for New York permitted vessels to compete in the market place. It is absurd to think 10–15 thousand pound out of state fluke trip limits landed in New York ports wouldn’t affect the price.”

Broader impacts of landings flexibility might also extend to other fisheries. For example, if vessels permitted in North Carolina were to land flounder catches in northern states during the winter, it may jeopardize shore side businesses that these vessels rely on to pack and process shrimp and other fisheries during the summer and fall seasons. Such changes in landing location are also moderated by community ties and relationships of loyalty and reciprocity between fishers and processors. Concerns over such impacts gave rise to a variety of seasonal or moderated landings flexibility proposals from members of the fishing community that are intended to reduce impacts on local prices or shore side businesses.

4. Discussion

The summer flounder fishery serves as a case to explore the conflict likely to arise when territorially allocative systems of resource governance (such as state-based quotas) encounter rapid changes in natural resource distribution and/or use patterns. The nature of this encounter is complex; the institutional context influences the magnitude, pattern and indeed even the possibility of human response to the resource shift, while the resource shift creates conflicts that drive institutional change. These components iteratively shape each other, highlighting the importance of policy history and existing policy narratives in forming baselines for response to change.

The time series of fishing activity extends back to 1996, but a much broader ecological and institutional history influences contemporary conflict. For example, the initial state quota allocation for summer flounder was based on historical landings between 1980 and 1989, resulting in a high proportion of quota for Virginia and North Carolina. However, NEFSC trawl survey data from the 1980s indicate a concentration of biomass off Rhode Island, while trawl surveys from the late 1960s show biomass concentrated off the coasts of Virginia and North Carolina. The disconnect between these patterns suggest that landing history in the 1980’s may have been influenced by the location of fish stocks from earlier decades. Historical availability of fish in North Carolina and Virginia may have driven the development of capacity that has influenced several iterations of management outcomes. This history may reconcile seemingly contradictory narratives that appear in the qualitative results, where fishers from different areas maintain different positions about the historical distribution of summer flounder.

Additional information is needed to fully contextualize the results presented here; a key consideration is the potential transfer of state fishing permits. The results are based on the landing state, but permits can be held by individuals living in other states, or with multiple or changing residencies. Data showing a movement in fishing location for a given state’s permits does not capture how many permits may have been transferred to other states over the course of the time series. As such northward locational shift of trips landing in southern states may to some extent reflect some movement of permits to holders in northern states. The plots provided are accurate in that trips landing in North Carolina have indeed shifted northward, but they do not capture the intricacies of how fisheries might adapt within current institutional constraints. As of submission of this paper, information on individuals holding multiple state permits or permits from states where the individual did not reside was not available from MAFMC.

The exact driver(s) of the shift in summer flounder is an active area of research [33,55], but research acknowledges that there has been a change in patterns of fish distribution. Regardless of its specific role in this case, climate will continue to affect ecological change in fisheries, which could increase the number and intensity of distributive conflicts over management and allocation of resources as stocks shift, expand, or contract. Understanding and anticipating these conflicts is an important component of understanding and planning for adaptation to dynamic change in fisheries, whether caused by sea temperature change, patterns of human exploitation, regime change or a combination of these factors. A key challenge for management is understanding how to
analyze the role of these interacting drivers, and determining whether they necessitate novel management approaches or can be managed under existing policy frameworks.

Other fisheries are shifting geographically and these have yet to undergo a policy revision like summer flounder. An analysis of 105 species in the Northeast and Mid-Atlantic found significant northward shift across these species [8]. In other fisheries, management response may be hampered by poor data, insufficient resources, or the additional complication of species moving across national boundaries. Other fisheries may not have the robust historical data available in this case, and so may require different methods to assess ecological change and management response. Any application of lessons from this case must consider these variations in context.

In addition, the type of underlying shift in fish populations can differ in nature. In the summer flounder fishery, data points to a geographic shift in biomass and a reduction in some areas of their range. However, some species are undergoing range expansion and entering areas where they are not part of the management status quo, while not necessarily reducing in abundance in other areas of their range. For example, black sea bass (Centropristis striata) have been increasing in abundance in the Gulf of Maine, leading to concern over ecological interactions with existing commercial fisheries through predation of lobsters and cod. Fishers in Maine are unable to land black sea bass in any quantity as permits for landing and processing these fish are not yet available. The lagged response between ecological impacts and regulatory action is a concern across cases of fishery shift, whether the movement in question is a shift in abundance, range expansion, or range contraction.

5. Conclusion

The catch location for summer flounder shifted latitudinally northward from 1996 to 2014. Southern states have exhibited the most dramatic shift, and 73.13% of the available quota is allocated to states that have shifted northwards to a statistically significant degree. These shifts overlay a shift in the target fish populations and have entered directly into ongoing policy debates about appropriate management response. This fishery presents a unique case for examining how locational shift can be assessed and managed in fisheries shift. As changes continue in world fisheries, movement of fish stocks is likely to remain an important issue for managers.

The locational shifts presented in this paper are most likely an outcome of ecological shifts, fisher response, and the constraints and opportunities for adaptation presented by the existing regulatory structure. These aspects combine to shape the locational shifts that are observed, and drive narratives used by conflicting groups to explain changes, and define appropriate policy response. The narratives presented by the various parties are not necessarily mutually exclusive, and reflect distinct interpretations and beliefs about both the change observed, and the status quo from which these changes emerged.

This case highlights the stress that allocative systems of resource management can experience in the face of distributive conflict. Because the summer flounder management system is based upon allocation of resources among static terrestrial spatial units, a spatial shift of both the stock and fishers challenges the fundamental rationale of the system. In contesting new rules, fishers conflict over not only new information and proposed changes, but also the fundamental purpose of quota allocation, the fairness of historical allocation, and the ecological history of the species. The spatial shift creates an inflection point for the management system, where underlying logics and assumptions must be re-justified, and old narratives are re-interpreted given new goals and information. Questions about if, why, and how the fish population has shifted merge with a contested history of resource use and different assumptions about the purpose of allocation. Thus, ecological change creates not only conflict, but opportunity for policy reassessment and adaptation.

Acknowledgements

This project grew out of the “Shifting Fish and Fishers” graduate pursuit at the National Socio-Environmental Synthesis Center (SESYNC), which included Kaycee Coleman, Emma Fuller, Josh Stoll, and Adrienne Tecza. Emma Fuller developed and first implemented the bootstrapping and inverse weighted regression approach. We also thank Arielle Baker and Chris Free (Rutgers); Jon Kramer, Katherine Johnson, Mike Smorul, and Philippe Marchand (SESYNC); Geret DePiper, Michael Fogarty, Julia Olson, and Sean Lucey (NOAA Northeast Fisheries Science Center); Richard Robins (Mid-Atlantic Fisheries Management Council); Heather Deese (Island Institute); Daniel Dunn and Lisa Campbell (Duke); Oyster House Foundation.

Funding

This work was supported by the National Socio-Environmental Synthesis Center under funding received from the National Science Foundation (NSF) DBI-1052875, and a NSF Coastal SEES grant (OCE-1426891) to Malin Pinsky and Kevin St. Martin. Bradford Dubik was supported by NSF (GREFP DGE: 100014190). Talia Young was supported by NSF (GREFP DGE: 0937373) and a David H. Smith Conservation Fellowship.

Appendix A

See Table A.1.

Table A.1

<table>
<thead>
<tr>
<th>State</th>
<th>Mean latitudinal shift / yr (km)</th>
<th>Number of trips</th>
<th>Results from linear regression</th>
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<td></td>
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References


Appendix B. Supplementary material

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.marpol.2018.10.032.


