11-2017

Evaluating Climate Change Adaptation Mechanisms in Fisheries Management Laws and Regulations

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Rhode Island Sea Grant Law Fellow Program
November 2017

Climate change presents a challenge to the fishing industry and managers alike. Changing environmental conditions affect fish location, abundance, and ecosystem relationships, which can result in dramatic shifts in economically important stocks. These shifts can stress management systems as well as the fishermen who depend on effective management.

Climate-influenced changes present both challenges and opportunities. For example, New England cod stocks have dramatically declined in recent years—a trend attributed to rapid increases in ocean temperatures in the Gulf of Maine, combined with a management failure to account for those changes when setting quotas.[1] The result was declaration of a federal disaster in 2012, reflecting the extreme hardships that the required cuts to quota imposed on industry.[2] On the other hand, warm-water species such as black sea bass have expanded their distribution northward, providing new fishing opportunities to fishermen in these areas.

Effective and adaptive fisheries management systems are needed both to avoid economic and environmental dislocation associated with climate-driven changes in fish stocks and to enable the industry to take advantage of new opportunities. The legal literature has considered how frameworks can be designed to adapt to climate change in a variety of regulatory contexts. This article applies these legal theories of adaptive management to fisheries management systems in the U.S. In Part I, the article reviews the U.S. fishery management system, including federal, regional, and state management. Part II evaluates fisheries management legal frameworks against each of four adaptive management frameworks identified in the legal literature in order to identify where and how fisheries law enables or undermines resilience. In part III, this analysis is applied to a specific fishery—black sea bass—to illustrate how these insights are applied in practice. Part IV concludes that close consideration of specific procedural and substantive aspects of fisheries legal frameworks and

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[1] Marianne Lavelle, *Collapse of New England's Iconic Cod Tied to Climate Change*, SCIENCE, http://www.sciencemag.org/news/2015/10/collapse-new-england-s-iconic-cod-tied-climate-change .

[2] *See Groundfish Disaster Economic Assistance Program*, MASS. EXEC. OFFICE OF ENERGY & ENVTL. AFF., http://www.mass.gov/eea/agencies/dfg/dmf/programs-and-projects/groundfish-disaster-economic-assistance-program.html (last visited Sep. 7, 2017).

This guide is a product of the Marine Affairs Institute at Roger Williams University School of Law and the Rhode Island Sea Grant Legal Program. Research and drafting provided by Rho de Island Sea Grant Law Fellows Logan Pearce and Joseph Bingaman, under the guidance of Read Porter, Senior Staff Attorney. This document is to be used for research purposes only and is not legal advice.

individual fisheries is needed to understand whether and how they enable adaptive management in the face of environmental change.

1 The U.S. Fisheries Management System

U.S. fisheries management is a complex system that includes separate federal, regional, and state frameworks that work together to govern fishing in state and federal waters. This section provides an overview of these management systems and how they interact in practice.

1.1 Federal Fisheries Management: The Magnuson Stevens Act

Congress enacted the Magnuson-Stevens Fishery Conservation and Management Act, also known as the Magnuson-Stevens Act (MSA), in 1976 to regulate fishing in U.S. federal waters. The MSA is the primary statute governing marine fisheries from the seaward boundary of the territorial sea to the seaward extent of the Exclusive Economic Zone, 200 nautical miles from shore.[3]

The MSA delegates responsibility for fisheries management in these waters to eight regional fishery management councils (FMCs). Each FMC is made up of members from each state in the region and from the regional office of the National Marine Fisheries Service (NMFS).[4] In addition to the voting members, each council has four non-voting members who represent the United States Coast Guard, U.S. Fish and Wildlife Service, U.S. Department of State, and the Atlantic States Marine Fisheries Commission (ASMFC).[5]

FMCs manage fisheries under their jurisdiction by establishing a fishery management plan (FMP) "for each fishery under its authority that requires conservation and management."[6] Once a FMP is complete and approved by the Council in compliance with the Act, NMFS issues regulations to implement the FMP.[7] FMPs must contain mandatory elements and may contain discretionary elements, and they must be consistent with ten national standards set out in the Act.[8] The mandatory elements include assessment of "the present and probable future condition" of the fishery, as well as its optimum yield, maximum sustainable yield, and "objective and measurable criteria" for determining when a stock is overfished.[9] Each FMC must establish annual catch limits for the fishery based on a mechanism that must be set out in the FMP.[10] If NMFS determines that a stock is overfished according to the criteria in a FMP, the FMC must amend the FMP to include

[3] 16 U.S.C. §§ 1802 (defining EEZ); 1811(a) (declaring sovereign authority over fishing); 1853 (authorizing permits for fishing as element of FMPs).
[4] *Id.* §§ 1801(b)(5); 1852.
[5] *Id.*
[6] *Id.* § 1852(h)(1).
[7] 16 U.S.C. § 1854.
[8] *Id.* §§ 1851 (national standards), 1853 (contents of FMPs).
[9] 16 U.S.C. § 1853.
[10] *Id.* §§ 1852(h)(6) (requiring Council to set annual catch limits); 1853(a)(15) (requiring annual catch limit mechanism in FMPs).

measures sufficient to rebuild the stock within the shortest period possible, generally not to exceed 10 years.[11]

Status determination criteria and yield thresholds are based on stock assessments conducted by the National Marine Fisheries Service (NMFS), as well as analysis from Council committees and panels.[12] The MSA requires and authorizes FMCs to create committees and panels to support their work. Each council is required to establish a Scientific and Statistical Committee (SSC) "to assist it in the development, collection, evaluation, and peer review of [] statistical, biological, economic, social, and other scientific information," including by approval of stock assessments and associated status determination criteria and yield thresholds for management of stocks under the Council's management.[13] Annual catch limits "may not exceed the fishing level recommendations" determined by SSCs.[14] FMCs also may establish Advisory Panels, must establish a fishing industry advisory committee and must establish an advisory committee for any FMP or amendment for a highly migratory fishery that occurs in more than one region.[15]

FMCs rely heavily on their committees and panels in carrying out their appointed tasks. For example, the New England Fishery Management Council (NEFMC) uses Oversight Committees, Plan Development Teams, and Advisory Committees in addition to its SSC.[16] Oversight Committees include council members and "generally relate[] to a specific fishery or important management issue." They develop specific measures for inclusion in an FMP or an amendment or framework adjustment.[17] The Advisory Panels provide the Oversight Committees with advice from stakeholders throughout the planning processes.[18] Plan Development Teams provide the Oversight Committee with technical support on scientific, legal, and implementation issues.[19] These panels and committees enable the FMC to create and implement FMPs.

Some fisheries do not exist solely in a single fishery management region. The Secretary of Commerce, through NMFS, is responsible for managing specific highly migratory species (tuna, marlin, oceanic sharks, sailfishes, and swordfish).[20] For other fisheries that "extend beyond the geographical area of authority of any one Council," the Secretary may designate which FMC is responsible for developing the FMP for the fishery or require that multiple FMCs jointly manage the

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[11] *Id.* § 1854(e).

[12] Richard D. Methot, Stock Assessment: Operational Models in Support of Fisheries Management, *in* THE FUTURE OF FISHERIES SCIENCE IN NORTH AMERICA 137, 142-44 (R.J. Beamish & B.J. Rothschild, eds., 2009)

[13] *Id.* § 1852(g)(1)(A).

[14] *Id.* § 1852(h)(1).

[15] *Id.* § 1852(g).

[16] *See, e.g.,* New England FMC, *History and Organizational Structure*, http://www.nefmc.org/about/history (detailing New England FMC's reliance on in conducting its business).

[17] *Id.*

[18] *Id.* (stating that Advisory Panels' members consist of "…members from the fishing industry, scientists, environmental advocates, and others with knowledge and experience related to fisheries issues").

[19] *Id.*

[20] *Id.* §§ 1852(a)(3), 1802(21) (defining highly migratory species)

fishery.[21] In the case of joint management, one FMC will be designated the administrative lead for developing the FMP, but all involved FMCs must approve the resulting FMP before it can take effect.[22]

In practice, different fisheries are managed in different ways.[23] For example, the Mid-Atlantic FMC (MAFMC) serves as the sole responsible Council for the management of mackerel, squid, and butterfish.[24] The New England FMC (NEFMC) therefore does not have voting authority on this FMP, although some of its members participate in management via the MAFMC committee structure.[25] On the other hand, the spiny dogfish FMP is jointly managed by MAFMC and NEFMC, so both Councils must vote for management to take effect.[26]

1.2 State and Regional Fishery Management: Atlantic States Marine Fisheries Commission

States retain jurisdiction over fishing in state waters, which in most states extends from shore out to 3 nautical miles.[27] States manage fishing for stationary species in their waters independently, but many stocks migrate or otherwise move across state boundaries. For these species, states have recognized the need for binding regional management to avoid overfishing.

States have addressed the challenge of regional management by entering into interstate compacts creating regional fisheries management entities. In 1940, the 15 Atlantic Coast states created the Atlantic States Marine Fisheries Commission (ASMFC) by interstate compact in order to support "the better utilization of fisheries . . . of the Atlantic seaboard."[28] Each state member is represented on the Commission by 3 commissioners, and each state receives a vote on each issue before the commission.[29]

The work of the ASMFC, like FMCs, is substantially supported through associated boards, commissions, and panels. ASMFC's fisheries management is conducted pursuant to the Interstate Fisheries Management Program (ISFMP) charter.[30] The ISFMP charter establishes a Policy Board,

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[21] 16 U.S.C. § 1854(f).

[22] 50 C.F.R. § 600.111.

[23] *See generally* MAFMC, REPORT TO CONGRESS ON COUNCIL MANAGEMENT COORDINATION (Oct. 11, 2007).

[24] Telephone Interview with Jason Didden, Fishery Management Specialist, MAFMC (Aug. 22, 2019).

[25] *Id.*

[26] *Id.*; see also MAFMC, REPORT TO CONGRESS ON COUNCIL MANAGEMENT COORDINATION 11 (Oct. 11, 2007) (discussing joint management between MAFMC and NEFMC).

[27] *Id.* § 1856 (state jurisdiction).

[28] ATLANTIC STATES MARINE FISHERIES COMPACT at preface, Pub. L. No. 539, 56 Stat. 267, 1 (1950).

[29] *Id.* at art. III (commissioners); ASMFC COMPACT RULES AND REGULATIONS art III § 2 (voting).

[30] ASMFC, INTERSTATE FISHERIES MANAGEMENT PROGRAM CHARTER § 1 (2016) (citing ASMFC COMPACT RULES AND REGULATIONS, at art. IV.).

Species Management Boards, and additional committees and teams for technical and advisory support (Fig. 1).[31]

- The ISFMP Policy Board includes all of the commissioners[32] and is responsible for administration and management of the Commission.[33]
- Species Management Boards are responsible for creating and implementing FMPs and are made up of Commissioners from the states that have "declared an interest in the species' management program."[34]
- Technical Committees, Plan Review Teams, and Advisory Panels support each of the Species Management Boards.

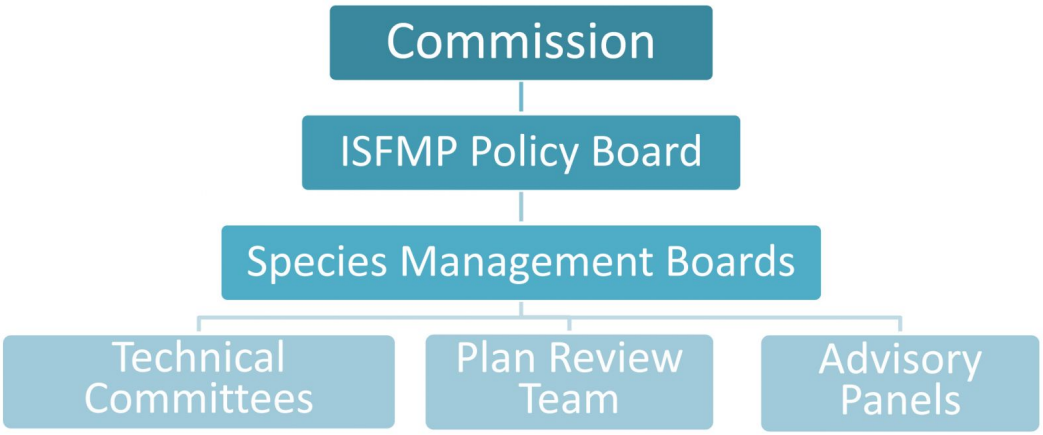

Figure 1. ASMFC Structure.

Atlantic regional fisheries management operates through "coastal FMPs" designed to prevent overfishing and maintain sustainable stocks of fish through scientifically-based management measures.[35] The standards and procedures for coastal FMPs are set forth in the ISFMP Charter, in accordance with requirements established by Congress in the Atlantic Coastal Fisheries Cooperative Management Act (ACFCMA), which provides guidance for coastal FMPs, federal-regional coordination, and state implementation of coastal FMPs.[36]

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[31] *Id.* §§ 3-5.

[32] *Id.* ("The ISFMP Policy Board is comprised of the Commissioners from the fifteen member states and representatives of the District of Columbia (DC), the Potomac River Fisheries Commission ("PRFC"), NOAA Fisheries and the U.S. Fish and Wildlife Service. It meets at least bi-annually to establish and monitor the program.")

[33] ASMFC, INTERSTATE FISHERIES MANAGEMENT PROGRAM CHARTER, Preface, (2016), https://www.asmfc.org/files/pub/ISFMPCharter_Feb2016.pdf.

[34] *Id.* § 4(a).

[35] *Id.* § 6.

[36] 16 U.S.C. §§ 5101-5108.

The Act requires ASMFC to consult with the appropriate FMC when developing a coastal FMP for a stock that is located in both state and federal waters and to seek areas where federal and regional management can be complementary.[37] The Secretary of Commerce can adopt regulations to enforce these coastal FMPs if no complementary federal FMP exists.[38] In addition, the federal government must support and cooperate with ASMFC in interjurisdictional fisheries management, including in fisheries science and management.[39]

Among other requirements, coastal FMPs must set out "[a] detailed statement on a state-by-state basis of each specific regulatory, monitoring, and research requirement that each state must implement in order to be in compliance with the plan."[40] The ACFCMA in turn requires states to implement and enforce coastal FMPs.[41] Noncompliance with a coastal FMP by a state can result in a moratorium on fishing in that state[42] and, for fisheries that also occur in federal waters, direct federal regulation of fishing in state waters.[43] In practice, these management measures include specification of allowable catch each year, which may be allocated by region or by state. These state allocations control how much of a species is available to fishermen in each coastal state, and therefore play a central role in the ability of the FMP to adapt to changing conditions.

2 Adaptive Management in US Fisheries Legal Frameworks

Fisheries are changing, and fisheries management systems will have to adapt in order to successfully support sustainable stocks and industry. This section considers whether and how U.S. fishery management systems are prepared for these changes. This analysis is based on evaluation of fisheries management under theories of adaptive management developed by legal scholars.

2.1 Stationarity or a No-Analogue Future?

Legal systems are often developed based on current and observed historical conditions. To be effective in the future, however, they must be able to adapt if and when those conditions change. Stationarity is the idea that "natural systems fluctuate within an unchanging envelope of variability."[44] This "envelope of variability" bounds the higher and lower expected change of a

[37] 16 U.S.C. § 5104.
[38] *Id.* § 5103.
[39] *Id.* § 5103.
[40] ASMFC, INTERSTATE FISHERIES MANAGEMENT PROGRAM CHARTER § 6(b) (2016).
[41] 16 U.S.C. § 5104.
[42] *Id.* § 5106.
[43] *Id.*
[44] P.C.D. Milly et al., *Stationarity Is Dead: Whither Water Management?,* 319 SCIENCE 573, 573 (2008); Robin Kundis Craig, "*Stationarity is Dead" -- Long Live Transformation: Five Principles For Climate Change Adaptation Law*, 34 HARV. ENVTL. L. REV. 10, 15-17 (2010).

system throughout a year.[45] Stationarity thus allows regulators to design policy for a defined range of predictable scenarios, which can simplify the task of regulation.

A regulatory system based on stationarity assumptions can work effectively under observed past conditions but start to break down when conditions violate those assumptions. Climate change is causing environmental conditions to vary beyond the bounds of the stationarity envelope, resulting in fluctuations in natural systems that models may not be designed to predict and policies may not be designed to manage.[46] As a result, both scientists and legal scholars now increasingly agree that stationarity is "dead" as a basis for climate-related regulation.[47] Instead, we are entering a "no-analogue future" where climate change is causing unprecedented changes in environmental conditions, and there is no historical basis for predicting where temperatures, sea levels, weather patterns, or any number of other factors will stabilize in time.[48] Legal frameworks designed for a no-analogue future are not based on defined parameters that serve as boundary conditions, but rather must assume that changing conditions represent the new normal. This section considers how fisheries management reflects stationarity and how it may be strained by changing conditions.

U.S. fishery management reflects stationarity in its geographic assumptions. Federal fisheries management assigns management of fish stocks to a particular, geographically-delimited FMC.[49] However, changing ocean conditions may change or expand the range of managed stocks in unexpected ways. Intercouncil fisheries management tools are available for such situations, but the experience with joint management has been challenging, especially for states like Rhode Island that border two fishery management regions but are represented on only one.[50] In addition, no formally-defined triggers or other procedural mechanisms are provided for shifting responsibility for stock management from one council to another should the stocks move or expand their geographic range. As a result, commentators have noted that this management framework locks management authority for a given stock into the geographic range of that stock at a certain point in time.[51] ASMFC membership, on the other hand, is inclusive of a wider geographic lens that allows the states interested in a stock to change over time—a more flexible management framework. As a result, limits on change in state allocations transition are likely to arise primarily from political forces (e.g., historical anchoring) than the structure of the management framework.

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[45] *Id.*

[46] Craig, *supra* note 44, at 15-16.

[47] Craig Anthony Arnold, *Adaptive Water Law*, 62 KAN. L. REV., 1043, 1052 (2014).

[48] J.B. Ruhl, *Climate Change Adaptation and the Structural Transformation of Environmental Law*, 40 ENVTL. L. 363, 394 (2010).

[49] 16 U.S.C. § 1852(h)(1).

[50] MAFMC, REPORT TO CONGRESS ON COUNCIL MANAGEMENT COORDINATION 34-38 (Oct. 11, 2007) (noting that a greater proportion of Rhode Island fish landings, both by value and by weight, arise from MAFMC-managed fisheries).

[51] Susan E. Farady, *Moving Targets: Fisheries Management in New England in the Midst of Climate Change*, *in* CLIMATE CHANGE IMPACTS ON OCEAN AND COASTAL LAW 73, 78 (Oxford Univ. Press 2015) (noting geographic dispute related to authority over management of loligo squid).

Stock assessments and modeling efforts based on stationarity assumptions may not accurately capture changes in stocks in a no-analogue future, and they may provide misleading information to managers.[52] As Szuwalski and Hollowed explain, "the tools currently used to manage exploited populations have shortcomings when applied to stocks for which population processes are changing over time. If the fisheries management community is going to continue to follow the current approach to setting harvest controls (i.e. setting management targets for individual species based on reference fishing mortalities and biomasses), the issue of non-stationarity should be addressed."[53] For example, changing water temperatures may result in stock fluctuations that are not predicted by stationarity-based fisheries models, resulting in maximum sustainable yield and management determinations that do not effectively maintain stock biomass at desirable levels.[54]

Stationarity limitations in fisheries science are indirectly linked to fisheries laws, most notably through National Standard 2. National Standard 2 requires that conservation and management measures be based on the best available science.[55] This requirement has been the focus of extensive litigation in disputes over the scientific basis of management decisions, suggesting that NMFS has wide latitude in using available science, as long as its decisions are grounded in science and adequately explained.[56] As a result, National Standard 2 is unlikely to restrict the use of stationarity assumptions in annual catch limit determination or rebuilding plans unless and until more accurate models are available. Once no-analogue future models are available, managers could be required to deploy them, with potentially unpredictable results on associated decisions, such as annual catch limits and rebuilding plans and timelines.

2.2 Preservationism and Transitionalism in Fisheries Management

Preservationism and transitionalism provide a second lens through which legal scholars have viewed adaptive management. Preservationist policies adopt a baseline approach "where historical conditions are used to judge whether management or regulatory standards have been satisfied, or whether restoration or mitigation goals have been met."[57] Preservationist policies, such as protection

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[52] *See* Cody S. Szuwalski & Anne B. Hollowed, *Climate Change and non-stationary population processes in fisheries management*, 73 ICES J. MAR. SCI. 1297 (2016) (discussing bias in biomass estimates and management targets resulting from non-stationary processes).

[53] *Id.* at 1301. *See also* Matthew J. S. Windle et al., Exploring spatial non-stationarity of fisheries *survey data using geographically weighted regression (GWR): an example from the Northwest Atlantic*, 67 ICES J. MAR. SCI. 145 (2010) (identifying improvements to fisheries model by addressing spatial non-stationarity).

[54] *Id.*

[55] 16 U.S.C. § 1851.

[56] *See, e.g.* Flaherty v. Bryson, 850 F.Supp.2d 38 (D.D.C. 2012) (upholding NMFS acceptable biological catch rule because it was not required to select plaintiff's preferred model in the absence of contrary data); San Joaquin River Group Authority v. NMFS, 819 F.Supp.2d 1077 (E.D.Cal.2011) (considering bias corrections in management measures); The Ocean Conservancy v. Gutierrez, 394 F.Supp.2d 147 (D.D.C.2005) (NMFS justified in considering studies, expert opinion, and considerations raised by the public in establishing rule).

[57] Eric Biber & Josh Eagle, *When Does Legal Flexibility Work in Environmental Law?*, 42 ECOL. L.Q. 787, 797 (2015) ("many scholars argue that current environmental and natural resources law relies heavily on a preservationist or baseline approach,"). Preservationism in this context is distinct from its meaning as an environmental norm for the use of natural

of an area as habitat for a particular species, embody the idea that natural systems can be maintained in perpetuity in their current condition or returned to a specified prior condition.[58] Preservationism thus can be seen to implement stationarity assumptions.[59]

Scholars tend to agree that preservationism is a problematic construct for regulations that will be affected by climate change.[60] If climate change undermines baseline assumptions due to climate-mediated changes to resources and habitats, preservationist policies may achieve their stated intentions. These critiques associate preservationism with a lack of flexibility and inability to adapt to changes of the magnitude expected with climate change.[61] In addition, preservationist policies raise difficult questions of where the baselines should be set.

Transitionalism can be viewed as a successor to preservationism.[62] Transitionalism refers to legal regimes that are designed to manage for change, both procedurally and substantively.[63] Transitionalist conservation policy would seek to achieve two overarching principles: use of management tools (notably, techniques of habitat restoration and enhancement) to support transitional strategies, and focus on conservation of broader biodiversity goals rather than on preservation of particular species, purposes, or conditions.[64] Transitionalism is thus inherently forward-looking in that it is designed to enable and encourage transformation and movement.[65]

Fisheries management reflects both preservationist and transitional elements. From a preservationist perspective, fisheries management decisions are tightly tied to historical biomass, as estimated in FMPs.[66] The use of historical biomass can be problematic under changing conditions: "if environmental conditions have changed, that which was virgin biomass in the past will not

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resources, where it provides a contrast to exploitation. *See* Gerry J. Nagtzaam, *The International Whaling Commission and the Elusive Great White Whale of Preservationism*, 33 WM. & MARY ENVTL. L. & POL'Y REV. 375, 385-387 (2009) (comparing exploitive, conservationist, and preservationist norms under the international whaling regime); J.B. Ruhl, *Thinking of Environmental Law as a Complex Adaptive System: How to Clean Up the Environment by Making a Mess of Environmental Law*, 34 HOUS. L. REV. 933, 992-993 (1997) (contrasting preservationism with "resourcism").

[58] Ruhl, *supra* note 48, at 393.

[59] *See, e.g.,* Ruhl, *supra* note 48, at 395 ("if stationarity is dead in conservation science, preservationism is dead in conservation policy").

[60] Ruhl, *supra* note 48, at 395; Craig, *supra* note 44, at 17; Biber & Eagle, *supra* note 57, at 797-98 (2015) (collecting sources).

[61] Ruhl, *supra* note 48, at 395; Biber & Eagle, *supra* note 57, at 797-800 (outlining substantive critiques and proposed reforms associated with preservationism).

[62] *Id.* at 394-95.

[63] *Id.* at 395-96.

[64] *Id.*

[65] *Id.*

[66] 50 C.F.R. § 600.310 (establishing guidelines for national standard 1, including MSY and status determination criteria); NAT'L MAR. FISHERIES SERV., DESCRIPTION OF METHODOLOGY FOR DETERMINING OVERFISHING AND OVERFISHED STATUS 3, http://www.nmfs.noaa.gov/sfa/fisheries_eco/status_of_fisheries/archive/2013/methodology.pdf.

necessarily be the same as could be achieved in the absence of fishing today."[67] In such cases, stock status determinations and resulting annual catch limits or rebuilding plans may be unrealistic, resulting in unexpected management outcomes.[68] For example, a stock deemed overfished may not be capable of recovery[69]—a situation that arguably may be occurring in the case of Atlantic cod[70]—or may recover in a different time period than expected.

On the other hand, some commentators argue that fisheries management is extremely flexible and responsive to changing conditions, an approach that can be characterized as highly transitionalist. In particular, Professors Eric Biber and Josh Eagle note that managers can and do rapidly respond to changing conditions through a variety of discretionary mechanisms, including incorporating new science, altering optimum yield determinations, and amending stock models used to establish catch targets.[71] Using these and other procedural tools, "the fisheries governance system has managed to produce thousands of annual management measures for the hundreds of fisheries under management for nearly forty years."[72] Indeed, they conclude that FMCs had so much flexibility prior to the 1996 Sustainable Fisheries Act that their decisions were not successful in producing MSY from stocks under management.[73] Fishermen transitioned among stocks in response to resultant stock declines.[74]

The coastal lobster fishery of southern New England is a prime example of a transitionalist approach to fisheries management.[75] Managers of this fishery had known for several years that the

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[67] John K. Pinnegar & Georg H. Engelhard, *The 'Shifting Baseline' Phenomenon: A Global Perspective*, 18 REVIEWS IN FISH BIOL. & FISHERIES 1, 2 (2008)

[68] *Id.* at 1-2 (2008) ("The emergence of precautionary management has resulted in greater emphasis on fisheries 'reference points'. Chief among these precautionary reference points has been the biomass of the stock relative to assumed 'virgin stock size' (B_0). In most fisheries assessments, estimating virgin biomass (B_0) depends either on extrapolating back to well before we began to have reliable data or on taking estimates of annual recruitment and calculating what virgin biomass these would have produced in the absence of fishing pressure. All such calculations are highly subjective." (internal citations omitted)).

[69] Szuwalski & Hollowed, *supra* note 52, at 1299 (discussing "one-way trips" that occur "when a stock has been depleted to a small fraction of the estimated unfished biomass or its proxy and then it does not recover when fishing pressure is reduced.")

[70] The connection between cod stocks and climate change is debated in the scientific literature. Keith M. Brander, *Climate change not to blame for cod population decline*, 1 NATURE SUSTAINABILITY 262 (2018) (comparing North Sea and Gulf of Maine cod stocks to suggest that fishing pressure, not climate change, is causing decline of Gulf of Maine cod); AJ Pershing et al., *Slow adaptation in the face of rapid warming leads to collapse of the Gulf of Maine cod fishery*, 350 SCIENCE 809 (2015) (arguing that climate change is primary driver for Gulf of Maine cod decline).

[71] Biber & Eagle, *supra* note 57, at 802-04.

[72] *Id.* at 803.

[73] *Id.* at 808 ("[S]tocks improved as the law became less flexible--i.e., as it imposed greater constraints on the discretion of management councils and NOAA.").

[74] Daniel Pauly et al., *Fishing Down Marine Food Webs*, 279 SCIENCE 860 (1998) (tracking changes in species landed by fishing industry over time).

[75] Farady, *supra* note 51, at 74-76.

stock was failing as a result of environmental drivers and continued fishing pressure.[76] By 2013, ASMFC concluded that its members doubted the stock's ability to rebuild to historical levels, but instead of closing the fishery, managers allowed it to continue.[77] This decision was based on the uncertainty that the southern New England lobster stock would recover even with a full moratorium; instead, it was decided that the best course of action would be instead to allow the stock to continue to be depleted while the fishermen were transitioned to fishing other stocks.[78]

Rhode Island has implemented the expected transitional management in the lobster fishery primarily through a shift to Jonah crab. Jonah crab is an increasingly important species in southern New England, including Rhode Island, due to increased landings and market value.[79] Rhode Island has limited eligibility for participation in the increasingly important commercial Jonah crab fishery to fishermen with a lobster trap allocation,[80] a step that makes sense due to the similarity of lobster and crab gear and to allow lobster fishermen to replace lost earnings with increased crab catch. While the long-term sustainability of this approach is uncertain,[81] it embodies the transitionalism concept through the reservation of an entire stock for fishermen who are participants in a related, declining fishery.

The decline of the southern New England lobster fishery and transition to Jonah crab can be seen as an embodiment of transitionalism over preservationism. A preservationist approach would have placed a moratorium on lobster harvest in order to allow these stocks to recover, and likely would be required for stocks managed under the MSA. At the federal level, the amendments to the MSA in 1996 and 2007 constrained the procedural flexibility available to FMCs, including through requirements to determine annual catch limits, deploy accountability measures to prevent overfishing, and impose rebuilding plans on short timeframes upon a determination that a stock is overfished.[82] Under these provisions, FMCs are more constrained than the ASMFC in implementation of transitional management approaches.

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[76] ASMFC American Lobster Technical Committee, Recruitment Failure in the Southern New England Lobster Stock (2010).

[77] Farady, *supra* note51, at 84.

[78] *Id.* at 84-85.

[79] ASMFC, INTERSTATE FISHERY MANAGEMENT FOR JONAH CRAB 1 (2015).

[80] 25-8 R.I. CODE R. § 4:15.5.2(B).

[81] The ASMFC developed a FMP for Jonah crab in response to concerns over the sustainability of the rapidly growing fishery, which targets a species at a lower trophic level than lobster which has a largely unknown life history and biomass. *See* ASMFC, INTERSTATE FISHERY MANAGEMENT FOR JONAH CRAB (2015).

[82] *See* Lindsay Walton, *Introduction to the Magnuson-Stevens Act*, in CLIMATE CHANGE IMPACTS ON OCEAN AND COASTAL LAW 65, 67-68 (Randall S. Abate, ed. 2015) (discussing amendments to MSA).

2.3 Command and Control

"Command and control" regulatory systems operate by establishing prescriptive standards of conduct.[83] Because these systems are seen as rigid, they may be considered incompatible with adaptation to changing conditions. This rigidity is one of several criticisms of command-and-control systems, which are widely seen as problematic in the legal literature.[84] Legal scholars have advocated for a range of reforms for command-and-control frameworks, notably including the use of flexible, market-driven or self-regulatory mechanisms to increase the efficiency of regulatory systems.[85]

Legal commentary on fisheries management has been consistent with broader arguments against command-and-control and advocating for market-driven regulatory systems.[86] Commentators characterize fisheries management as a prototypical command-and-control system because it is complex and prescriptive.[87] Fishing regulations may comprehensively dictate how the fishing industry operates: when fishing can occur, how much of a given stock can be caught each trip, what gear or vessels may be used to catch it, when it can be landed, to whom it can be sold, among other requirements.

Market-driven management systems, such as individual fishing quotas (IFQ) or "catch shares," have been presented as an alternative.[88] Catch share systems remove certain fisheries regulations—typically, those related to effort restrictions, such as seasons and trip limits, and allow fishermen flexibility to catch a certain amount of fish on an annual basis rather than during a short season. However, these systems do not affect other fisheries regulations, such as stock assessment and yield determination processes and some gear restrictions (e.g., circle hooks or mesh size requirements to address bycatch). In this respect, fisheries market-management systems are consistent with other

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[83] Jodi L. Short, *The Paranoid Style in Regulatory Reform*, 63 HASTINGS L.J. 633, 559-660 (2012) (quoting James E. Krier & Richard B. Stewart, *Using Economic Analysis in Teaching Environmental Law: The Example of Common Law Rules*, 1 UCLA J. ENVTL. L. & POL'Y 13, 15n.3 (1980)) ("Although 'command and control' has become widely used short-hand in contemporary legal circles, it is rarely defined and its meanings and functions have become either submerged or taken for granted. . . . A 1980 article by James Krier and Richard Stewart provides an early definition of the term: 'As the phrase perhaps implies, this regulatory approach typically proceeds by imposing rigid standards of conduct . . . backed up by sanctions designed to assure full compliance with such standards . . . .'").

[84] *Id.* at 662-663 (coding concerns as "bureaucracy, coercive, costly, end-of-pipe, ineffective, inefficient, information, interest group, legalistic, and uniform.")

[85] *See id.* at 662-668; Daniel C. Esty, *Red Lights to Green Lights: From 20th Century Environmental Regulation to 21st Century Sustainability*, 47 ENVTL. L. 1 (2017) (arguing for broad shift toward market-based regulatory structures and incentives).

[86] Alison Rieser, *Prescriptions for the Commons: Environmental Scholarship and the Fishing Quotas Debate*, 23 HARV. ENVTL. L. REV. 393 (1999).

[87] *Id.* at 398-99.

[88] *Id.*; *see also* NOAA, NOAA CATCH SHARE POLICY (2010), http://www.nmfs.noaa.gov/sfa/management/catch_shares/about/documents/noaa_cs_policy.pdf.

legal systems, where "most of the market approaches that have been used in the United States operate within the standard command-and-control framework."[89]

While command-and-control regulatory systems, including fisheries management, have been criticized, the relationship between these systems and climate resilience have received surprisingly little attention to date. However, three of the catalogued complaints about command-and-control systems appear to implicate resilience, including rigidity, "end-of-pipe" approach, and informational limitations. The remainder of this section assesses each of these critiques in the context of fisheries management and climate resilience.

2.3.1 Rigidity in Fisheries Management

The rigidity critique of command-and-control systems suggests that regulatory systems based on complex systems of rules are too rigid and inflexible to effectively govern[90]—or to adapt to changing conditions. While fisheries management is undoubtedly complex, legal commentators have noted that systems of rules are not necessarily inflexible or difficult to change.[91] Fisheries management, in particular, is among the nimblest regulatory systems from both a procedural and a substantive perspective.[92]

From a procedural perspective, fisheries managers have demonstrated an ability to effectively manage within the constraints of federal and state rulemaking requirements. Managers use regulatory amendments to set new annual measures in every fishery under management, as well as to rapidly respond to new information when required, such as through adjustment of catch limits.[93] In addition, FMCs have developed framework adjustment processes to enable them to change FMPs without the need to conduct the multi-year process of developing a new plan amendment.[94] While some management actions, such as full FMP amendment, may require long processes, the evidence to date does not suggest that the command-and-control structure of fisheries management has caused procedural rigidity that would undermine response to climate change.[95]

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[89] Daniel H. Cole, *Environmental Instrument Choice in a Second-Best World: A Comment on Professor Richards*, 10 DUKE ENVTL. L. & POL'Y F. 287, 289 (2000) (quoting J. CLARENCE DAVIES & JAN MAZUREK, POLLUTION CONTROL IN THE UNITED STATES: EVALUATING THE SYSTEM 15 (1998)).

[90] Short, supra note 83, at 689 n.281 (collecting articles); J.B. Ruhl, *Thinking of Environmental Law as a Complex Adaptive System: How to Clean up the Environment by Making a Mess of Environmental Law*, 34 HOUS. L. REV. 933, 940 (1997).

[91] Short, *supra* note 83, at 987; Cole, *supra* note 89, at 293 n.39 (citing Kenneth R. Richards, *Framing Environmental Policy Instrument Choice*, 10 DUKE ENVTL. L. & POL'Y F. 221, 264 (2000)) (noting that "one of the primary advantages of hierarchical instruments (i.e., direct regulations) is that they allow rapid adaptation to changes.").

[92] Biber & Eagle, *supra* note 57, at 802-808.

[93] *Id.* at 802-03 (noting that "in practice the fisheries governance system has managed to produce thousands of annual management measures for the hundreds of fisheries under management for nearly forty years").

[94] Dan Gourlie, *Reeling in Uncertainty: Adapting Marine Fisheries Management to Cope with Climate Effects on Ocean Ecosystems*, 47 ENVTL. L. 179, 220-221 (2017) (noting limitations of framework adjustment for rapid response).

[95] Lawmakers have expressed concern that a recent Executive Order seeking regulatory repeals may undermine the rulemaking necessary for federal fisheries management. Letter from Raúl M. Grijalva, Ranking Member, U.S. House of

Fisheries management structures also provide substantive flexibility that may support resilient approaches to changing conditions. FMCs and regional entities have broad discretion to set harvest levels as well as to identify the most appropriate management measures to achieve those levels at the state and regional levels.[96] Managers may not deploy these tools regularly to adapt fisheries management approaches in practice—for example, regional bodies such as ASMFC may be slow to reallocate quota from state to state in response to changing conditions, a political judgement that protects entrenched fishermen and related businesses. However, fisheries managers at both the federal and regional levels do have sufficient legal authority to change management measures and yield targets more proactively if they should so choose.

2.3.2 End-of-Pipe Regulation in Fisheries Management

The "end-of-pipe" critique of command-and-control systems is that they mitigate impacts through regulations instead of establishing systems that empower industries to avoid those impacts in the first place.[97] "End-of-pipe"-style regulations could, in theory, undermine climate adaptation efforts by preventing industry from adopting new or different technology to adapt to changing conditions. While commentators have noted that command-and-control systems often contain mechanisms or incentives allowing creative and novel solutions,[98] the "end-of-pipe" critique suggests a shift from specific technological requirements to market-driven regulations that allow industry to determine how to achieve required outcomes.[99]

The "end-of-pipe" critique can be applied primarily to the aspects of fisheries regulations that seek to avoid negative impacts—notably, bycatch and overfishing. Some bycatch avoidance regulations work through prescriptive gear limits, such as the mesh size restrictions in the New England groundfish trawl fishery.[100] Other regulations are less prescriptive, such as the limits on incidental catch of haddock in the northeast herring mid-water trawl fishery.[101] Under this system, the herring

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Reps. Comm. on Nat'l Res. And Jared Huffman, Ranking Member, U.S. House of Reps. Subcomm, on water, Power, and Oceans, to President Donald Trump (Feb. 2, 2017) ("We are writing today to express our grave concern over the executive order . . . requiring federal agencies to, among other things, identify at least two regulations to be repealed when proposing a new regulation. . . . All fisheries that take place in federal waters require regulatory action to open and close seasons, set catch limits, modify conservation and management measures, or adjust participation eligibility requirements. In many cases, multiple regulations must be enacted each year for a single fishery and that is a good thing . . ."). While this order may affect some types of fisheries rulemakings, it does not apply to actions needed to manage fisheries on an ongoing basis because they are not "significant." *See, e.g.* Atlantic Highly Migratory Species: Atlantic Bluefin Tuna Fisheries, 82 Fed. Reg. 39,047 (Aug. 17, 2017) (noting inapplicability of Executive Order 13,771 because temporary closure of tuna fishery is not a significant rulemaking under Executive Order 12,866).

[96] *Id.* at 803-06 (noting legislative changes to reduce discretion).

[97] Short, *supra* note 83, at 690 n.282 (collecting articles).

[98] *Id.* (noting that environmental statutes are based on performance standards, not on the use of specific technologies, and that regulated entities can adopt a range of approaches to meet those standards).

[99] Amy Sinden, *The Tragedy of the Commons and the Myth of a Private Property Solution*, 78 U. COLO. L. REV. 533, 550-51 (2007).

[100] 50 C.F.R. § 648.80.

[101] 50 C.F.R. § 648.86(a)(3).

fishery is constrained once it reaches a maximum level of haddock bycatch.[102] Bycatch caps enable fishermen to avoid bycatch by any means rather than through a single required method—an approach that heeds "end-of-pipe" critiques. However, the practical experience of such caps can be difficult—for example, the mid-water herring fishery was essentially closed for months in 2016 after hitting its cap.[103] Climate change may affect bycatch, however regulated, as it changes the distributions and characteristics of fish stocks. However, these changes may cause particular challenges in systems such as Atlantic herring, in which fishermen are responsible for avoiding bycatch rather than relying on set gear restrictions as a safe harbor.

Efforts to avoid overfishing are based on management measures to achieve yield targets. Historically, management measures employed effort limitations to meet these targets, including through daily or trip-based possession limits and fishing seasons.[104] Market-based management, in the form of catch share systems, has more recently been employed to offer fishermen more flexibility in when and where to fish.[105] While effort-based and catch-share systems have many differences, it is not clear that one or the other is better prepared for changing environmental conditions. Instead, both are ultimately intended to achieve yield targets, which themselves will change as individual stocks fluctuate. Efforts to shift fisheries management from single-species yield targets to overall ecosystem health, through "fishery ecosystem plans" or other ecosystem-based management systems, could have a greater impact by allowing fishermen to alter target stocks within an ecosystem over time as stocks shift in response to changing conditions.[106]

2.3.3 Informational Deficits in Fisheries Management

The informational deficit critique of command-and-control systems applies to management under changing conditions. This critique argues that "regulators lack information held by regulated entities that is essential to effectively dispatching their jobs. This makes regulation both costly and ill-informed."[107] To address informational deficits, command-and-control systems often include information-gathering or disclosure mechanisms to transfer knowledge from industry to regulators.[108] In the climate change context, informational deficits may be problematic if regulated

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[102] *See* NMFS, Atlantic Herring Fishery: Changes to Haddock Incidental Catch Measures (Sep. 14, 2011) (explaining system).

[103] Laurie Schreiber, *Herring v. Haddock in Data Debate*, FISHERMAN'S VOICE, Feb. 2016, http://www.fishermensvoice.com/archives/201602Index.html.

[104] NMFS, NOAA Catch Share Policy (Jan. 4, 2017), https://www.fisheries.noaa.gov/webdam/download/64669109.

[105] *Id.*

[106] *See* E.K. Pikitch et al., *Ecosystem-based Fisheries Management*, 305 SCIENCE 346 (2004) (advocating for shift from single-species to ecosystem approach).

[107] Short, *supra* note 83, at 691, 691 n.286 (collecting articles); David A. Dana & Hannah J. Wiseman, *A Market Approach to Regulating the Energy Revolution: Assurance Bonds, Insurance, and the Certain and Uncertain Risks of Hydraulic Fracturing*, 99 IOWA L. REV. 1523, 1523 (2014) ("Command and control regulations will be an important first step to prevent contamination but cannot address all risks, particularly those for which industry has more knowledge than agencies.").

[108] Justin R. Pidot, *Governance and Uncertainty*, 37 CARDOZO L. REV. 113 (2015) (identifying typology of strategies for addressing informational deficits in governance systems).

entities are aware of changing conditions, but regulators are not. In such cases, decisions may be tailored to past conditions but suboptimal for the present and future.

Fisheries managers must make decisions in the face of uncertainty about the status and trends of fish stocks. These decisions are based on data and interpretive models obtained from fishery-dependent and fishery-independent sources.[109] Both federal and regional management are subject to substantive and procedural limitations on how they apply these data. For example, procedural mechanisms such as the SSCs are required to ensure that managers deploy scientific information effectively,[110] and substantive requirements like National Standard 2 require the use of the best available scientific information.[111]

Rapid changes in marine ecosystems may strain the ability of existing data sources to support effective management decisions. Fishermen may perceive changes in the abundance and range of fish populations before these changes are reflected in stock assessments, model outputs, or management decisions such as state allocations. In such cases, expansion of fishery-dependent data collection could be one among an array of options for reducing informational deficits and ensuring that management decisions remain well-matched to actual conditions.

2.4 Principled Flexibility

Professor Robin Kundis Craig has proposed "principled flexibility" as the aspirational standard to which environmental regulations should aspire in an age of climate change. She defines this construct to mean that:

> both the law and regulators (1) distinguish in legally significant ways uncontrollable climate change impacts from controllable anthropogenic impacts on species, resources, and ecosystems that can and should be actively managed and regulated, and (2) implement consistent principles for an overall climate change adaptation strategy, even though the application of those principles in particular locations in response to specific climate change impacts will necessarily encompass a broad and creative range of adaptation decisions and actions.[112]

Professor Craig identifies promotion of principled flexibility in natural resource management as one of five principles for climate adaptation. This approach includes flexibility in management when facing climate-mediated changes. For example, climate change may increase water temperature, resulting in degradation of water quality for fish and triggering restrictions on pollution in order to return the watercourse to its prior state.[113] A principled flexibility approach would recognize that

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[109] PATRICK KILDUFF ET AL., ASMFC, GUIDE TO FISHERIES SCIENCE AND STOCK ASSESSMENTS 7-14 (Tina L. Berger, ed. 2009) (discussing types and uses of data sources).
[110] 16 U.S.C. § 1852(g)(1)(A).
[111] *Id.* § 1851(a)(2).
[112] Craig, *supra* note 44, at 17-18.
[113] *Id.* at 64.

imposition of restrictions will not solve the problem and allow a "climate adaptation" exemption to avoid inefficiency and wasted effort—provided that the responsible agency can demonstrate the impossibility of accomplishing its regulatory mandate.[114] Flexibility to implement adaptive management mechanisms is also needed, including the ability to make regular changes in regulations in response to changing conditions.[115] Substantively, decisions would be made on a "no regrets" basis that seeks to be beneficial even if projected changes do not occur as expected.[116]

Fisheries management laws and regulations incorporate a variety of mechanisms consistent with principled flexibility. For example, the minimum stock size threshold used to determine overfished status can be informed by life history fluctuations or "other considerations."[117] The guidelines for National Standard 2 require inclusion of "the relevant range of scientific disciplines" and acknowledgement of information gaps and identification of assumptions and uncertainty.[118] Similarly, National Standard 6 requires that conservation and management measures must account for variation in fisheries, and its associated guidelines call for an adequate buffer for conservation to avoid overfishing—a "no regrets" policy.[119] The administrative functioning of fisheries management is also highly adaptive, as regulations to accomplish critical tasks (e.g., season openers and closures, yield target determinations) are issued at least annually. Further, the practical experience with the southern New England lobster fishery suggests that policy makers have substantial discretion to allow reductions in biomass of stocks impacted by climate change.

In many respects, then, fisheries management appears consistent with principled flexibility—although managers have rarely explicitly distinguished the influences of climate change from anthropogenic influences. This may be starting to change, however. For example, NOAA Fisheries has developed a climate science strategy intended in part to ensure compliance with the best available science mandate under the MSA—an important step towards identification of controllable impacts and adaptation principles.[120]

These examples suggest that fisheries management includes substantial flexibility, but that flexibility is associated only in limited circumstances with the explicit, legally-significant constraints and climate strategies needed for it to be considered "principled flexibility" as defined by Professor Craig.

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[114] *Id.*

[115] *Id.* at 66.

[116] *Id.*

[117] 50 C.F.R. § 600.310(e)(2)(ii)(B). *See also* Craig, *supra* note 44, at 46-48 (suggesting that yield criteria, and in particular MSY, should be converted to a standard that is "clearly sustainable even under climate change.").

[118] 16 U.S.C. § 1851; 50 C.F.R. § 600.315(a).

[119] 16 U.S.C. § 1851; 50 C.F.R. § 600.335.

[120] NOAA, NOAA Fisheries Climate Science Strategy, Technical Memorandum NMFS-F/SPO-155 (Jason S. Link et al., eds., 2015).

3 Black Sea Bass: Management of a Changing Fishery

Consideration of the ability of fisheries management systems to adapt to changing conditions can be illustrated through a case study applying theoretical considerations to a specific context. This section applies the discussion in the prior section to the Atlantic black sea bass fishery—a complex fishery that is experiencing rapid change.

3.1 Fishery Overview

The black sea bass (*Centropristis striata*) is a bottom-dwelling, predatory fish often found near reefs and sheltered bottom areas.[121] The fish can grow up to be around two feet in length and may live for fifteen to twenty years.[122] Adults generally migrate north and inshore to follow warming water temperatures in the spring and then travel back south and offshore during the fall.[123]

Black sea bass is a popular species that is harvested by a variety of gear types in both coastal and offshore waters across the entire Atlantic coast.[124] Commercially, otter trawl gear accounts for 65% of catch, while fish pots and traps, lobster traps, hand lines, and other gear are also used.[125] Because the species crosses jurisdictional lines, the MAFMC and the ASMFC cooperatively manage the black sea bass fishery from North Carolina to Canada as a single stock under Amendment 9 of the Summer Flounder, Scup and Black Sea Bass FMP, as amended, which MAFMC created in cooperation with NEFMC, the South Atlantic FMC, and NMFS.[126] NMFS has issued regulations to implement the FMP.[127]

Over the past few years, the black sea bass stock has been shifting northwards in correlation with rising ocean temperatures.[128] For example, over thirty percent of the total catch of black sea bass in both 2016 and 2017 was caught in sector 616, which is located directly east of the coast of New Jersey and south of Long Island. [129] This catch represents a substantial increase from 2014 and 2015, when sector 616 was only responsible for sixteen percent and thirteen percent, respectively, of the

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[121] Maryland Department of Natural Resources, *Black Sea Bass*, http://dnr.maryland.gov/fisheries/Pages/Fish-Facts.aspx?fishname=Black%20Sea%20Bass.

[122] *Id.*

[123] *Id.*

[124] MAFMC, BLACK SEA BASS FISHERY INFORMATION DOCUMENT 4 (2017).

[125] *Id.*

[126] *See* MAFMC, *Fishery Management Plan and Amendments: Summer Flounder, Scup, Black Sea Bass*, http://www.mafmc.org/fisheries/fmp/sf-s-bsb.

[127] 50 C.F.R. §§ 648.140 – 648.149.

[128] MAFMC, Black Sea Bass Fishery Information Document (2017). http://www.mafmc.org/s/BSB_fishery_info_doc2017.pdf.

[129] MAFMC, Black Sea Bass Fishery Information Document (2016), http://www.mafmc.org/s/BSB_fishery_info_doc2016.pdf; MAFMC, Black Sea Bass Fishery Information Document (2017), http://www.mafmc.org/s/BSB_fishery_info_doc2017.pdf. Sector 616 was responsible for most of the black sea bass landings in both 2016 and 2017. In 2016 sector 616 was responsible for roughly thirty-five percent of black sea bass landings, and in 2017 it was responsible for thirty-four percent of landings. *Id.*

total catch.[130] The increases in northerly sectors contrast against declines in more southerly areas. Similarly, state contributions to black sea bass recreational landings have shifted northwards.[131] For example, New Jersey contributed 38 percent of recreational landings in 2012, but only 12 percent in 2016.[132] Conversely, Connecticut landings increased from six percent in 2012 to 17 percent in 2016.[133] This trend has led to "extremely high availability" of fish in northern states, which is contributing to recreational quota overages "despite very restrictive management measures"[134] and contributing to high levels of discard in commercial fisheries.[135]

Black sea bass has historically been considered a "data-poor stock," and several models for mapping the population have been rejected due to the uncertain nature of the survey data, resulting in calls for additional fishery-independent surveys to be conducted in order to more accurately survey the fish stocks.[136] A benchmark stock assessment was completed and reviewed in 2016 by the Stock Assessment Review Committee, resulting in changes to the stock assessment model and development of new biological reference points for the species.[137]

In 2017, the MAFMC SSC accepted the revised stock assessment model for use in setting overfishing limits for black sea bass management.[138] The stock assessment indicates that the stock is neither overfished nor undergoing overfishing.[139] The model estimates that spawning stock biomass—the threshold indicator for minimum stock size, is 2.3 times greater than the level at MSY, and fishing mortality (0.27) was less than the threshold mortality for MSY (0.36).[140] Both biomass and fishing mortality levels indicate that the stock is substantially healthier than in previous years, when biomass at times fell below the minimum stock size threshold (particularly prior to federal management).[141]

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[130] MAFMC, Black Sea Bass Advisory Panel Information Document (2014), http://www.mafmc.org/s/BSB-AP-FPR-Info-Doc-June-2014-s9ie.pdf; MAFMC, Black Sea Bass Fishery Information Document (2015), http://www.mafmc.org/s/BSB_fishery_info_doc2015_final-r13c.pdf.

[131] MAFMC, BLACK SEA BASS FISHERY INFORMATION DOCUMENT (2017); MAFMC, BLACK SEA BASS ADVISORY PANEL INFORMATION DOCUMENT (2014). Recreational landings are used because they are likely to be geographically linked with the location where fish are caught.

[132] *Id.*

[133] *Id.*

[134] ASMFC, ADDENDUM XXVII TO THE SUMMER FLOUNDER, SCUP, AND BLACK SEA BASS FISHERY MANAGEMENT PLAN § 2.1.2 (2016).

[135] Alex Kuffner, *Front Line of Climate Change: Black Sea Bass Surge off R.I.*, PROVIDENCE J., Jul. 15, 2018, http://www.providencejournal.com/news/20180715/front-line-of-climate-change-black-sea-bass-surge-off-ri.

[136] Gary Shepherd, *Black Sea Bass, in* NORTHEAST DATA POOR STOCKS WORKING GROUP REPORT 423, 434 (2008), https://www.nefsc.noaa.gov/publications/crd/crd0902/blackSeaBass/bsbText.pdf.

[137] MAFMC, BLACK SEA BASS FISHERY INFORMATION DOCUMENT (2017).

[138] Memorandum from Michael Luisi, MAFMC Chairman, to John Boreman, Chair, MAFMC SSC (Jan. 27, 2017), http://www.mafmc.org/s/January-2017-SSC-Report.pdf.

[139] MAFMC, BLACK SEA BASS FISHERY INFORMATION DOCUMENT (2017).

[140] *Id.* at 2.

[141] *Id.* at 2-3.

The fishery management plan divides the black sea bass stock between the recreational fishery and the commercial fishery; the recreational fishery receives 51% of the total quota and the commercial fishery receives 49%.[142] Under this formula for the year 2017, 4.12 million pounds of black sea bass was allocated to the commercial fishery and 4.29 million pounds was allocated to the recreational fishery.[143] These quota allocations incorporate a buffer, so that they are less than the annual catch limits for both the commercial and the recreational sectors.[144] In past years, commercial sector landings have closely approximated quota, while recreational landings have routinely exceeded quota, including landings of 184% of quota in 2016.[145]

The commercial black sea bass quota is divided among the states on a state-by-state basis.[146] The ASMFC established these state allocations in 2002, during the development of Amendment 13 to the FMP, to allocate fishing by state under the new federal coastwide quota system, which was intended in part to avoid possible inequities as the landings shifted northwards.[147] The ASMFC renewed these state allocations in 2004 for the years 2005-07.[148] It then renewed them without expiration in 2007,[149] and the original allocation percentages remain in effect today.

Under the state allocation system, each state is responsible for managing its own commercial fishery, primarily through input controls such as time and area closures and license limitation schemes.[150] States must also comply with coastwide restrictions. Coastwide specifications for the commercial fishery include minimum commercial size, minimum net mesh size, and escape vent size and placement on traps and pots.[151] Coastwide recreational specifications include minimum size, possession limit, and season restrictions, which since 2011 have been set separately for the northern

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142 *Id.*

143 MAFMC, Black Sea Bass Fishery Information Document (2017).

144 *Id.* at 5.

145 *Id.*

146 *Id.*

147 MAFMC & ASMFC, AMENDMENT 13 TO THE SUMMER FLOUNDER, SCUP, AND BLACK SEA BASS FISHERY MANAGEMENT PLAN, VOL. 1 15 (2002) ("After considerable debate, the Commission adopted allocation percentages for 20013 and 2004 that represented a compromise between the allocation percentages associated with [] various base periods . . . [1988-97 and 1993-97] and the current fishing patterns, i.e. 2001 landings"). ASMFC, ADDENDUM XIX TO THE SUMMER FLOUNDER, SCUP, AND BLACK SEA BASS FISHERY MANAGEMENT PLAN (2007).

148 ASMFC, ADDENDUM XII TO THE SUMMER FLOUNDER, SCUP, AND BLACK SEA BASS FISHERY MANAGEMENT PLAN (2004).

149 ASMFC, ADDENDUM XIX TO THE SUMMER FLOUNDER, SCUP, AND BLACK SEA BASS FISHERY MANAGEMENT PLAN (2007).

150 *Id.* ("Under this program, states have the responsibility of managing their quota for the greatest benefit of the commercial black sea bass industry in their state. States designed allocation systems based on state specific landing patterns using possession limits and seasons to ensure a continuous and steady supply of product over the season for producers and/or a fair and equitable distribution of black sea bass to all fishermen who have traditionally landed black sea bass in their state.").

151 50 C.F.R. § 648.144.

and southern states in order to constrain recreational catch in areas where sea bass are highly available and quota overages occurring.[152]

The Rhode Island Department of Environmental Management (RIDEM) manages commercial and recreational fisheries in the state, including for black sea bass.[153] Rhode Island receives 11 percent of the commercial black sea bass allocation, which totaled approximately 453,200 pounds in 2017.[154] Rhode Island requires its commercial fishermen to obtain a Restricted Finfish endorsement.[155] Endorsements are limited based on a "rotating door" licensing system with a 1:1 exit/entry ratio. Under this system, one new license with a restricted finfish endorsement is available for every one license with a restricted finfish endorsement that is not renewed.[156] The state regulations split the year into six seasons, each with its own catch limit.[157] For example, the January 1 to April 30 season is allocated twenty-five percent of the state's quota, and fishermen are allowed to land 750 pounds of black sea bass per week during this period.[158] The fishery is closed from August 1 until September 14.[159] RIDEM regulations also implement the required gear requirements and minimum size limits—fifteen inches for recreational and eleven inches for commercial, as well as daily or weekly possession limits that vary by season.[160]

3.2 Climate Change Impacts on the Black Sea Bass Fishery

The black sea bass fishery is changing rapidly along with changing environmental conditions. As a result, it is a useful case study to illustrate how the theories of climate adaptation discussed in section 2 may play out in practice. This section provides evaluates the fishery on each of the adaptation theories.

3.2.1 Stationarity

The black sea bass fishery exhibits stationarity primarily in a mismatch between the location of the stock and its managers. While understanding of the fishery has improved as the stock has shifted northwards, that range shift has not affected responsibility for management or allocations of fishing rights on a state level.

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[152] ASMFC, ADDENDUM XXVII TO THE SUMMER FLOUNDER, SCUP, AND BLACK SEA BASS FISHERY MANAGEMENT PLAN (2016); ASMFC, ADDENDUM XXI TO THE SUMMER FLOUNDER, SCUP, AND BLACK SEA BASS FISHERY MANAGEMENT PLAN FOR PUBLIC COMMENT (2011) (establishing regional restriction system).

[153] R.I. Admin. Code 25-8-4:3.14.

[154] MAFMC, BLACK SEA BASS FISHERY INFORMATION DOCUMENT (2017).

[155] The Restricted Finfish endorsement includes: scup, summer flounder, tautog, striped bass, and black sea bass. Non-Restricted Finfish include all species of finfish and squid available for commercial harvest except the five species specified in the restricted finfish endorsement category. 25 R.I. ADMIN. CODE 8-21:6.1.1(a)(vi).

[156] R.I. Admin. Code 25-8-21:6.1.10 (2017).

[157] R.I. Admin. Code 25-8-4:3.14.2(B) (2017).

[158] R.I. Admin. Code 25-8-4:3.14.2(B)(1) (2017).

[159] R.I. Admin. Code 25-8-4:3.14.2(B)(4) (2017).

[160] *Id.*

From a fishery science perspective, the shifting stock range and high levels of availability noted in the northern states suggests that the stock may have shifted outside of its historic geographic envelope of variability. This potential violation of stationarity conditions does not appear to have led to inadequate or unrealistic stock models, however, due to continued scientific investment. As the black sea bass has long been considered a data-poor stock, managers have worked to better understand the stock and to develop realistic stock assessment models, even as the stock has been changing. As the most recent model was adopted within the last calendar year,[161] it is likely that it captures the dynamic movement of the stock since 2002. Moreover, this model produced new status determination criteria,[162] which may be effectively matched to conditions in effect when the model was developed.

While investments in black sea bass modeling may avoid stationarity issues from a scientific perspective, the management structure for the species illustrates procedural stationarity at both federal and regional levels. The federal Mid-Atlantic Fisheries Council (MAFMC) is responsible for management of the federal black sea bass fishery and FMP, but a substantial portion of the stock under federal management now exists in states that are not members of the MAFMC and therefore not represented by council members with voting powers.[163] For example, Rhode Island is home to an increasing share of the Black Sea Bass fishery, but is a voting member only of the NEFMC. While the NEFMC is consulted on issues related to the black sea bass FMP, consultation is not equivalent to direct management responsibility. This mismatch is similar to a range shift affecting loligo squid, which gave rise to efforts (unsuccessful to date) to add Rhode Island to the MAFMC.[164]

Regional black sea bass management does not create a geographic mismatch between the regulators and stock because all states in the black sea bass range are ASMFC members. However, the ASMFC has not updated or changed its state quota allocations since they were initially negotiated in 2002, based on historical harvest as far back as 1988.[165] While the creation of set state allocations was intended to avoid inequity as the stock shifted northward,[166] continuation of the initial allocations over such a long period suggests that those allocations are not linked to the evolving geographic range and prevalence of the species. This static allocation may avoid economic dislocation to the industry in southerly states where stocks are declining, but it may conversely result in higher bycatch and related discard mortality—and a missed economic opportunity for fishers—in northerly states with lower allocations but larger stocks.

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161 MAFMC, BLACK SEA BASS FISHERY INFORMATION DOCUMENT (2017).

162 *Id.*

163 16 U.S.C. § 1852 (defining state membership in FMCs).

164 Farady, *supra* note 51, at 78.

165 MAFMC & ASMFC, *supra* note 147.

166 *Id.*

3.2.2 Preservationism/Transitionalism

As described in the previous section, the recent adoption of a new stock assessment model and status determination criteria suggest that managers are attempting to model the black sea bass stock as it exists today, rather than to anchor it in a past condition. In this respect, its status as a data-poor stock may provide an advantage to managers. Future decisions about deployment and further evolution of the model and related criteria will determine whether the system seeks to preserve current conditions or continues to evolve with the changing stock dynamics.

The fishery does exhibit preservationism in how quota is allocated by the ASMFC. Black sea bass state quota allocations have been unchanged for a long period and do not appear to be transitioning with the northward expansion of the stock, instead maintaining allocations based on past landings.[167] As the ASMFC has eliminated the requirement to reconsider its black sea bass state allocations over time,[168] it appears to have adopted a preservationist posture with regard to the economic basis of the fishing industry rather than allowing harvest to transition with shifting stock geography. This approach contrasts with hypothetical transitionalist mechanisms, such as policies that automatically shift allocations based on stock geography, as identified by scientific stock assessment.

3.2.3 Command and Control

Black sea bass management is largely managed through command-and-control input controls, such as gear requirements, minimum size and possession limits, and complex seasons. These elements are used to manage allocations to commercial and recreational sectors that are determined by managers and do not change from year to year.[169] However, as for other fisheries, the status determination criteria, including total allowable landings, are determined based on evolving fishery models.[170] Thus, the black sea bass is typical of other fisheries in that it is a complex system that combines both rigid command-and-control elements and flexible, adaptive mechanisms.

The input controls used to manage black sea bass catch, as implemented both through NOAA and state regulations, are typical "end-of-pipe" elements that do appear to limit the ability of the industry to adapt to climate change. For example, the regulations for pot construction require two escape vents, bound together with one of four types of biodegradable fasteners, with different stipulated dimensions (at least 2" x 2" if square, 2.5" in diameter if circular, and 1-3/8" X 5-3/4" if rectangular).[171] These and other, similarly-specific gear restrictions are used in lieu of market-based mechanisms, such as bycatch caps, and do not provide incentives for fishermen in high-availability, low-quota areas to avoid catch. Similarly, permitting limitations, such as Rhode Island's non-

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[167] MAFMC & ASMFC, *supra* note 147.

[168] ASMFC, ADDENDUM XIX TO THE SUMMER FLOUNDER, SCUP, AND BLACK SEA BASS FISHERY MANAGEMENT PLAN (2007).

[169] MAFMC, BLACK SEA BASS FISHERY INFORMATION DOCUMENT (2017) (noting 51% - 49% allocations to recreational and commercial sectors).

[170] *Id.*

[171] 25 R.I. ADMIN. CODE § 8-4:3.14.3.

transferable endorsement[172] and the state-by-state quota system, also limit the ability of black sea bass fishermen to trade fishing rights as the stock moves geographically. As a result, fishermen in high-availability areas are limited in their ability to access a newly-abundant resource.

Black sea bass management is rigid in some respects—notably, through its state quota allocations—but it does enable modification of technological input controls through flexibility mechanisms. Specifically, managers are authorized to modify conservation and management measures through an abbreviated framework adjustment process adopted under Amendment 12 to the black sea bass FMP.[173] The framework adjustment process enables managers to add and modify other management measures without the need for a full FMP amendment[174]—a process that has been used nine times to date since 1999.[175] ASMFC, though not its federal counterpart, can also issue addenda to alter stock management provisions applicable in state waters—an option used 27 times to date for black sea bass.[176]

Finally, the black sea bass fishery management appears to effectively be addressing its informational deficits. While historically a data-poor fishery, the fishery has adopted a new stock assessment model and associated status determination criteria, as previously discussed. The fishery also incorporates buffers to account for uncertainty in information.[177] For the 2017 season, for example, the overfishing limit was set at 12.05 million pounds, whereas the acceptable biological catch was set at a combined 10.47 million pounds.[178] This buffer protects the stock from becoming depleted should management assumptions prove to be incorrect.

3.2.4 Principled Flexibility

The black sea bass fisheries management has not adopted explicit provisions to distinguish between controllable and uncontrollable change in the fishery or adopted management principles to guide its decisions in adapting to those changes. As a result, the elements of black sea bass management that embody principled flexibility do so implicitly, such as through incorporation of buffers and incorporation of climate science into stock assessment models. Managers recognized in 2002 that the stock was shifting northwards when it established its state allocations,[179] but it has not addressed continuing shifts since that time—a contrast to other fisheries, such as summer flounder, which has

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[172] 25 R.I. ADMIN. CODE 8-21:6.1.1(a)(vi).

[173] MAFMC & ASMFC, AMENDMENT 12 TO THE SUMMER FLOUNDER, SCUP, AND BLACK SEA BASS FISHERY MANAGEMENT PLAN 141-42 (1998).

[174] *Id.*

[175] MAFMC, *Fishery Management Plans & Amendments: Summer Flounder, Scup, Black Sea Bass*, http://www.mafmc.org/fisheries/fmp/sf-s-bsb.

[176] ASMFC, *Black Sea Bass*, http://www.asmfc.org/species/black-sea-bass (listing management actions).

[177] *Fisheries of the Northeastern United States; Black Sea Bass Fishery*, 82 Fed. Reg. 24,078 (May 17, 2017) (to be codified at 50 C.F.R. pt. 648).

[178] MAFMC, BLACK SEA BASS FISHERY INFORMATION DOCUMENT (2017).

[179] MAFMC & ASMFC, *supra* note 147.

shifted more dramatically as a consequence of a successful rebuilding process.[180] Similar consideration of the effects of changing stock dynamics would be needed to fully incorporate principled flexibility concepts into black sea bass fishery management.

4 Conclusion

Fisheries are changing over time due to climate change in ways that may strain federal and regional management systems. Legal theorists have considered how climate change may affect regulatory systems and have suggested several ways in which laws and regulations may not be capable of adapting to changing circumstances and how they may be able to do so more effectively. They have argued that legal frameworks are based on an assumption that conditions vary within an envelope that can be assessed from historical conditions, but that climate change is creating change that has no analogue in past experience. They similarly argue that legal frameworks are based on the idea of preserving the past in perpetuity rather than allowing the transitions that will be needed as conditions change. Third, they argue that command-and-control systems are not adaptable because they are rigid, focused on specific technology, and created without sufficient information. Finally, when they do adapt, those adaptations are not based on considered policy guidance.

This paper has evaluated whether and how federal and regional fisheries legal frameworks reflect each of these criticisms. As other commentators have noted, domestic fisheries management is a complex system that incorporates adaptive management in some ways while in others is linked to historical baselines and models. Close consideration of specific procedural and substantive aspects of fisheries legal frameworks is therefore needed to understand whether and how they enable adaptive management in the face of climate change.

Consideration of how legal frameworks are implemented in the context of particular fisheries is important to determine the adaptive capacity of fisheries management in practice. As the black sea bass fishery illustrates, regional and federal fisheries management structures are adapting to climate-related changes through enhanced stock assessment models and status determination criteria. However, additional development and evolution, such as development of mechanisms for

[180] ASMFC, ADDENDUM XXVII TO THE SUMMER FLOUNDER, SCUP, BLACK SEA BASS FISHERY MANAGEMENT PLAN 2-3 (2016) ("The interim solution of state-by-state conservation equivalency based on estimated state harvests in 1998 was successful initially in mitigating the disparity in conservation burden among states, but the approach is increasingly being viewed as an inadequate long-term solution given recent changes in resource status and fishery performance. Seventeen years have passed since 1998. Even if the allocations were perfectly equitable when adopted over a decade ago, they are now likely out of synch given the substantial variation in stock dynamics that has occurred since then. Over the many years since Amendment 2 was first implemented, the summer flounder spawning stock biomass has increased approximately six-fold, and the number of age classes has increased from 2-3 to 7 or more. These changes have led to geographic shifts in the distribution of the resource (As the stock has rebuilt, its range has expanded). Climate change may also be contributing to shifts in migratory patterns, spatially and temporally. Taken together, these changing conditions have altered the dynamics regarding the challenge of maintaining balance in equivalent conservation burden across the management unit.").

recalibration of management responsibility and state landings allocations, will be needed for the fishery to meet the climate challenge. Proactive management and legal development would be required for black sea bass management—and fisheries management more broadly—to fully embody the principled flexibility approach and maximize climate resilience.