New England Fishery Management Council
50 WATER STREET | NEWBURYPORT, MASSACHUSETTS 01950 | PHONE 978 465 0492 | FAX 978 465 3116
John F. Quinn, J.D., Ph.D., *Chairman* | Thomas A. Nies, *Executive Director*

August 19, 2020

Mr. Michael Pentony
Regional Administrator
NMFS, Northeast Regional Office
55 Great Republic Drive
Gloucester, MA 01930

RE: Comments on the Six-Inch Mesh Codend EM EFP

Dear Mike:

The New England Fishery Management Council has no objection to experimental fishery proposal that would allow two commercial fishing vessels participating in an electronic monitoring program to fish in the Southern New England Regulated Mesh Area with a 6-inch (15.24 cm) diamond mesh codend as published in the *Federal Register* August 4, 2020.

If you have any questions, please contact me.

Sincerely,

Thomas A. Nies
Executive Director

Dr. Jon Hare, Science and Research Director
Northeast Fisheries Science Center
166 Water Street
Woods Hole, MA 02543-1026

August 24, 2020

VIA ELECTRONIC MAIL

Dear Jon:

We write to inquire how funds appropriated by the U.S. Congress for at-sea monitoring (ASM) that total $30.9 million have been or will be spent and we look forward to your written response.

1) How much of the $30.9 million has been spent on industry ASM cost for 2018 and for 2019 compared to the projected cost, and how much was set aside for 2020? Given the lapse in coverage due to the pandemic, what is now the anticipated industry cost for 2020?

2) Funds set aside for "NMFS shore side costs" are $1.2, $2.7, and $3.4 million for 2018, 2019 and 2020, respectively. The shore side costs have tripled over the 3-year period, and greatly exceed the amounts set aside for industry cost. Please describe the shore side expenditures and amounts for each year.

3) Recently the NEFSC altered the 2020 spend plan approved by Congress to allow ASM providers to bill for payroll "stand-by" and/or "quarantine" time. Please provide Congressional approval for this change and explain why the funds designated for industry costs are tapped for these payroll costs. Please provide an estimate of the amount to be spent on these payroll costs.

4) The 2019 spend plan allocated $700 thousand for "gear and analyses related to Amendment 23". Please identify what kind of "gear" is related to Amendment 23 as well as a description of the specific analyses and expenditures for each.

5) Please describe the costs and expenditures in the "shared mission support" set aside.

6) Please describe the costs and expenditures in the EM/ET technology set aside, and advise if the industry is able to tap these funds to cover the cost of EM equipment?

7) Please describe the balance of unspent funds to date compared to $30.9 million appropriated.

8) The 2020 Congressional appropriations report includes a directive for NOAA "*to submit a report to the Committee not less than 180 days after enactment of this act that outlines the current status of electronic monitoring and reporting EM/ER technology for the Northeast multispecies fishery, including an assessment of whether fully operational EM/ER procedures will be ready to replace At-Sea Monitoring on a voluntary basis by September 30, 2021, and if not, an evaluation of the current barriers. The report should also specify methods that will improve the quality and utility of At-Sea Monitoring and electronic monitoring data for purposes of achieving more reliable estimates of stock abundance a $1,000,000 increase above the fiscal year 2019 level*". Please provide a copy of this report.

9) The 2020 Congressional appropriations report also includes an Electronic Monitoring and Reporting line item for federal fisheries throughout the United States. This item directs NMFS to prioritize the Northeast multispecies groundfish fishery. Please identify the programs being covered through this directive for the northeast groundfish fishery and monies allocated to fulfill this directive.

Electronic Monitoring and Reporting—Within Fisheries Ecosystem Science Programs and Services, the Committee provides no less than the fiscal year 2019 level for EM/ER to support the development, testing, and installation of EM/ER technologies across the country. The Committee recognizes that advancements in EM/ER have the potential to cut costs and improve data collection for most U.S. fisheries. NMFS is directed to prioritize EM/ER implementation in fiscal year 2020 and expedite to the fullest extent practicable the transition to full EM/ER. Within the funds provided for these activities, not less than $3,500,000 shall be available, in accordance with 16 U.S.C. 3701, for collaborative partnerships that include non-Federal matching funds to implement cost-shared EM/ER programs that support fisheries conservation and management. During the development and implementation of electronic reporting and monitoring programs, NOAA shall consult directly with industry and work through the Fishery Management Councils (established under sections 1851 and 1852 of title 16, United States Code) to develop appropriate cost-sharing arrangements that are commensurate with the ex-vessel value of the fishery. Furthermore, NMFS shall continue to work in fiscal year 2020 with the charter for-hire recreational fishery fleet in the Gulf of Mexico; the Northeast multispecies groundfish fishery fleet, including small vessels within that fleet; the Maine lobster fleet; and any regional fishery fleet interested in implementing EM/ER technologies to better track information that is currently collected through the use of human observers.

Sincerely,

Maggie Raymond, Associated Fisheries of Maine

Jackie Odell, Northeast Seafood Coalition

CC: New England Fishery Management Council

IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF COLUMBIA

CONSERVATION LAW FOUNDATION
62 Summer Street
Boston, Massachusetts 02110

Plaintiff,

v.

WILBUR ROSS, in his official capacity
as Secretary of Commerce,
United States Department of Commerce
1401 Constitution Avenue NW
Washington, DC 20230

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
United States Department of Commerce
Room 5128
1401 Constitution Avenue NW
Washington, DC 20230

CHRIS OLIVER, in his official capacity
as Assistant Administrator for Fisheries,
National Marine Fisheries Service
1315 East-West Highway
Silver Spring, MD 20910

NATIONAL MARINE FISHERIES SERVICE
United States Department of Commerce
Room 14555
1315 East-West Highway
Silver Spring, MD 20910

Defendants.

Civil Action No. ___________

COMPLAINT FOR INJUNCTIVE AND DECLARATORY RELIEF

1. Plaintiff Conservation Law Foundation ("CLF") on behalf of its adversely affected members hereby challenges the unlawful decision of the National Marine Fisheries Service ("NMFS") to approve and implement Framework 59 to the Northeast Multispecies Fishery Management Plan, because, among other things, it failed to establish measures necessary to rebuild Atlantic cod stocks to healthy levels as mandated by the Magnuson-Stevens Fishery Conservation and Management Act, 16 U.S.C. §§ 1801-1884 ("Magnuson-Stevens Act" or "the Act"), and violated the Administrative Procedure Act, 5 U.S.C. §§ 701-706 ("APA"). CLF requests this Court to remand Framework 59 and require NMFS to establish new management measures that conform to the Magnuson-Stevens Act as expeditiously as possible and by a date certain.

INTRODUCTION

2. Massive shoals of Atlantic cod once inhabited the coastal waters off the northeastern United States and Canada. Their abundance was legendary; historical accounts describe being able to catch cod simply by dipping a basket in the water.

3. For centuries, cod was a major driver of the regional economy in New England and Eastern Canada, and the stocks seemed limitless. Even as fishing pressure increased through the 1800s, Thomas Huxley, a prominent fisheries scientist famously declared the cod population to be "inexhaustible."

4. Ecologically, Atlantic cod (*Gadus morhua*) is a high level predatory fish native to cold-water marine ecosystems in the North Atlantic. Atlantic cod was a foundational species in North Atlantic coastal ecosystems for millennia, constituting a substantial portion of the total biomass and playing a primary role in transferring energy up the food chain.

5. Today, the Gulf of Maine and Georges Bank cod stocks—the two stocks of Atlantic cod under U.S. jurisdiction and management—are severely depleted and persist at only a fraction of their former sizes, due primarily to unsustainable fishing pressure.

6. Under the Magnuson-Stevens Act, NMFS has a mandatory duty to rebuild fisheries in a time period that is "as short as possible" taking into account various factors and "not [to] exceed 10 years," except where the biology of the stock, environmental conditions or an international agreement dictate otherwise. 16 U.S.C. § 1854(e)(4)(A).

7. Federal scientists for decades have found that both Atlantic cod stocks are subject to overfishing (meaning the rate of removals is too high) and are overfished (meaning the population abundance is at an excessively low level). Yet NMFS has continued to approve actions that end up failing to stop overfishing and failing to rebuild cod stocks as required by law. These failures have resulted in continued harm to the species.

8. Framework 59 to the Northeast Multispecies Fishery Management Plan is the most recent action by NMFS to set conservation and management

measures for Atlantic cod and implement the stocks' rebuilding plans. *See* 85 Fed. Reg. 45,794 (July 30, 2020) (final rule); New England Fishery Management Council, Northeast Multispecies Fishery Management Plan Framework Adjustment 59 (Apr. 10, 2020) ("Framework 59").

9. Framework 59 provides an extraordinarily clear example of how NMFS has implemented the rebuilding requirement in the Northeast region so as to read it entirely out of the Act. Atlantic cod stocks have been under formal rebuilding plans for decades, yet in Framework 59 NMFS authorized conservation and management measures that undisputedly cannot rebuild Gulf of Maine cod by the deadline of 2024. And for Georges Bank cod, there is nothing in the record and no rational basis to support the conclusion that this stock will rebuild by its 2026 deadline if managed under the Framework 59 conservation and management measures.

10. Framework 59, moreover, rests on arbitrary and capricious decision-making that fails to comply with other requirements of the Magnuson-Stevens Act and the relevant regulatory framework.

11. These violations of the Magnuson-Stevens Act and the APA harm CLF and its members' interests in healthy Atlantic cod populations and in protecting and restoring the species' role in the marine ecosystem. This harm will continue in the absence of action by this Court.

12. Plaintiffs request that this matter be advanced for hearing at the earliest opportunity, pursuant to 16 U.S.C. § 1855(f)(4).

JURISDICTION AND VENUE

13. The Court has jurisdiction over this case pursuant to the Magnuson-Stevens Act, which provides that the "district courts of the United States shall have exclusive jurisdiction over any case or controversy arising under" the Act, 16 U.S.C. § 1861(d), and explicitly anticipates judicial review of regulations and fishery management actions, *id.* § 1855(f).

14. The Court also has jurisdiction over this case pursuant to the APA, which allows courts to "hold unlawful and set aside agency action . . . found to be arbitrary, capricious, an abuse of discretion, or otherwise not in accordance with the law," 5 U.S.C. § 706(2)(A), and to "compel agency action unlawfully withheld," *id.* § 706(1).

15. The Court further has jurisdiction over this action pursuant to 28 U.S.C. § 1331, which grants the district courts "original jurisdiction of all civil actions arising under the . . . laws . . . of the United States."

16. The Court has authority to grant the requested relief pursuant to the Magnuson-Stevens Act, 16 U.S.C. §§ 1855(f), 1861(d), and the APA, 5 U.S.C. § 706(1)-(2), as well as the provisions of 28 U.S.C. §§ 2201-2202 (providing for declaratory and injunctive relief).

17. The Court has authority to award costs and attorneys' fees under 28 U.S.C. § 2412.

18. Venue is proper in this court pursuant to 28 U.S.C. § 1391(e)(1)(A)-(B), and 5 U.S.C. § 703, because Defendants reside in this judicial district, and because

a substantial part of the events or omissions giving rise to the claims occurred in the District of Columbia.

PARTIES

19. Plaintiff CLF is a non-profit membership organization dedicated to, among other things, protecting marine wildlife and their habitats as well as other coastal and ocean resources in New England.

20. To further these goals, CLF undertakes litigation and other advocacy on behalf of its members' interests; educates its members on conservation issues and on threats, challenges, and solutions for New England's oceans so that they can exercise their rights and protect their interests in those resources; promotes public awareness, education, and citizen involvement in the conservation of marine wildlife and resources; and supports programs for the conservation of marine wildlife and their habitats.

21. On behalf of its members, CLF has worked to prevent overfishing of Atlantic cod stocks for more than 30 years, and it has advocated extensively on behalf of its members for sustainable management of the species. CLF has repeatedly and continuously urged NMFS to fulfill its statutory duty to sustainably manage and rebuild overfished Atlantic cod stocks.

22. CLF first challenged NMFS's failure to prevent overfishing and rebuild several overfished groundfish stocks—including Atlantic cod—in 1991. *See Conservation Law Found. v. Mosbacher*, 1991 WL 501640 (D. Mass. 1991), *aff'd sub*

nom. Conservation Law Found. v. Franklin, 989 F.2d 54 (1st Cir. 1993). CLF also successfully challenged NMFS's failure to implement the 1996 amendments to the Magnuson-Stevens Act in *Conservation Law Found. v. Evans*, 209 F. Supp. 2d 1 (D.D.C. 2001), requiring the agency to give proper effect to the new legal mandates for bycatch and rebuilding. More recently, CLF challenged certain catch limits for Gulf of Maine cod, with the court again holding NMFS's action violated the Magnuson-Stevens Act. *See Conservation Law Found. v. Pritzker*, 37 F. Supp. 3d 254 (D.D.C. 2014).

23. CLF's members use and enjoy the ocean for fishing, wildlife observation, boating, research, and study. CLF's members value and depend on healthy Atlantic cod stocks for these activities. CLF's members also consume seafood, including Atlantic cod. CLF's members are directly affected by environmental injury caused by overfishing and unsustainable fishing of Atlantic cod. Injuries to CLF's members include injuries to their consumption and recreational and commercial use of Atlantic cod populations.

24. For example, Gilbert Chase is a resident of Northborough, Massachusetts. In his career, Mr. Chase worked as a fishery research biologist for the U.S. Bureau of Commercial Fisheries (now NMFS), as a biological oceanographer for the U.S. Naval Oceanographic Office, as a marine biologist and division diving officer for the New England Division of the U.S. Army Corps of Engineers, and as an advisor on the Stellwagen Bank National Marine Sanctuary Advisory Board. As a member of CLF, Mr. Chase is particularly concerned with the

protection of our oceans and marine resources. As a former fishery research biologist, environmental advocate, consumer of seafood products and citizen of the United States it matters greatly to Mr. Chase how our trust resources are protected and managed. He stands to be particularly injured if provisions of Framework 59 are allowed to proceed as those provisions will further deplete the already overexploited Atlantic cod stocks. This harm can only be addressed by remanding Framework 59 and ordering Defendants to stop directing fishing for Atlantic cod and take action to rebuild this iconic species.

25. Captain William Redington Tower, III is the son of a commercial fisherman and has been the Captain of a commercial fishing vessel and a recreational fisherman for decades. Currently a resident of Ogunquit, Maine, Captain Tower has worked as a marine biologist and consultant for NMFS and with the Woods Hole Oceanographic Institution studying fish migratory patterns. A member of CLF since 2013, Captain Tower has been an active supporter of the organization's oceans advocacy, particularly its recent efforts to stop the illegal and unsound management actions being taken with Atlantic cod in Framework 59. For at least forty years, Captain Tower has owned and operated a charter boat fishing business that commercially fishes for tuna, lobster, and groundfish, including Atlantic cod. Captain Tower's continuing economic and recreational interests in Atlantic cod stand to be particularly injured by the provisions of Framework 59 as they will further deplete the already overexploited cod stocks in the Gulf of Maine and on Georges Bank. Only through this Court vacating and remanding these

provisions of Framework 59 and directing Defendants to set annual catch limits to rebuild these stocks, will Captain Tower's injuries be redressed.

26. Peter Shelley is Senior Counsel and a Vice President at CLF. He has been a member of the organization since 1983. As an attorney he has worked to protect New England groundfish stocks, including Atlantic cod for more than 30 years. Mr. Shelley resides in Marblehead, Massachusetts and has been an active recreational fisherman for decades, fishing in the Gulf of Maine and southern New England at least five to six times a year. Due to NMFS's failure to effectively control the overexploitation of Atlantic cod, the quality and quantity of his saltwater fishing has decreased. Mr. Shelley's interest in healthy populations of Atlantic cod so that he and his grandchildren can continue to fish for Atlantic cod is injured by Framework 59 because the action will not rebuild the population in as short a time period as possible. If this Court vacates and remands those portions of Framework 59 that apply to the Gulf of Maine and Georges Bank cod stocks, and orders Defendants to set catch limits consistent with established mechanisms to rebuild these stocks, Mr. Shelley will be able to fish for and catch a healthier and more bountiful supply of Atlantic cod when they are rebuilt.

27. The aesthetic, conservation, recreational, commercial, cultural, scientific, educational, and other interests of CLF and its members have been, are being, and, unless the relief prayed for in this Complaint is granted, will continue to be adversely affected and irreparably injured by Defendants' failure to comply with the law in its management of Atlantic cod. These injuries are actual and concrete

and would be redressed by the relief CLF seeks here. CLF has no adequate remedy at law.

28. Defendant Wilbur Ross, United States Secretary of Commerce, is the highest-ranking official within the Department of Commerce and, in that capacity, has formal responsibility for the administration and implementation of the Magnuson-Stevens Act, as well as for compliance with all other federal laws applicable to the Department of Commerce. He is sued in his official capacity.

29. Defendant NOAA is an agency of the United States Department of Commerce with supervisory responsibility for NMFS. The Secretary of Commerce has delegated responsibility to implement and enforce compliance with the Magnuson-Stevens Act to NOAA, which in turn has sub-delegated that responsibility to NMFS.

30. Defendant Chris Oliver, Assistant Administrator for Fisheries, is the highest-ranking official within NMFS and, in that capacity, has direct responsibility for the administration and implementation of the Magnuson-Stevens Act with regard to Atlantic cod, and for compliance with all other federal laws applicable to the agency. He is sued in his official capacity.

31. Defendant NMFS is a federal agency within NOAA, in the U.S. Department of Commerce, with the responsibility of protecting and managing the fish, marine mammals, and other marine resources of the United States. NMFS has been delegated authority by the Secretary of Commerce to implement and enforce the Magnuson-Stevens Act, including approving fishery management plans

and amendments to those plans, and promulgating implementing regulations. NMFS is the government agency primarily responsible for ensuring the requirements of the Magnuson-Stevens Act are followed and enforced, including the requirements to determine the status of managed stocks, identify and rebuild overfished populations of fish, and set annual catch limits to end and prevent overfishing.

LEGAL BACKGROUND

The Magnuson-Stevens Act

32. Congress enacted the Magnuson-Stevens Act in 1976, in order "to conserve and manage the fishery resources found off the coasts of the United States." 16 U.S.C. § 1801(b)(1).

33. The Magnuson-Stevens Act establishes eight Regional Fishery Management Councils, including the New England Fishery Management Council ("New England Council"), and tasks them with preparing fishery management plans and recommending regulations to implement the plans. *Id.* § 1852.

34. The Secretary of Commerce, acting through NMFS, reviews all submitted plans, plan amendments, and regulations, *id.* § 1854(a)-(b), and upon approval, promulgates regulations and otherwise implements the plans and plan amendments, *id.* §§ 1854(b)(3), 1855(d).

35. The Magnuson-Stevens Act also provides authority for NMFS to enact emergency regulations, independent of the regular fishery management plan process. *Id.* § 1855(c).

36. The Act requires that all fishery management plans, plan amendments, and implementing regulations must be consistent with ten "National Standards" for fishery conservation and management. *Id.* § 1851(a).

37. National Standard 1 requires that "[c]onservation and management measures shall prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery . . . ." *Id.* § 1851(a)(1). Optimum yield in turn is defined by the Act as the amount of fish that, "in the case of an overfished fishery, provides for rebuilding to a level consistent with producing the maximum sustainable yield in such fishery." *Id.* § 1802(33)(C).

38. The Act defines the terms "overfishing" and "overfished" to mean "a rate or level of fishing mortality that jeopardizes the capacity of a fishery to produce the maximum sustainable yield on a continuing basis." *Id.* § 1802(34). Regulatory guidelines clarify that "overfishing" refers to the rate of removals from a stock (i.e., the act of fishing at an unsustainable rate), whereas "overfished" refers to a stock having a biomass below which it can produce maximum sustainable yield on a continuing basis. *See* 50 C.F.R. § 600.310(e)(2)(i).

39. National Standard 2 requires that "[c]onservation and management measures shall be based upon the best scientific information available." 16 U.S.C. § 1851(a)(2). Other National Standards address coordination, equity, efficiency,

contingency planning, costs, fishing communities, bycatch, and safety of human life at sea. *Id.* § 1851(a)(3)-(10).

40. In addition to the National Standards, the Magnuson-Stevens Act provides direct requirements for fishery management plans. The first and central requirement is that fishery management plans must "contain the conservation and management measures . . . necessary . . . to prevent overfishing and rebuild overfished stocks, and to protect, restore, and promote the long-term health and stability of the fishery." *Id.* § 1853(a)(1)(A). Fishery management plans also must "specify objective and measurable criteria for identifying when the fishery to which the plan applies is overfished (with an analysis of how the criteria were determined and the relationship of the criteria to the reproductive potential of stocks of fish in that fishery)." *Id.* § 1853(a)(10).

41. The Magnuson-Stevens Act also requires the Secretary to take specific actions to rebuild overfished stocks. NMFS must identify fish stocks that are overfished and notify the respective council, as well as publish an annual report listing stocks with an overfished status. *Id.* § 1854(e)(1)-(2). Upon notification, NMFS becomes subject to a mandatory duty to "end overfishing immediately in the fishery and to rebuild affected stocks of fish," which is to be achieved by "prepar[ing] and implement[ing] a fishery management plan, plan amendment, or proposed regulations for the fishery." *Id.* § 1854(e)(3).

42. Rebuilding, in turn, must take place within a time period that is "as short as possible," generally not exceeding ten years. *Id.* § 1854(e)(4). When

rebuilding is underway, NMFS must review progress "at routine intervals that may not exceed two years," to determine whether rebuilding is progressing adequately. *Id.* § 1854(e)(7).

43. The Act's requirements for fishery management plans reflect the rebuilding mandate, stating that for overfished stocks, plans must "contain conservation and management measures to prevent overfishing or end overfishing and rebuild the fishery." *Id.* § 1853(a)(10).

44. In 2006, Congress amended the Magnuson-Stevens Act to require all fishery management plans to "establish a mechanism for specifying annual catch limits . . . at a level such that overfishing does not occur in the fishery, including measures to ensure accountability." Pub. L. No. 109-479, § 104(a)(10), 120 Stat. 3575, 3584 (Jan. 12, 2007); 16 U.S.C. § 1853(a)(15).

45. In regulatory guidelines promulgated under the Act, *see* 16 U.S.C. § 1851(b), NMFS reiterates that mechanisms for specifying annual catch limits must use an "ABC control rule," which is a defined "policy for establishing a limit or target catch level that is based on the best scientific information available," 50 C.F.R. § 600.310(f)(1)(iv). *See also id.* § 600.310(f)(2) ("The ABC control rule must articulate how ABC [acceptable biological catch] will be set compared to the OFL [overfishing limit] based on the scientific knowledge about the stock or stock complex and taking into account scientific uncertainty."). The resulting ABC value must account for scientific uncertainty. *See id.* § 600.310(f)(ii). Because of their essential purpose, control rules should yield more conservative catch limits as

biomass estimates, or other proxies, for a stock or stock complex decline and as scientific and management uncertainty increase. 50 C.F.R. § 600.310(f)(1).

46. NMFS's regulatory guidelines also elaborate on the statutory requirement for fishery management plans to include objective and measurable status determination criteria. *Id.* § 600.310(e)(2). Annual catch limits and accountability measures, in turn, "must prevent overfishing" when measured against the stock's status determination criteria. *Id.* § 600.310(f)(4)(i). More broadly, the agency states that "[t]he system of [annual catch limits] and [accountability measures] designed must be effective in protecting the stock or stock complex as a whole." *Id.* § 600.310(f)(4)(ii).

The Northeast Multispecies Fishery Management Plan

47. The fishery management plan governing the two U.S. stocks of Atlantic cod is the Northeast Multispecies Fishery Management Plan. *See* New England Fishery Management Council: Management Plans: Northeast Multispecies, https://www.nefmc.org/management-plans/northeast-multispecies.

48. The Northeast Multispecies Fishery Management Plan was first promulgated in 1986 and it has been amended twenty-one times since its adoption. *See id.* Plan amendments are generally integrated with environmental review documentation (environmental impact statements or environmental assessments) and are posted on the New England Council's website. *Id.*

49. The New England Council takes certain types of actions through "framework adjustments," rather than full plan amendments. Sixty framework adjustments to the Northeast Multispecies Fishery Management Plan have been made by the Council, including Framework 59, the subject of this lawsuit. *See id.*

50. After the plan, plan amendments, and framework adjustments are approved by NMFS, the agency promulgates implementing regulations via the Federal Register. Implementing regulations for the Northeast Multispecies Fishery Management Plan are codified at 50 C.F.R. Part 648, Subpart F.

51. The Northeast Multispecies Fishery Management Plan, its amendments and framework adjustments, and the regulations in the Code of Federal Regulations, together create the regulatory structure for management of Atlantic cod and the other groundfish off New England.

The Administrative Procedure Act

52. The APA sets forth basic requirements for federal rulemaking processes, including public notice and opportunity to comment on a proposed rule and required timelines for making a final rule effective. *See* 5 U.S.C. § 553.

53. The APA grants the right of judicial review to "[a] person suffering legal wrong because of agency action, or adversely affected or aggrieved by agency action." *Id.* § 702. Under the APA, a court must "hold unlawful and set aside agency action . . . found to be . . . arbitrary, capricious, an abuse of discretion, or otherwise not in accordance with law." *Id.* § 706(2)(A).

54. An agency action is arbitrary and capricious under the APA "if the agency has relied on factors which Congress has not intended it to consider, entirely failed to consider an important aspect of the problem, offered an explanation for its decision that runs counter to the evidence before the agency, or is so implausible that it could not be ascribed to a difference in view or the product of agency expertise." *Motor Vehicle Mfrs. Ass'n. v. State Farm Mutual Auto. Ins. Co.*, 463 U.S. 29, 43 (1983).

55. The APA also instructs courts to "hold unlawful and set aside" any agency action that is taken "in excess of statutory jurisdiction, authority, or limitations, or short of statutory right." 5 U.S.C. § 706(2)(C).

56. The APA further states that courts shall "compel agency action unlawfully withheld or unreasonably delayed." *Id.* § 706(1).

FACTUAL BACKGROUND

History of the Cod Fishery

57. Humans have fished for Atlantic cod for millennia. Cod are believed to have driven the expansion of European colonial settlement around the North Atlantic, eventually leading to the Massachusetts Bay Colony and, subsequently, the states of New England. *See, e.g.*, Mark Kurlansky, Cod: A Biography of a Fish that Changed the World, at 19-29 (1997).

58. Atlantic cod was a major driver of the regional economy in New England and Eastern Canada. Early colonial economies depended heavily on cod

exports, with important trade routes to Europe and the Caribbean. *See, e.g.*, Kurlansky, *supra*, at 63-89.

59. In addition to economic value, the cod fishery has been an enduring source of cultural and historical identity in New England. Atlantic cod was so important that some of the newly-independent colonies featured cod imagery on their state seals and currencies; a carved wooden cod effigy has hung in the Massachusetts State House for over two centuries.

60. Atlantic cod also played a key role in the marine ecosystems of the North Atlantic, as a wide-ranging generalist predator. Present in tremendous numbers, cod provided a major vector for energy transfer from lower to upper trophic levels in benthic ecosystems. *Cf.* Jason S. Link et al., Trophic Role of Atlantic Cod in the Ecosystem, 9 Fish & Fisheries 1 (2008).

61. The fishery for Atlantic cod off North America has been prosecuted over the centuries with a variety of fishing technologies—from simple sailing vessels with baited hooks dangling over the sides, to modern steel-hulled and diesel-powered fishing boats that drag large nets across the ocean and use modern electronic technologies to find fish. *See, e.g.*, W.H. Lear, History of Fisheries in the Northwest Atlantic: The 500-Year Perspective, 23 J. Nw. Atl. Fish. Sci. 41, 44-63 (1998).

62. Annual removals of Northwest Atlantic groundfish were relatively stable for approximately three centuries, then started increasing toward the late 1800s. Industrialization of the fleet in the early 20th Century led to a sharp

increase in catches, which became even steeper in the late 1950s with the advent of foreign distant-water fleets. These large factory ships were capable of catching, processing, and freezing at sea tremendous amounts of fish, and they operated just a few miles off the U.S. coastline. At the peak of foreign fishing in the 1960s, Northwest Atlantic groundfish removals reached around 2.5 million metric tons per year, much of which was Atlantic cod. *See* Lear, *supra*, at 62-67.

Passage of the Magnuson-Stevens Act

63. After several years of debate and draft legislation, Congress passed the Fisheries Conservation and Management Act (later renamed the Magnuson-Stevens Act) in 1976. *See* Pub. L. No. 94-265, 90 Stat. 331 (Apr. 13, 1976).

64. The law, among other things, declared the United States' sovereignty over a 200-mile offshore zone, and established management authority over all fishery resources within that area. *See* 16 U.S.C. §§ 1811-1812. In combination with this jurisdictional expansion, the law contained a regulatory structure designed to push out foreign fishing vessels. *See id.* §§ 1821-1825.

65. To manage domestic fisheries within the newly-established 200-mile zone, the law established a regional regulatory structure, in which eight regional fishery management councils act as the first movers for management actions, and the Secretary of Commerce (in the form of NMFS) reviews, approves, and implements the actions. *See id.* §§ 1852, 1854.

66. The New England Council is one of the eight regional councils and was given responsibility for managing fish stocks in federal waters off Connecticut, Rhode Island, Massachusetts, New Hampshire, and Maine. *Id.* § 1852(a)(1). This management responsibility includes the two U.S. stocks of Atlantic cod at issue in this matter.

Atlantic Cod Collapse

67. Following passage of the Magnuson-Stevens Act in 1976, domestic investment in fishing fleets increased, and U.S. fishing capacity skyrocketed. The domestic fleet, eager to exercise its new capacity, effectively picked up where the foreign fleets left off. Fishing pressure on Atlantic cod and other groundfish stocks resumed at high levels, and cod landings in New England reached all-time highs in the late 1970s and early 1980s. *See, e.g.*, Vaughn C. Anthony, The New England Groundfish Fishery after 10 Years under the Magnuson Fishery Conservation and Management Act, 10 N. Am. J. Fish. Mgmt. 175 (1990) (noting a doubling of fishing effort between 1976 and 1983).

68. The first stock assessment of Atlantic cod under the Magnuson-Stevens Act took place in 1977. It determined that both the Gulf of Maine and Georges Bank cod stocks already were subject to overfishing. *See* Fredric M. Serchuk, Analysis of the Georges Bank and Gulf of Maine Cod Stocks, Woods Hole Lab. Ref. No. 77-24 (Dec. 1977).

69. NMFS briefly adopted an Interim Groundfish Management Plan for Atlantic cod and other species in 1982, which was replaced by the permanent Northeast Multispecies Fishery Management Plan in 1986. *See* 51 Fed. Reg. 29,642 (Aug. 20, 1986).

70. Management efforts for Atlantic cod in the 1970s and 1980s were ineffective in the face of a burgeoning U.S. fishing fleet, with their new electronic technologies and higher-horsepower vessels. *See, e.g.*, Steven A. Murawski, NOAA Fisheries, A Brief History of the Groundfishing Industry of New England, https://www.fisheries.noaa.gov/new-england-mid-atlantic/commercial-fishing/brief-history-groundfishing-industry-new-england (noting early federal management used "ineffective controls on net mesh size, closed areas and minimum fish sizes in landings").

71. In the face of intense overfishing, the abundance of the entire groundfish complex declined by 65 percent in the first ten years of management by NMFS and the New England Council (1977 to 1987). *See* Anthony, *supra*, at 182.

72. Fishing mortality rates in the 1980s were estimated to have been two to three times the levels associated with maximum sustainable yield. This meant the fishery was removing 50-70 percent of all adult cod each year. *See, e.g.*, R.K. Mayo & L. O'Brien, Atlantic Cod, in NOAA Tech. Mem. NMFS-NE-115, Status of Fishery Resources Off the Northeastern United States for 1998.

73. Catch of Atlantic cod began to decline in the late 1980s and early 1990s, as the stocks' biomass dwindled under intense overfishing. *See, e.g.*,

Northeast Fisheries Science Center, Operational Assessment of 14 Northeast Groundfish Stocks 36, 45 (Jan. 7, 2020) ("2019 Operational Assessments"). Catch of Atlantic cod never again reached the levels seen in the 1980s. *See id.*

74. Today, some forty years after the first stock assessment under the Magnuson-Stevens Act and forty-four years after Congress first directed NMFS to prevent overfishing, the situation has only grown worse: both U.S. cod stocks have dropped to significantly lower levels of biomass, and remain subject to overfishing. *See id.* at 24-26. The "historic lows" in biomass of the 1980s identified at the time of the early stock assessments now, in hindsight, represent historic highs in the time period, and the most recently accepted assessment models estimate biomass in both Atlantic cod stocks to be less than 10 percent of target levels.

The Sustainable Fisheries Act of 1996

75. Congress responded to the continued overfishing and stock collapse of species like Atlantic cod by passing the Sustainable Fisheries Act of 1996, which reauthorized and amended numerous provisions of the Magnuson-Stevens Act. *See* Pub. L. No. 104-297, 110 Stat. 3559 (Oct. 11, 1996).

76. The Sustainable Fisheries Act strengthened the conservation requirements of the Magnuson-Stevens Act to ensure U.S. fisheries were managed sustainably.

77. Congress added to the Magnuson-Stevens Act a direct requirement to rebuild overfished fish stocks, in the Sustainable Fisheries Act. *See id.* § 109(e), 16

U.S.C. § 1854(e) (requiring Secretary to identify overfished stocks, notify the respective council, and rebuild affected stocks by a date certain).

78. Congress intended the new rebuilding mandate to bind and commit federal managers to restoring overfished stocks, so as to bring fish populations back to healthy levels and enable sustainable harvest into the future. *See, e.g.*, S. Rep. No. 104-276, at 5 (May 23. 1996) (explaining that "[a] Council would have one year [later amended to two years] to come up with a plan to stop overfishing and rebuild the fishery, and the Secretary would be required to step in if the Council fails to act"); *see also* 32 Weekly Comp. Pres. Docs. 2040 (Oct. 11, 1996) (signing statement from President Clinton) ("Most important are new measures to prevent our fish stocks from being overfished and to ensure that already depressed stocks are rebuilt to levels that produce maximum sustainable yields from the fisheries.").

Decades of Failing to Rebuild

79. NMFS first implemented the Sustainable Fisheries Act in New England's groundfish fishery in 1999, when it approved Amendment 9 to the Northeast Multispecies Fishery Management Plan. *See* 64 Fed. Reg. 471 (Jan. 5, 1999).

80. In its next annual harvest specifications package, however, the New England Council recommended and NMFS approved a management action, Framework Adjustment 33, that explicitly relied on prior, less precautionary, mechanisms for calculating the allowable harvest that were inconsistent with the

terms of Amendment 9. Because Framework 33 failed to comply with the Sustainable Fisheries Act, it was invalided in court. *See Conservation Law Found. v. Evans*, 209 F. Supp. 2d at 18.

81. NMFS and the New England Council's second attempt to implement requirements of the Sustainable Fisheries Act came in 2004, with Amendment 13 to the New England Multispecies Fishery Management Plan. *See* 69 Fed. Reg. 22,906 (April 27, 2004).

82. In Amendment 13, NMFS approved formal rebuilding plans for twelve overfished groundfish stocks, including both stocks of Atlantic cod. *See* New England Fishery Management Council, Final Amendment 13 to the Northeast Multispecies Fishery Management Plan (Dec. 18, 2003); *see also* 69 Fed. Reg. at 22,909, 22,920-21.

83. Rebuilding plans essentially consist of three elements: a time frame for rebuilding (i.e., a number of years), a probability of success (i.e., a likelihood that the stock will actually be rebuilt by the deadline, which must be at least 50 percent), and a fishing mortality rate for rebuilding which is referred to as "$F_{REBUILD}$" (i.e., a rate of catching fish that, when applied across the rebuilding time frame, should result in biomass rebuilding to the target level by the end of the time frame). The three elements are interrelated, such that a change in one will inherently involve a change in one or both of the others, and such that when two of the elements are set, the third is determined as a result.

84. When setting the time frame for rebuilding Atlantic cod stocks in Amendment 13, the Council recommended and NMFS approved the longest period of years permissible under the law. For Gulf of Maine cod, the maximum time allowable for rebuilding was 10 years; the Council recommended and NMFS approved 10 years as its rebuilding target. For Georges Bank cod, the maximum allowable time for rebuilding was 22 years; the Council recommended and NMFS approved 22 years as its rebuilding target. *See* Amendment 13, at I-34 to I-35.

85. When these rebuilding periods were approved, the law required, as it does today, that stocks must be rebuilt in "as short [a time] as possible." 16 U.S.C. § 1854(e)(4)(A)(i).

86. The New England Council's stated rationale for choosing the maximum number of years for rebuilding, instead of a shorter time frame, was: "the Council believes it appropriate to extend the rebuilding period to mitigate, in part, the economic impacts of the rebuilding programs." *Id.* at I-34. NMFS appeared to regard it as a matter for "the Secretary to exercise his discretion" to determine, rather than as being subject to a binding requirement to rebuild in as short a time as possible. 69 Fed. Reg. at 22,920.

87. Because NMFS approved such long rebuilding timeframes for the Atlantic cod stocks, the fishing mortality rate for rebuilding ($F_{REBUILD}$) was able to be set at or even above the fishing mortality rate corresponding with maximum sustainable yield (referred to as "F_{MSY}"), which is generally an upper limit for fishing mortality for a normal healthy stock. *See* Amendment 13, at I-43 ($F_{REBUILD}$

set equal to F_{MSY} for first five years of Gulf of Maine cod rebuilding plan, then reduced marginally); *id.* at I-49 ($F_{REBUILD}$ set above F_{MSY} for first five years of Georges Bank cod rebuilding plan, then set at F_{MSY}).

88. Phrased differently, because NMFS approved such long timeframes for rebuilding Atlantic cod stocks, the harvest rate set for the rebuilding period was able to remain the same as the harvest rate for a healthy stock. *See id.* at I-39.

89. In 2010, the Council developed and NMFS approved Amendment 16 to the Northeast Multispecies Fishery Management Plan. Amendment 16 responded to the 2006 amendments to the Magnuson-Stevens Act by creating a mechanism for setting annual catch limits in the fishery to prevent overfishing. *See* 75 Fed. Reg. 18,262 (Apr. 9, 2010).

90. A core element of the annual catch limit mechanism established by Amendment 16 was a control rule for setting acceptable biological catch ("ABC"), which is a precursor number to the final annual catch limit. Control rules for setting ABC are referred to as "ABC control rules." They are defined by NMFS in regulatory guidance, as an aspect of the statutorily-mandated "mechanism for specifying annual catch limits." 16 U.S.C. § 1853(a)(15); *see also* 50 C.F.R. § 600.310(f)(1)(iv), (f)(2).

91. Control rules are generally applied by a council's Scientific and Statistical Committee ("SSC"), using the best available scientific information (usually the results of the most recent stock assessment) to specify the acceptable biological catch. *See* 50 C.F.R. § 600.310(f)(3).

92. The ABC control rule established in Amendment 16 was a simple set of options, with conditions triggering the use of each option. The options are generally referred to as Option A, which reflects the default approach for normal circumstances, Option B and Option C, which increase in stringency for different rebuilding situations, and Option D, which applies in data-limited and other situations:

a. ABC should be determined as the catch associated with 75% of F_{MSY}.

b. If fishing at 75% of F_{MSY} does not achieve the mandated rebuilding requirements for overfished stocks, ABC should be determined as the catch associated with the fishing mortality that meets rebuilding requirements ($F_{REBUILD}$).

c. For stocks that cannot rebuild to B_{MSY} [the stock's biomass target] in the specified rebuilding period even in the absence of fishing, the ABC should be based on incidental bycatch, including a reduction in the bycatch rate (i.e., the proportion of the cod stock caught as bycatch).

d. Interim ABC's should be determined for stocks with unknown status according to case-by-case recommendations from the SSC.

New England Fishery Management Council, Final Amendment 16 to the Northeast Multispecies Fishery Management Plan, at 78-79 (Oct. 16, 2009) ("Amendment 16"); *see also* 75 Fed. Reg. at 18,265 (describing the ABC control rule).

93. The Amendment 16 ABC control rule, applicable to all groundfish including Atlantic cod, provided for departures from the options listed above, but only if the availability of better information enables the use of a more precise approach to setting the ABC:

> The[] ABC control rule[] will be used in the absence of better information that may allow a more explicit determination of scientific uncertainty for a stock or stocks. If such information is available—that is, if scientific uncertainty can be characterized in a more accurate fashion—it can be used by the SSC to determine ABCs.

Id. at 78.

94. Amendment 16 also updated the $F_{REBUILD}$ values for Gulf of Maine cod and Georges Bank cod, based on the most recent round of stock assessments. *See id.* at 79, 83-84. The Council noted: "In the case of [Gulf of Maine] cod . . . , the rebuilding fishing mortality exceeded F_{MSY}. Since fishing at a higher level than F_{MSY} constitutes overfishing, the mortality target for th[is] stock[] was shown as F_{MSY} in the draft amendment." *Id.* at 79. This meant that, for Gulf of Maine cod, the rebuilding plan established in Amendment 13 would continue to have absolutely no effect on the amount of annual catch. *See also id.* at 487.

95. For Georges Bank cod, the $F_{REBUILD}$ value ended up being almost exactly 75 percent of F_{MSY}. *See id.* at 86. This meant it was virtually identical to the fishing mortality rate that would have been applied, had the stock been perfectly healthy. *See id.* at 78-79; 487. So, for Georges Bank cod too, the rebuilding plan established in Amendment 13 continued to have no meaningful effect on the amount of annual catch.

96. In December 2011, a new stock assessment was published for Gulf of Maine cod that showed the stock to be in far worse condition than previously estimated. The results indicated that Gulf of Maine cod was experiencing severe overfishing (fishing mortality rates of more than 5 times the F_{MSY} limit) and was

significantly overfished (biomass at 19 percent of the B_{MSY} target). *See* Northeast Fisheries Science Center, 53rd Northeast Regional Stock Assessment Workshop (53rd SAW) Assessment Report, Ctr. Ref. Doc. 12-05, at 59 (Mar. 2012).

97. Shortly after the new assessment for Gulf of Maine cod was released, NMFS formally notified the Council pursuant to 16 U.S.C. § 1854(e)(7) that the New England Multispecies fishery management plan "ha[d] not resulted in adequate progress toward ending overfishing and rebuilding of [Gulf of Maine] cod." NMFS directed the Council to implement "measures that would end overfishing on the [Gulf of Maine] stock." Letter from Samuel Rauch, Acting NMFS Assistant Administrator, to C.M. "Rip" Cunningham, New England Council Chairman (January 26, 2012).

98. Despite the dire situation, NMFS explicitly allowed overfishing on Gulf of Maine cod to continue throughout the 2012 fishing year. *See* 77 Fed. Reg. 19,944 (Apr. 3, 2012).

99. In early 2012, an assessment update was published for Georges Bank cod, among others, showing (as occurred with Gulf of Maine cod) the stock was in worse condition than previously believed. The assessment concluded Georges Bank cod was still subject to overfishing and still overfished. *See* Northeast Fisheries Science Center, Assessment or Data Updates of 13 Northeast Groundfish Stocks through 2010, Ctr. Ref. Doc. 12-06, at 14 (Mar. 2012) (finding Georges Bank cod biomass at 8 percent of target levels, and fishing mortality at nearly double the overfishing level).

100. Based on the 2012 assessment update for Georges Bank cod, NMFS formally notified the New England Council, pursuant to 16 U.S.C. § 1854(e)(2), that the stock was still overfished and continued to be subject to overfishing. *See* Letter from Daniel S. Morris, Acting NMFS Regional Administrator, to C.M. "Rip" Cunningham, New England Council Chairman (May 30, 2012).

101. New stock assessments for Gulf of Maine cod and Georges Bank cod were published in 2013. *See* Northeast Fisheries Science Center, 55th Northeast Regional Stock Assessment Workshop (55th SAW) Assessment Report, Ctr. Ref. Doc. 13-11 (June 2013). Both stocks were estimated to be at even smaller fractions of their respective biomass targets than had been found in their prior assessments; both stocks were still overfished and were still subject to overfishing. *See id.* at 25-26, 680.

102. In late 2013, NMFS formally notified the New England Council pursuant to 16 U.S.C. § 1854(e)(2), based on the latest round of stock assessments, that both Gulf of Maine cod and Georges Bank cod were still overfished and subject to overfishing. *See* 78 Fed. Reg. 64,480 (Oct. 29, 2013).

103. In 2014, NMFS approved a new rebuilding plan for Gulf of Maine cod through Framework Adjustment 51. *See* New England Fishery Management Council, Framework Adjustment 51 to the Northeast Multispecies [Fishery Management Plan] (Feb. 24, 2014) ("Framework 51"); *see also* 79 Fed. Reg. 22,421 (Apr. 22, 2014).

104. In the time elapsed between the original rebuilding plans set in Amendment 13 in 2004, and the new rebuilding plan for Gulf of Maine cod set in Framework 51 in 2014, federal appellate court made clear that the Act's rebuilding section provided a substantive constraint on the setting of rebuilding time frames, in the words "as short as possible." *See* 16 U.S.C. § 1854(e)(4)(A)(i); *Nat. Res. Def. Council v. NMFS*, 421 F.3d 872, 879-81 (9th Cir. 2005) (holding the statutory "as short as possible" language requires the councils and NMFS to minimize the time frame used for rebuilding, regardless of "whatever the[maximum permissible] length" may be).

105. Also prior to the Framework 51 rebuilding plan for Gulf of Maine cod, NMFS had revised its regulatory guidelines and directly stated that rebuilding plans should avoid using the maximum permissible number of years for rebuilding, and instead should set a time frame inward of the statutory maximum, in order to comply with the "as short as possible" language of the Act, and for a number of other sound policy reasons. *See* Final Rule, National Standard Guidelines, 74 Fed. Reg. 3178, 3201 (Jan. 16, 2009) ("T_{max} [i.e., the statutory maximum] is a limit which should be avoided.").

106. In Framework 51, the Council recommended and NMFS again approved the longest possible time frame for rebuilding Gulf of Maine cod, which was ten years. *See* Framework 51, at 4; 79 Fed. Reg. at 22,424.

107. Because the Council recommended and NMFS approved the longest possible time frame for rebuilding Gulf of Maine cod in Framework 51, the

corresponding $F_{REBUILD}$ rate was again higher than 75 percent of F_{MSY}, the default fishing mortality rate applied to healthy groundfish stocks. *See id.* at 22,424-25.

108. Because $F_{REBUILD}$ for Gulf of Maine cod under the Framework 51 rebuilding plan was higher than F_{MSY}, in subsequent years when the Council recommended and NMFS approved annual catch limits for Gulf of Maine cod under the ABC control rule, the stock would use Option A, the default option for healthy stocks. *See id.* at 22,424 ("[C]atches will continue to be set consistent with the Council's default control rule . . . .").

109. Choosing such a long rebuilding time frame, with its correspondingly high $F_{REBUILD}$ rate, was an intentional decision by NMFS and the Council. No rebuilding time frame was even considered for Gulf of Maine cod in Framework 51 that would have reduced the fishing mortality rate below the default Option A value of 75 percent of F_{MSY}. *See id.* at 22,424 (admitting that "all of the rebuilding strategies considered in Framework 51 for [Gulf of Maine] cod . . . were calculated using an $F_{REBUILD}$ that was greater than 75% F_{MSY}.").

110. As such, the Framework 51 rebuilding plan for Gulf of Maine cod had no effect on the annual management of the stock in subsequent years.

111. In late 2014, a new stock assessment update was published for Gulf of Maine cod, showing the stock's status, again, to be worse than previously believed. *See* Michael C. Palmer, 2014 Assessment Update Report of the Gulf of Maine Atlantic Cod Stock, Ctr. Ref. Doc. 14-14 (Oct. 2014). Biomass was estimated to be 3 or 4 percent of target levels, and fishing mortality rates were determined to be

around seven times the sustainable level. *See id.* at 6. The stock was determined to still be overfished, and still subject to overfishing. *Id.*

112. Based on the new stock assessment results, NMFS sent a letter to the Council in late 2014, "urg[ing] the Council to take meaningful and timely actions for Gulf of Maine (GOM) cod" following the 2014 stock assessment update, which found "that the GOM cod stock is overfished, subject to overfishing, and in very poor overall condition." *See* Letter from John K. Bullard, NMFS Regional Administrator, to E.F. "Terry" Stockwell III, New England Council Chair (Sept. 25, 2014). NMFS did not, however, make a finding of inadequate rebuilding progress under 16 U.S.C. § 1854(e)(7) for the stock.

113. In early 2015, NMFS formally notified the New England Council, pursuant to 16 U.S.C. § 1854(e)(2) and (7), that based on the 2014 stock assessment, that Gulf of Maine cod was still overfished and subject to overfishing, and stated that the Council "must end overfishing and rebuild this stock." 80 Fed. Reg. 12,621 (Mar. 10, 2015).

114. At the end of 2015, a new round of stock assessments was completed. *See* Northeast Fisheries Science Center, Ref. Doc. No. 15-24: Operational Assessment of 20 Northeast Groundfish Stocks, Updated Through 2014 (Nov. 2015). The results showed that Gulf of Maine cod was still overfished and subject to overfishing. *Id.* at 11.

115. For Georges Bank cod, the 2015 assessment update was rejected during peer review, and therefore not used for management purposes. *Id.* at 36, 39-

40. Instead, the Operational Assessment Panel recommended, and the SSC and NMFS approved, using a data-limited method for setting catch limits for the stock. No overfishing determination was made for Georges Bank cod based on the 2015 assessment, but its status was determined to still be overfished based on qualitative information. *Id.* at 39 ("All information available in the update assessment indicates that stock size has not increased.").

116. In 2017, NMFS notified the Council in a letter that, based on the 2015 operational assessments, Gulf of Maine cod and Georges Bank cod were overfished, the former was subject to overfishing, and the latter had an unknown overfishing status. NMFS wrote: "This letter serves as official Council notification of our determinations under sections 304(e)(2) and (7) of the Magnuson-Stevens Fishery Conservation and Management Act." Letter from John Bullard, NMFS Regional Administrator, to John F. Quinn, New England Council Chairman (Aug. 31, 2017).

117. Shortly thereafter, NMFS finalized and published new 2017 operational stock assessments, which confirmed yet again that Gulf of Maine cod was subject to overfishing and was overfished. *See* Northeast Fisheries Science Center, Operational Assessment of 19 Northeast Groundfish Stocks, Ctr. Ref. Doc. 17-17 (Oct. 2017). For the Georges Bank cod stock, the same data-limited approach was used, which did not quantitatively determine status; an overfished designation was still recommended due to the generally poor stock condition. *Id.* at 38.

118. In 2018, NMFS published a Federal Register notice based on the 2017 operational assessments of their determination that "[p]ursuant to section 304(e)(2)

of the Magnuson-Stevens Fishery Conservation and Management Act," Gulf of Maine cod and Georges Bank cod were both overfished and subject to overfishing. 83 Fed. Reg. 9298 (Mar. 5, 2018).

119. The most recent round of stock assessments was conducted in 2019, and concluded that both stocks of Atlantic cod have been subject to overfishing for all of the years analyzed (1982-2018 for Gulf of Maine cod, and 1978-2011 for Georges Bank cod), and both stocks have been overfished, meaning biomass was below the minimum threshold, in all but two years of those same time periods. *See* 2019 Operational Assessments, *supra* para. 73, at 33.

120. The operational assessments from 2019 currently are the best scientific information available.

Framework 59

121. Framework Adjustment 59 to the Northeast Multispecies Fishery Management Plan is the latest action developed by the New England Council and approved and implemented by NMFS.

122. Framework 59 was initiated by the New England Council at its meeting in June 2019, for the purpose of, among other things, setting catch limits for fifteen groundfish stocks for fishing years 2020-2022.

123. The catch limits set in Framework 59 represented NMFS and the New England Council's management response to recently-completed operational assessments from 2019. *See, e.g.*, 85 Fed. Reg. at 45,794 ("This action is necessary

to respond to updated scientific information . . . ."); Framework 59, at 178 ("Alternative 2 [the alternative selected] would reflect the results of the 2019 groundfish operational assessments.").

124. After several rounds of drafting and analysis by the Council's Plan Development Team and its SSC, the full Council voted on the contents of Framework 59 at its December 2019 meeting. The package was finalized and sent to NMFS for review in April 2020, prior to the May 1 start of the fishing year.

125. Framework 59 set catch limits for Gulf of Maine cod based on Option A from the Amendment 16 ABC control rule: 75 percent of F_{MSY}. Option A is intended to apply to normal situations when a stock is healthy. *See supra* para. 92. Option A sometimes is referred to as the "default control rule." *See* Amendment 16, at 487.

126. Scientific modeling conducted during the Framework 59 process, based on the 2019 operational assessment for Gulf of Maine cod, showed the stock had a zero to one percent chance of rebuilding by 2024, its current rebuilding deadline, even if there were no fishing taking place.

127. A minority report from the Council's SSC pointed out that under these circumstances, the ABC control rule required Option C to be used to set catch limits for Gulf of Maine cod, since the stock had no meaningful chance of rebuilding by its deadline even in the absence of fishing. *See* Memorandum from SSC to Tom Nies, New England Council Executive Director, at 13 (Nov. 22, 2019), reprinted in Framework 59, Appendix I; *see also supra* para. 92 (control rule).

128. Option C involves setting catch limits based on bycatch only, including a reduction in bycatch. *See* Amendment 16, at 78-79. Option C would have yielded lower annual catch limits for Gulf of Maine cod, had it been applied. See Memorandum, *supra* para. 127, at 13.

129. The majority recommendation from the Council's SSC provided no substantive justification in its report for the choice to apply Option A to Gulf of Maine cod, rather than Option C.

130. The New England Council adopted the majority recommendation from the SSC and set catch limits for Gulf of Maine cod in Framework 59 based on Option A. The Council provided no substantive justification for this choice in the documentation accompanying Framework 59, other than the fact that the SSC recommended it.

131. NMFS subsequently provided no further justification when it approved the decision to set Gulf of Maine catch limits based on Option A, other than the fact that the Council and its SSC had selected it.

132. Framework 59 contained no other conservation and management measures applicable to Gulf of Maine cod that serve, in a meaningful way, to "rebuild the [] stock." 16 U.S.C. § 1854(e)(3).

133. For Georges Bank cod, Framework 59 set catch limits for fishing years 2020-2022 based on a data-limited approach referred to as "PlanBsmooth."

134. PlanBsmooth was used as the basis for setting catch limits for the Georges Bank cod stock in the previous two cycles of harvest specifications, namely Framework Adjustment 55 and Framework Adjustment 57.

135. Neither the Council, its SSC, nor NMFS, in the current harvest specification cycle or in previous cycles, has ever shown that PlanBsmooth will rebuild (or has at least a 50 percent likelihood of rebuilding) Georges Bank cod by its deadline of 2026.

136. The 2019 operational assessments showed declining indices of abundance for Georges Bank cod, indicating that the use of PlanBsmooth for the past several years has not, in fact, led to rebuilding of the stock—but rather to a further decline in the stock's biomass. *Cf.* Framework 59, at 177-78 (stating, with no rational support and in the face of facts to the contrary, that "the proposed ABCs are not expected to lead to declines in biomass for the[] stocks" using data-limited methods like PlanBsmooth).

137. In Framework 59, the New England Council's SSC chose to use the PlanBsmooth results for Georges Bank cod as the ABC, rather than in past actions such as Framework 55 and Framework 57, when it used the PlanBsmooth results for Georges Bank cod as the higher overfishing limit ("OFL"), not the ABC. *See* Memorandum, *supra* para. 127, at 4.

138. The net effect of this change was to remove the buffer accounting for scientific uncertainty, making the new Georges Bank cod catch limits less precautionary than in past actions. Specifically, the change resulted in annual

catch limits for Georges Bank cod that are 25 percent higher than they would have been if the PlanBsmooth results had been used to specify the OFL, as was done in the past. *See id.* at 12.

139. A majority of the SSC stated this change was made for Georges Bank cod so as to be consistent with how they used PlanBsmooth results for other stocks. The SSC majority provided no further rationale for the change and provided no justification for effectively eliminating the scientific buffer by eliminating the prior buffer provided between the OFL and the ABC calculation. *See id.* at 9.

140. A minority of the SSC "opposed [] the process used for setting ABC for Georges Bank cod," and stated the PlanBsmooth output should continue to be used as the stock's OFL. The minority expressed concern "that the approach recommended by the majority of the SSC removes a crucial buffer that is used for other stocks and previously for this stock." *Id.* at 13.

141. The SSC majority also did not explain how the choice to leave the OFL value undefined was consistent with the Act's mandate to "specify objective and measurable criteria for identifying when the fishery to which the plan applies is overfished." 16 U.S.C. § 1853(a)(10).

142. The SSC also did not provide an explanation as to why this change was advisable, necessary, logical, or consistent with the Act's catch limit and rebuilding mandates, given that it leads to a relative increase in catch for a stock that already appeared to be declining under the use of this PlanBsmooth approach.

143. Simply accepting the SSC's recommendation, neither the Council nor NMFS provided any further substantive rationale for deciding to use the PlanBsmooth output as an ABC for Georges Bank cod in Framework 59.

144. Framework 59 contained no other conservation and management measures applicable to Georges Bank cod that serve, in a meaningful way, to "rebuild the [] stock." 16 U.S.C. § 1854(e)(3).

145. NMFS received Framework 59 and published the Council's recommendations for public comment on May 29, 2020. *See* 85 Fed. Reg. 32,347. NMFS provided 17 days for public comment on the action. *Id.*

146. CLF submitted a letter on behalf of its members in response to the proposed rule on June 15, 2020, urging NMFS to disapprove the measures for Atlantic cod. CLF pointed out that the catch limits proposed for Gulf of Maine cod and Georges Bank cod could not rebuild the stocks by their statutory deadlines, were of limited use as they had no effective accountability mechanism, and were inconsistent with the existing rebuilding plans and the approved ABC Control Rule in the groundfish fishery management plan, which required NMFS to set catch limits based on bycatch only and reduce such bycatch under Option C.

147. NMFS approved Framework 59 and published a final rule implementing it on July 30, 2020. *See* 85 Fed. Reg. at 45,794.

148. In the final rule, NMFS acknowledged CLF's comment letter but provided no meaningful response. The agency argued that the catch limits for Atlantic cod set in Framework 59 "are consistent with the current rebuilding

programs," even though they fail to rebuild the stocks by the deadlines in their respective rebuilding programs. *Id.* at 45,804. NMFS provided no direct explanation for ignoring Option C in the ABC control rule for Gulf of Maine cod. *See id.* And the agency provided no rational basis for using the PlanBsmooth output as an ABC rather than OFL for Georges Bank cod. *See id.*

149. NMFS's approval of Framework 59 and publication of the Framework 59 final rule is a final agency action subject to review under the Magnuson-Stevens Act and the APA. 16 U.S.C. § 1855(f); 5 U.S.C. § 704.

CAUSES OF ACTION

COUNT I: FRAMEWORK 59 VIOLATES THE MAGNUSON-STEVENS ACT AND THE APA WITH RESPECT TO GULF OF MAINE COD

150. Plaintiffs re-allege and incorporate by reference the allegations contained in all preceding paragraphs of this Complaint.

151. NMFS has a mandatory duty to rebuild overfished fisheries consistent with 16 U.S.C.§ 1854(e).

152. The Gulf of Maine stock of Atlantic cod was overfished at the time the Sustainable Fisheries Act was passed in 1996, over two decades ago. The stock is currently in its second formal rebuilding plan.

153. NMFS found that its first rebuilding plan failed to produce adequate progress toward rebuilding Gulf of Maine cod, and has repeatedly found that the stock remains overfished under both rebuilding plans.

154. The current rebuilding plan for Gulf of Maine cod was established by Framework 51 in 2014.

155. The deadline for rebuilding Gulf of Maine cod is the year 2024.

156. The rebuilding plan is implemented through biennial harvest specification packages based on periodic stock assessments.

157. Framework 59 is the most recent specifications package and is based on the 2019 operational assessments. Framework 59 establishes catch limits and management measures for Gulf of Maine cod for fishing years 2020-2022 and implements existing rebuilding plans for overfished stocks.

158. Based on the latest stock assessment, there is a zero to one percent chance of Gulf of Maine cod rebuilding by the year 2024, even if fishing were to wholly cease on the stock.

159. Under the catch limits established in Framework 59, Gulf of Maine cod cannot rebuild by 2024.

160. Framework 59 furthermore sets catch limits for Gulf of Maine cod using an inapplicable ABC control rule option that should only be applied to healthy stocks, instead of using a control rule option that applies to stocks severely behind schedule with rebuilding—as is the case with Gulf of Maine cod.

161. Framework 59 fails to contain any other rebuilding measures for Gulf of Maine cod, despite the New England Council having been notified repeatedly (most recently in 2018 and 2020) of the stock's overfished status under 16 U.S.C. § 1854(e)(2).

162. NMFS's approval of Framework 59 and promulgation of the Framework 59 Final Rule, relative to Gulf of Maine cod, violated the legal requirements in the Magnuson-Stevens Act to "rebuild affected stocks of fish," 16 U.S.C. § 1854(e)(3), to use the best available science, *id.* § 1851(a)(2), and to have a functioning mechanism for specifying annual catch limits, *id.* § 1853(a)(15), as well as the APA.

163. This violation of the Magnuson-Stevens Act by NMFS threatens CLF and its adversely affected members with irreparable injury for which it has no adequate remedy at law.

COUNT II: FRAMEWORK 59 VIOLATES THE MAGNUSON-STEVENS ACT AND THE APA WITH RESPECT TO GEORGES BANK COD

164. Plaintiffs re-allege and incorporate by reference the allegations contained in all preceding paragraphs of this Complaint.

165. NMFS has a mandatory duty to rebuild overfished fisheries consistent with 16 U.S.C.§ 1854(e).

166. The Georges Bank stock of Atlantic cod was overfished at the time the Sustainable Fisheries Act was passed in 1996, over two decades ago.

167. Georges Bank cod is currently in a rebuilding plan established by Amendment 13, in 2004.

168. NMFS has repeatedly found that Georges Bank cod remains overfished, despite being under a rebuilding plan.

169. The deadline for rebuilding Georges Bank cod is the year 2026.

170. The rebuilding plan is implemented through biennial harvest specification packages based on periodic stock assessments.

171. Framework 59 is the most recent such implementing action and is based on the 2019 operational assessments. Framework 59 establishes catch limits and management measures for Georges Bank cod for fishing years 2020-2022.

172. Framework 59 bases catch limits for Georges Bank cod, and, in turn, its implementation of the stock's rebuilding plan, on the output of a data-limited methodology utilizing population survey indices.

173. The data-limited methodology used to set catch limits for, and rebuild, Georges Bank cod has never been demonstrated to rebuild the stock by its statutory deadline of 2026. To the contrary, U.S. and Canadian survey indices for Georges Bank cod show a recent decline in biomass, indicating the stock is becoming further overfished rather than rebuilding.

174. Framework 59 furthermore arbitrarily changes its treatment of the data-limited methodology outputs, relative to past actions, such that the resulting catch limits become higher and less precautionary, do not account for scientific uncertainty, and leave the annual overfishing status determination criterion for Georges Bank cod undetermined—without providing any reasoned explanation of how this approach will promote sustainability of the stock, prevent overfishing, and rebuild the stock.

175. Framework 59 fails to contain any other rebuilding measures for Georges Bank cod, despite the New England Council having been notified

repeatedly (most recently in 2018 and 2020) of the stock's overfished status under 16 U.S.C. § 1854(e)(2).

176. NMFS's approval of Framework 59 and promulgation of the Framework 59 Final Rule, relative to Georges Bank cod, violated the legal requirements in the Magnuson-Stevens Act to "rebuild affected stocks of fish," 16 U.S.C. § 1854(e)(3), to use the best available science, *id.* § 1851(a)(2), to have a functioning mechanism for specifying annual catch limits, *id.* § 1853(a)(15), and to have objective and measurable criteria for determining when the stock is subject to overfishing, *id.* § 1853(a)(10), as well as the APA.

177. This violation of the Magnuson-Stevens Act by NMFS threatens CLF and its adversely affected members with irreparable injury for which it has no adequate remedy at law.

PRAYER FOR RELIEF

WHEREFORE, CLF respectfully requests the Court enter judgment for Plaintiff providing the following relief:

1. Declare that Defendants violated the Magnuson-Stevens Act and the APA as described above, when they approved and implemented the Framework 59 conservation and management measures for Gulf of Maine cod.
2. Declare that Defendants violated the Magnuson-Stevens Act and the APA as described above, when they approved and implemented the Framework 59 conservation and management measures for Georges Bank cod;

3. Order and enjoin Defendants to take emergency action to establish ABCs for the Gulf of Maine and Georges Bank cod stocks based on incidental bycatch only, consistent with Option C of the approved control rule for the Northeast Multispecies Fishery Management Plan.

4. Order and enjoin Defendants, within six months of the Court's order, to implement additional or revised management measures necessary to achieve adequate progress toward rebuilding Gulf of Maine cod by 2024 and Georges Bank cod by 2026;

5. Retain jurisdiction over this matter until such time as Defendants have fully complied with the Court's order;

6. Grant Plaintiff the costs of suit, including reasonable attorney fees pursuant to 28 U.S.C. § 2412; and

7. Grant such other relief as the Court deems just and proper.

Dated: August 28, 2020

Respectfully submitted,

/s/Erica Fuller

Erica Fuller (D.D.C. Bar No. MA001)
Peter Shelley (*pro hac vice* pending)
Conservation Law Foundation
62 Summer Street
Boston, Massachusetts 02110
(617) 850-1754
efuller@clf.org
pshelley@clf.org

Counsel for Plaintiff
Conservation Law Foundation

From:Edward Barrett
President
Massachusetts Fishermens Partnership

To:Thomas A.Neis
Executive Director
New England Fisheries Management Council

Dear Director Nies,

The Massachusetts Fishermens Partnership (MFP)would like to submit the following comments in regards to Amendment 23.The MFP is an umbrella organization of 16 commercial fishing nonprofits that works with over 4000 fishermen representing all gear types. Many of the vessel's MFP advocates for target groundfish as day boats. Many of the vessel's MFP advocates for homeport in the small coastal communities of Massachusetts.

The MFP does not support the preferred alternative of the NEFMC, that being 100% ASM coverage. We believe this action will have devastating economic impacts on an already fragile groundfish fishery. Since the inception of Amendment 16 the number of participants in the multispecies fishery has declined, so much so that ports that once supported 20-30 vessels targeting groundfish now have none. The infrastructure that supported this fleet has disappeared. No fish transportation business, no access to ice, with local seafood markets left only to market imported fish.Admendment23 with its increased costs will continue to acerbate this trend.

Specifically, we oppose the council preferred alternative for the following reasons:
1)The economic analysis is highly flawed. The economic analysis provided in the DEIS fails to account for the disproportionate impact ASM will have on smaller vessels. Profit margins for all vessels have been narrowing and with the current COVID pandemic have all but disappeared. Added costs of up to $700/day on every trip will insure that.

The DEIS pretends that electronic monitoring (EM) can save costs. Both EM options are currently pilot projects. Under the "audit" model crew needs to handle each discard to produce a video. Since most groundfish vessels are operating with minimum crew it is unreasonable to think this task can be done without the opportunity cost of less time fishing and more time handling discards. This will certainly lower a vessels ability to make a profit. Under the "max retention "model dockside monitoring is needed. Who will pay for that?

2)This action undermines Amendment 18 goal of fleet diversity. The analysis in the DEIS concludes quota will move from less efficient to more efficient vessels. Since when has it been the councils goal to manage towards "efficiency "?Is it not the Sustainable Fisheries Act to uphold National Standard 8 goal to provide "sustained participation "to fishing communities? At what point did the council define what an "efficient "vessel is? At what point did the council decide what communities meet that criteria?
3)We do not believe %100 ASM will provide a significant boost to stock assessment science in relation to the cost burden it will create. For many years now NEFSC has been collecting observer data under DAS and catch share systems. By now reasonable discard projections must be able to be made without burdening the fishing fleet with expensive ASM costs. The assertion by environmental NGO's that discards are hampering stock growth flies in the face of the reality of the GOM cod stock growth under DAS. With strict trip limits and significantly more vessels fishing the stock rebounded even though

discards were much higher. Certainly the NEFSC could come up with scientifically reasonable discard rate without having %100 ASM.4)The MFP disagrees with the assertion that %100 ASM monitoring is needed for enforcement. Under current management a vessel must pretrip notify, maintain a VMS tracking system, report landings to dealers who must also report landings. IN addition, enforcement officers inspect both at sea and dockside. MFP feels this level of reporting is enough to successfully enforce management regulations. Why one individual was able to skirt law in light of all this is any bodies guess. Observers are not law enforcement and do not have the training or the tools to do this. 5)The MFP believes Amendment 23 will impact the safety of our fishermen. We can easily visualize scenario's where the pressure to pay for ASM will force vessels to fish in marginal conditions because they are being billed per day both at sea and stand by time during a trip. This could create incentives for vessels to fish in poor weather to minimize costs. 6) Amendment 23 will impact food security. Less boats, which is an almost certainty under Ad 23, will result in less local seafood. This spring we saw the results of a pandemic threatening protein supplies for the American public. Why at this time would we want to manage towards a smaller fleet with less seafood available to the people of this country? Why would we want to continue to rely on 94% of our seafood being imported?

In conclusion we feel the best choice for now is a vote for "no action". The MFP supports the comments of our member associations, the Northeast Seafood Coalition and Northeast Fishery Sector 12.The council needs to explore ways in which new technologies in PARTNERSHIP with our fishermen could provide groundbreaking science that would fuel our ability to understand the challenges our ocean face. Throwing dead fish over the side in front of a camera will not get us there. The MFP would look forward to partnering with NOAA to develop technological innovation that would benefit all. Unfortunately Amendment 23 will not get us there. Let us not further erode the fleet diversity our fishing community deserves.

Respectfully,

Edward Barrett
President
Massachusetts Fishermens Partnership

NORTHEAST HOOK FISHERMAN'S ASSOCIATION

91 FAIRVIEW AVE
PORSTMOUTH NH 03801

April 10, 2019

New England Fishery Management Council
50 WATER STREET | NEWBURYPORT, MASSACHUSETTS 01950 | PHONE 978 465 0492 | FAX 978 465 3116
Thomas A. Nies, *Executive Director*

Dear Executive Director Tom Nies & Council Chairman Dr. John Quinn

Subject: AMENDMENT 23/GROUNDFISH MONITORING

We represent a group of Commercial Fishermen with the Limited Access Handgear HA Permits, employing the use rod and reel, handlines or tub trawls to catch Cod, Haddock and Pollock along with small quantities of other regulated and non-regulated marine fish.

We are requesting that the NEFMC exempt Common Pool <u>and</u> Sector Vessels issued a limited access NE multispecies Handgear A or Small Vessel Category permit from Dockside Monitoring (DSM).

1. We requested the same exemption from the NMFS in our comments for Dockside Monitoring in Framework 45 and this request was granted. NMFS stated:

   ”*Vessels issued a limited access NE multispecies Handgear A or Small Vessel Category permit, and vessels issued an open access NE multispecies Handgear B permit, land very small amounts of regulated species and ocean pout compared to vessels issued limited access NE multispecies DAS permits. Thus, dockside/roving monitoring costs would represent a greater proportion of their operational costs compared to NE multispecies vessels operating under a NE multispecies DAS. Based on public input, there is the potential that such costs would be more than the value of fish landed on a particular trip. Accordingly, FW 45 proposes to exempt Handgear A, Handgear B, and Small Vessel category permits from any dockside/roving monitoring requirements when operating in the common pool. Under such an exemption, it would not be possible for dockside/roving monitor service providers to provide statistically random coverage of all common pool trips, as required under Amendment 16. Therefore, the proposed regulations would also revise the Amendment 16 dockside/roving monitoring coverage provisions to accommodate this exemption, and specify that service providers must provide random coverage of all trips subject to the dockside/roving monitoring requirements.*” Docket ID: NOAA-NMFS-2010-0198 RIN 0648-BA27

2. Although Amendment 23 proposes that Dealers pay for DSM there is still the concern that the value of the catch and any subsequent profit made by the dealer (much smaller portion than the fisherman) will not be sufficient to cover the costs of the DSM for these permit categories. A Dealer may rightfully refuse to take the groundfish from a small vessel since they would lose money almost every time. **<u>These federally licensed fisherman can only sell their catch to federal dealers. Implementing DSM on these small vessel fishermen would eliminate these fishermen from the fishery if no dealer will provide a DSM to them at a financial loss)</u>**.

3. We are requesting that <u>both</u> Common Pool and Sector vessels are exempt from DSM. This makes sense since the reasons for requesting this exception is the same regardless if a vessel is in the common pool or in a sector.

Very Respectfully,
Marc Stettner /s/

NEHFA MEMBERS: Marc Stettner, Timothy Rider, AJ Orlando, Hilary Dombrowski, Paul Hoffman, Christopher DiPilato, Ed Snell, Scott Rice, Roger Bryson, Brian McDevitt, Anthony Gross, Doug Amorello

Sept 4th 2020

To: Tom Nies @ New England Fishery Council

Hi There, My Name is Andrew D. Wheeler, I have A Hand Gear "B" Permit Open Access. My Problem is I'm on disability and the permit Forbids the use of Labor saving devices. - There Are Permits that Allowed use of Haulers, But I do Not Have Access to Them.

Permit # 10024118

So my Question is I have A Broken Neck and Ulnar Dmg to my Left Arm. Could we use The A.D.A To Request Accomodation to my Current permit?

I know it is Limited For Good Reason!!! But Could we Maybe Allow the use of A "Hauler" But Limit the Catch or Hooks, or Just Find A way to Help me Fish without That Would Honor the Spirit of The B Hand Gear But Allow Me to Fish without the Added Burden?

I know I'm Asking For More than WAS Intended By "Open Access", But IF You can Help I Sure Would Appreciate it.

Thank you for your Time and wishing you well

[signature]

Cell # 207-350-3845
E Mail Addwheel42@tutanota.com
Contact Info
Andrew D. Wheeler
153 McKay Road
Edgecomb, ME 04556

September 9, 2020

RECEIVED
SEP 08 2020
NEW ENGLAND FISHERY
MANAGEMENT COUNCIL

To: Dr. John Quinn, Council Chairman

From: James Bramante

29 Lawndale Road

Stoneham, MA 02180

Dr. Quinn,

I am a retired ground fisherman, however I would like to express my concern over the catch leasing program. Over the years, we have been restricted to the replacement rule of 10% O.A.L. and 20% HP and I now see a potential for bypassing this rule and doing harm for future rebuilding of the groundfish stocks. For example, let us say any boat that holds a quota can lease his quota to any other regardless of this rule. This makes a small horsepower boat turn into a large boat such that a boat with 200 HP and any overall length can sell quota to any boat, any HP. This is a way around the regulations and it puts more pressure on the regulated groundfish stocks and habitat. As you know, a lot of scallop boats that have high HP and O.A.L. and see this as an opportunity to go groundfishing in the off season. May I suggest we hold to the 10-20 rule for the groundfish industry leasing and D.A.S. program.

Thank you,

James Bramante

CC: NMFS, Michael Pentony R.A.

conservation law foundation

For a thriving New England

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September 16, 2020

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Dear Sirs:

Conservation Law Foundation ("CLF") submitted a petition for rulemaking to end overfishing and rebuild Atlantic cod on February 13, 2020 under 5 U.S.C. § 553(e) of the Administrative Procedure Act. We also submitted a supplement to that petition, which included three attached documents, on June 24, 2020. Given that a final decision on the merits of our petition has not yet been made, we submit a second supplement for inclusion in the record of your review of CLF's petition containing scientific information not previously available.[1]

Please consider the attached draft report from Kerr, *et. al.* titled "Evaluating the Impact of Inaccurate Catch Information on New England Groundfish Management" as an additional

[1] CLF submitted its petition for rulemaking and now this additional supplement under 5 U.S.C. § 553(e) of the Administrative Procedure Act. We are seeking to compel the National Marine Fisheries Service to end overfishing of Atlantic cod immediately and rebuild the two stocks in this fishery in as short a time as possible as required by the Magnuson-Stevens Fishery Conservation and Management Act. *See* 16 U.S.C. §§ 1853(a)(1)(A) and 1854(e)(3) & (4).

supplement to our February 13, 2020 petition and as part of the basis for your final agency action on the petition. This report, while still in draft form, is critical to understanding the impacts that lack of monitoring and accountability in New England's groundfish fishery have had on the management of Atlantic cod stocks as pursuant to the Magnuson-Stevens Fishery Conservation and Management Act ("MSA"). The draft report states:

> The goal of [the] analysis was to simulation-test a range of underestimated catch scenarios and evaluate the impact on the performance of the stock assessment and management. This analysis focused on Gulf of Maine cod as a representative species in the groundfish complex because it has had discard incentives, potentially underestimated catch, and uncertainties in its stock assessment . . . **[The analysis] demonstrated that inaccurate catch information has the potential to impact stock trajectories, assessment and management performance of Gulf of Maine cod**.[2]

While the draft report does not quantify the amount of "missing catch," it is clear that bias in catch estimates—bias that is known to exist in the New England groundfish fishery due to observer effects and economic incentives to discard[3]—negatively affects science and management. On the other hand, the draft report demonstrates that fully accounting for catch can lead to faster rebuilding, more accurate stock assessments, greater landings, and more effective management.

In the design of the simulation test, Kerr, *et. al.* relied on analysis by the Groundfish Plan Development Team ("PDT") included in the Amendment 23 Draft Environmental Impact Statement.[4] Please also consider this analysis titled "Magnitude of potential 2018 missing Gulf of Maine cod discards" (attached) as part of the basis for your final agency action on the petition. Using Gulf of Maine cod as an example, the PDT's analysis[5] is an investigation into the possible missing catch for the stock in 2018 due to illegal discards and concludes:

> [T]he results of the analysis indicate a possible upper bound multiplier of 2.3 times GOM cod landings, roughly 1,100 thousand pounds (~498mt) of missing

[2] Kerr LA, Weston AE, Mazur M, and Cadrin SX. *Evaluating the Impact of Inaccurate Catch Information on New England Groundish Management* (DRAFT). Available at: https://s3.amazonaws.com/nefmc.org/2.-Report_-Eval_of_Inaccurate-Catch_7.15.20.pdf (emphasis added).
[3] *See* CLF petition for rulemaking for more details.
[4] *See* NEFMC. *Draft Amendment 23 to the Northeast Multispecies Fishery Management Plan including a Draft Environmetnal Impact Statement.* Formal Submission Draft dated March 4, 2020. Available at: https://s3.amazonaws.com/nefmc.org/200304_Draft_Groundfish_A23_DEIS_formal_submission_corrected_200312.pdf.
[5] *Id.* at 300-304; The analysis uses data from large-mesh trawl gear sector trips or sub-trips.

conservation law foundation

landings (or missing legal-sized discards), with an uncertainty range of 1.5 to 2.5,[6] or about 700 thousand pounds to 1,200 thousand pounds (~317mt to 544mt).[7]

Overall, this science reinforces the need for the agency to assert direct controls over the cod fishery, which has failed for so long to achieve the MSA's minimum requirements. Thank you for taking this supplementary information under consideration. Please do not hesitate to reach out to us with any questions you may have.

Sincerely,

Conservation Law Foundation
62 Summer Street
Boston, MA 02110
Telephone: 617-350-0990
Fax: 617-350-4030

Peter Shelley, Attorney
Erica Fuller, Attorney
Gareth Lawson, Senior Science Fellow
Allison Lorenc, Policy Analyst

[6] In fact, the maximum multiplier calculated was as high as 3.24x.
[7] *Id.* at 304.

DRAFT

Evaluating the Impact of Inaccurate Catch Information on New England Groundfish Management

Lisa A. Kerr[1], Ashley E. Weston[1], Mackenzie Mazur[1], Steven X. Cadrin[2]
[1]Gulf of Maine Research Institute, 350 Commercial Street, Portland, ME 04101, lkerr@gmri.org, 207-228-1639
[2]School for Marine Science & Technology, 836706 Rodney French Boulevard, New Bedford, MA 02744

1. Executive Summary

Underestimation of catch is a common problem in fisheries globally and has been an issue in the New England groundfish fishery. In response to this problem, the New England Fishery Management Council is considering increasing monitoring of the fishery to improve the accuracy of catch information. The goal of our analysis was to simulation-test a range of underestimated catch scenarios and evaluate the impact on the performance of the stock assessment and management. This analysis focused on Gulf of Maine cod as a representative species in the groundfish complex because it has had discard incentives, potentially underestimated catch, and uncertainties in its stock assessment. We examined the impact of a range of catch bias scenarios under two operating models with alternative natural mortality assumptions, two harvest control rules (sliding and constant fishing mortality), and two assumptions of the period of catch bias and (constant and a change over time). Through simulation testing, we demonstrated that inaccurate catch information has the potential to impact stock trajectories, assessment and management performance of Gulf of Maine cod. Scenarios with no catch bias exhibited accelerated rebuilding of the Gulf of Maine cod stock and were characterized by accurate stock assessment performance and effective management. Scenarios that assumed Gulf of Maine cod have higher natural mortality did not achieve the same rebuilding and management outcomes as observed under the lower natural mortality assumption. Under scenarios of constant catch bias, assessments exhibited consistent underestimation of recruitment and spawning stock biomass, and the magnitude of underestimation increased with increased bias in catch. However, fishing mortality estimates remained unbiased because they were informed by unbiased age composition. Under scenarios with a changepoint in catch bias, assessments initially performed well for 10-15 years after the changepoint and then performance increasingly degraded. Retrospective patterns the stock assessment (i.e., a systematic decrease in updated estimates of spawning stock biomass and increase in updated estimates of fishing mortality) resulted from changepoint catch bias scenarios, but not from constant catch bias scenarios. Estimated stock status was similar to “true” stock status determinations under constant catch bias scenarios, but changepoint catch bias scenarios exhibited instances of misperceived stock status. Results suggest that high to extreme bias in catch reporting was detrimental to sustainable management, however, catch reporting bias <50% had more limited impacts on assessment and management performance in the context of risk averse management. In general, the impacts of catch bias scenarios were similar across alternative harvest control rules with key differences in the

performance of the constant harvest control rules in the short-term (1-5 projection years) due to higher fishing mortality during this period. It is important to recognize the caveats and limitations of this analysis and that the results are contingent on the specification of the models and scenarios. This study provides a demonstration of the potential impact of underestimation of catch that can provide guidance to managers on the magnitude and direction of the impact of bias in catch reporting.

2. Background

Fisheries management decisions are informed by stock assessments which incorporate catch and survey time series, as well as biological information, to estimate the exploitable biomass of stocks. Accurate catch data, as well as correct specification of models (i.e., valid model assumptions, Francis 2011), are critical to ensuring that fish stocks are assessed accurately and that catch limits prevent overfishing. Misreported catch is a problem for many fisheries globally because of common problems with monitoring, enforcement, and the economic incentives driving this behavior (Agnew et al. 2009). The approach to monitoring fisheries is one aspect of a fisheries management procedure that can be evaluated to assess its impact on the goals of sustainable fisheries management (Rudd and Branch 2016). Management strategy evaluation can be used to evaluate the impact of misreported catch on stock assessment results and management recommendations.

Groundfish stocks in New England are managed under the Northeast multispecies groundfish federal fishery management plan (FMP) by the New England Fishery Management Council (NEFMC). The current groundfish monitoring program includes catch reports from fishermen and dealers, as well as estimates of discards based on data provided by at-sea observers on a portion of trips (10-35% of trips; Demarest 2019). The use of observed trips to infer total discards for the fishery assumes that these trips are representative of unobserved trips. Recent analyses suggest that this assumption may not be valid, resulting in underestimation of the total catch (McNamee et al. 2019). The NEFMC is considering adjusting the groundfish monitoring program through Amendment 23 to the Northeast Multispecies FMP with the aim of improving the reliability and accountability of catch reporting and to ensure a precise and accurate representation of catch (landings and discards; NEFMC 2020). In considering this action, the NEFMC reviewed analyses conducted by the Groundfish Plan Development Team (PDT) relevant to Amendment 23 issues.

The Groundfish PDT conducted a series of analyses of groundfish monitoring that evaluated the assumption that observed trips are representative of unobserved trips and that the current approach to quantifying fishery discards enables accurate accounting of total catch. Henry et al. (2019) identified changes in discard incentives by stock and fishing year and documented positive incentives to discard certain species within the groundfish fishery in certain years (e.g., Atlantic cod). Demarest (2019) documented significant differences in the operation of fishing vessels in the groundfish fishery between observed and unobserved trips, suggesting that fishing behavior is altered when a human observer is onboard. Linden (2019) used a predictive model based on observed trips to predict catch on unobserved trips and identified differences between the predicted and reported catch. Finally, Nitschke (2019a) compared the stock landings to effort and total catch ratios on observed and unobserved trips and found differences between observed and unobserved trips that support the presence of an observer effect. These analyses provide evidence of an observer effect on groundfish trips and suggest that estimating discards on unobserved trips based on observed trips may not be accurate and could result in an underestimation of total discards (McNamee et al. 2019). The analyses did not provide a precise quantification of the magnitude of underestimated discards, making it challenging to understand the potential impact on stock status determination and catch advice for groundfish stocks.

In response to this issue, the NEFMC is considering increasing monitoring in the groundfish fishery to improve the accuracy of catch information. One of the potential benefits of increased monitoring (e.g., observer or electronic monitoring) is improvement in the accuracy of stock assessments and the effectiveness of catch advice. However, increased monitoring is costly and there are limited analyses that demonstrate the impact of underestimated catch on fisheries management performance (e.g., Rudd and Branch 2016).

The goal of this analysis was to simulation test a range of underestimated catch scenarios and evaluate the impact on the performance of the stock assessment and fisheries management. This analysis focused on Gulf of Maine cod as a representative species in the groundfish complex for which discard incentives and accuracy of catch information are thought to be an issue as it is a constraining stock in the fishery (Nitschke 2019b). We examined the impact of catch bias, simulating different levels and timing scenarios, in the context of Gulf of Maine cod operating models with alternative natural mortality assumptions and management under two alternative harvest control rules (i.e., sliding and constant fishing mortality).

3. Methods

We used a closed-loop simulation model framework to test alternative scenarios of underestimated catch. The approach involves simulating the natural and human aspects of the managed fishery resource system. In this context, the perceived status of the resource triggers action based on a management procedure, and subsequent management decisions in-turn affect fishing activities and feedback on the resource (Punt et al. 2016). The framework consists of: 1) operating models, designed to emulate stock dynamics, and 2) management procedures that include an observation model (i.e., designed to emulate generation of survey and harvest data), a stock assessment fit to simulated fishery and survey data, estimated biological reference points, and a harvest control rule that determines catch advice. Using this framework, we simulated a range of underestimated catch scenarios through introduction of bias in catch reporting (i.e., observation bias) and bias in the implementation of catch advice, such that catch exceeded levels prescribed by catch advice (i.e., implementation bias). Models were written in the R statistical programming language (R Core Team, 2019) and code was version controlled through a GitHub repository that included technical documentation.

3.1. Operating models

We developed two operating models that emulated the two accepted stock assessment models for Gulf of Maine cod (NEFSC 2019). These models differed in their assumption of natural mortality, the M = 0.2 model (i.e., natural mortality = 0.2) and the M-ramp model (i.e., natural mortality increased from 0.2 to 0.4 during the time series). The operating models were age-structured (ages 1-9+) stochastic models designed to emulate the population dynamics of Gulf of Maine cod. In the context of the simulation framework, the operating models represented versions of the "true" dynamics of the resource and provide "perfect" knowledge of the resource from which we can evaluate the performance of stock assessment and management. Abundance of fish at age over time was calculated based on exponential survival (Eqn. 1, Table 1). Spawning stock biomass was a function of abundance-at-age, weight-at-age, and maturity-at-age of fish (Eqn. 2, Table 1). Recruitment was modeled using an empirical cumulative distribution function with a linear decline to zero at zero spawning stock (Eqn. 3, Table 1). Catch by the fishery was calculated as a function of the Baranov catch equation (Eqn. 4, Table 1).

The models were parameterized based on the most recent stock assessment update and benchmark assessment for Gulf of Maine cod (NEFSC 2013, NEFSC 2019, Table 2). Growth was modeled using a time invariant weight-at-age vector and maturity-at-age followed a logistic pattern. These values were consistent with the specification of growth and maturity used in stock assessment projections (Table 3, NEFSC 2019). We modified the stock-recruit relationship used in stock assessment projections of Gulf of Maine cod (NEFSC 2013) to utilize the last 20 years of observed recruitment (1998-2018) in the cumulation distribution function. The original fitting of the stock-recruit relationship used all historically observed recruitments, including extreme high values from the 1980s. This resulted in periodic extreme high recruitment in operating model simulations which were not consistent with moderate to low values of recruitment observed in recent decades. In addition to sampling from this distribution of recruitment, we incorporated a small amount of stochasticity (i.e., process error, Table 2). We modeled the harvest of cod by the fishery as a single fleet (i.e., recreational and commercial combined) consistent with the current stock assessment. Fishery selectivity-at-age was informed by the selectivity-at-age in the most recent stock assessment for the most recent selectivity block (Table 3). The selectivity curve represents the combined recreational and commercial catch.

Historic estimates of fishing mortality and recruitment (1982-2014) from the stock assessments (M = 0.2 scenario and M-ramp scenario) were used to condition the models and emulate estimated stock trajectories (NEFSC 2019). The historic period of the operating models spanned 1982-2014 and served to initialize forward projections starting from the current stock status of Gulf of Maine cod (i.e., overfished and overfishing is occurring; NEFSC 2019). The models were projected forward 36 years, from 2015 to the year 2050, under alternative management procedures.

3.2. Management Procedures

We aimed to emulate the current fishery management procedure of Gulf of Maine cod. The management procedure included: 1) data collection, 2) fitting a stock assessment, 3) estimating biological reference points, and 4) determining catch advice from a harvest control rule. The management procedure was applied starting in 2015.

Observation models

Observation models were designed to simulate collection of fishery dependent and fishery independent data with the characteristics and quality (i.e., uncertainty and bias) that typically inform the Gulf of Maine cod stock assessment. The fishery-dependent data generated included total catch and catch-at-age information. Fishery independent survey data included a survey index of abundance and an index of abundance-at-age.

We simulated data to emulate the Northeast Fisheries Science Center (NEFSC) bottom trawl survey. We modeled the survey index of abundance-at-age and an aggregated index of abundance (summed across ages) as a function of the total abundance available to the survey (i.e., resource abundance in the operating model), catchability of the survey, selectivity-at-age, and observation error (Eqn. 5, Table 4). We assumed lognormal error for the index of abundance and multinomial error for the index of abundance-at-age (Table 2). Survey selectivity-at-age followed a logistic pattern based on stock assessment fit values for the NEFSC spring bottom trawl (Table 3).

We modeled the fishery catch in number as described previously (Eqn. 4, Table 1) and calculated catch and catch-at-age in weight as described in Eqn. 5 and 6 (Table 4). We assumed lognormal observation error on total catch and multinomial errors on catch-at-age (Table 2). We assumed an observation error for the combined commercial-recreational catch based on values used in the Gulf of Maine cod assessment (i.e., CV = 5%). We modeled underestimation in catch reporting as a function of the true catch and a bias term described in detail in the *Underestimated catch scenarios* section (Eqn. 7, Table 4).

Stock Assessment Model

We integrated the current stock assessment model for Gulf of Maine cod, the Age-Structured Assessment Program (ASAP, Legault and Restrepo 1998), into the simulation framework. Model parameters in the estimation model were generally equivalent to those specified in the operating model, such that the assessment model was not mis-specified, except for the assumption of accurate catch for the catch bias scenarios. The weight-at-age, maturity-at-age, natural mortality, number of fleets (Fleets = 1), and selectivity blocks (blocks = 1) modeled were consistent between the operating model and estimation model. Fishery selectivity and survey selectivity-at-age were estimated in the assessment. Index observation error and recruitment process error were set to 0.5 and the CV on catch was consistent between the operating and estimation model (CV = 0.05, Table 2). The assessment accumulated an additional year of data each year the simulation loop was run such that the first assessment was comprised of 33 years of data and the final assessment included 68 years of data. Further detail on specification of ASAP are provided as dat files for the M=0.2 and M-ramp models (Supplementary files).

Biological Reference Points

Biological reference points (BRP) are the criteria by which we determine stock status and inform triggers for management actions in the context of harvest control rules. In the case of Gulf of Maine cod, a F_{MSY} proxy was calculated using a spawning potential ratio approach (Eqn. 8, Table 5). Spawning potential ratio was calculated at 40% and the value of F^* that results in the given ratio is the F_{MSY} proxy reference point (i.e., $F_{40\%}$, the fishing mortality expected to conserve 40% of the maximum spawning potential; Eqn. 9, Table 5). The associated biomass proxy was calculated through projection of the stock to an equilibrium spawning stock biomass, with recruitment drawn from the 1998-2018 time-series. Reference points for both the M = 0.2 and M-ramp models were calculated using M = 0.2 in accordance with the Gulf of Maine cod stock assessment (NEFSC 2019). Reference points were recalculated every two years to emulate the frequency which Gulf of Maine cod is reassessed for management purposes. We calculated both the “true” F_{MSY} and SSB_{MSY} proxy reference points values for M=0.2 and M-ramp models and estimated values under catch bias based on the stock assessments.

Harvest Control Rule

Two harvest control rules were tested: 1) a sliding harvest control rule, and 2) a constant harvest control rule. The sliding harvest control rule changed fishing mortality rate in response to biomass and was designed to emulate the Acceptable Biological Catch (ABC) control rule that is applied to groundfish species managed by the NEFMC. The ABC control rule dictates that the ABC is determined as the catch associated with fishing at either 75%F_{MSY} (based on the F_{MSY} proxy $F_{40\%}$ in the case of Gulf of Maine cod) or the mortality rate associated with rebuilding by a target rebuilding date ($F_{rebuild}$), whichever is less. For stocks that cannot rebuild to B_{MSY} in the specified rebuilding period, even with no fishing, the ABC should be based on incidental bycatch, including a reduction in bycatch rate. We emulated this using a sliding harvest control rule whereby the F-based advice decreased linearly when stock biomass was estimated to be less than the overfished threshold (i.e., 0.5 SSB_{MSY}). In addition, we modeled a constant fishing mortality control rule (F_{target} = 75%$F_{40\%}$) which removed the same fraction of the stock regardless of abundance. In simulating these harvest control rules, we assumed the Annual Catch Limit (ACL) was set to equal to the ABC. We modeled bias in achieving F_{target} through implementation error in the form of positive bias on total catch (i.e., catch exceeding catch advice; Eqn. 10, Table 5).

3.3. Underestimated catch scenarios

Underestimated catch scenarios were constructed through: 1) applying observation bias to fishery catch information going into the stock assessment (i.e., emulating underreporting; Eqn. 7, Table 4) and 2) applying implementation bias to catch advice (i.e., “true" catch is the intended catch plus unreported catch) in the operating model (Eqn. 10, Table 5). We assumed that missing catch consisted of discarded legal-sized cod (Nitschke 2019b). The same fishery selectivity curve was used to represent reported and unreported catch. Simulations assume 100% mortality of unaccounted for catch. Each catch bias scenario was projected for a period of 36 years and 100 simulations were run of each unique scenario.

Catch bias scenarios were designed to encompass a potential range of unaccounted for catch levels, because we do not know all sources and the magnitude of catch bias (Table 6). Although a quantification of unaccounted for catch was not possible across stocks, the groundfish PDT attempted to approximate the magnitude of unaccounted for catch in the commercial fishery for Gulf of Maine cod (Nitschke 2019b). This analysis suggested that missing catch for Gulf of Maine ranged from 150 to 250% times the total commercial catch. We used the upper limit of this range to inform one of the discard scenarios and encompassed the lower limit within the range of simulated scenarios. For integration in the simulation model framework, which models a combined commercial and recreational fleet, we adjusted the groundfish PDT estimate of bias in catch reporting to account for the proportional representation of recreational and commercial catch of Gulf of Maine cod which is estimated to be 50:50 over the years 2011-2018. Thus, the estimated upper limit value of 250% was adjusted to 125% to represent unaccounted for commercial catch as a proportion of total catch. The full range of our scenarios was extended to a maximum value of 200% to account for other potential sources of unaccounted for catch (e.g., recreational discards). Overall, four levels of catch bias were simulated (0, 50, 125, and 200% bias). The base case scenario was modeled with perfect observation of fishery catch and no implementation bias on fishing mortality. The simulated catch data input to the assessment was negatively biased and catch advice generated from the stock assessment was positively biased to influence the operating model dynamics and represent these levels of increasing bias in catch.

In addition to the magnitude of catch bias, the timing and duration of these issues are important to consider. The year in which bias in catch reporting started for Gulf of Maine cod is unknown and we explored two alternative scenarios. We ran scenarios under “constant bias” where bias was applied across all years of the simulation and a “changepoint in bias” in which bias was initiated in 2015 with no bias prior to 2015 (Table 6). During the historical period of the constant bias scenario, observation bias is applied as described above, but implementation bias is not as fishing mortality is input from the stock assessment during this period. The observed high fishing mortality rates during this period are assumed to reflect implementation bias. The changepoint in bias scenario was informed by NEFMC groundfish PDT work that supported a change in discard incentives in 2015 for Gulf of Maine cod (Henry et al. 2019).

3.4. Performance metrics

Sustainability, stock assessment, and management performance metrics were evaluated for each scenario. These included operating model time series (i.e., spawning stock biomass, recruitment, fishing mortality and catch) to evaluate how scenarios affect "true" stock dynamics. We also characterized trajectories of spawning stock biomass, recruitment, fishing mortality and catch over the short (1-5 years), medium (6-15 years), and long-term (15-36 years) of the projection period.

We quantified stock assessment time series, including estimated spawning stock biomass, recruitment, fishing mortality and catch, to evaluate how scenarios affect the estimated or perceived stock dynamics. To evaluate stock assessment performance, we compared the "true" operating model time series values (i.e., spawning stock biomass, recruitment, and fishing mortality) to estimated assessment values over the span of each stock assessment. Percent relative error estimates (*%REE*) of spawning stock biomass, recruitment, and fishing mortality was calculated:

$$\%REE_t = \frac{x_{est,t} - x_{true,t}}{x_{true,t}} \times 100$$

where $x_{est,t}$ was the stock assessment estimated value for quantity *x* at time *t* and $x_{true,t}$ was the operating model value of quantity *x* at time *t*. Values were summarized as averages for each stock assessment during the projection period and the median of 100 simulations was reported. We also evaluated retrospective patterns in stock assessment results through retrospective peels every five years over the span of projection period (2015-2050).

Management performance was evaluated through quantification of stock status over time. We compared the "true" biological reference point proxies for each operating model (M=0.2 and M-ramp) to biological reference points estimated under catch bias scenarios. We evaluated both the perceived stock status (estimated values from the stock assessment compared to estimated biological reference points) and "true" stock status (operating model values compared to 'true" biological reference points). Overfishing was characterized as $F_t > F_{40\%}$, overfished status was calculated as $SSB_t < SSB_{threshold}$ where $SSB_{threshold}$ was 0.5 $SSB_{F40\%}$ and a stock was considered rebuilt when $SSB_t > SSB_{F40\%}$.

3.5. Collaboration with NEFMC Groundfish PDT

We collaborated with the NEFMC Groundfish PDT to define and prioritize the range and number of scenarios for testing the performance of catch bias scenarios. The Groundfish PDT also provided input on the catch bias scenarios, parameterization of operating models, estimation model settings, and management procedures employed in simulation testing. This collaboration was conducted through a series of virtual meetings.

4. Results

The main body of this report summarizes results for scenarios simulated under the sliding harvest control rule. Results of simulations run under the constant fishing mortality harvest control rule are reported in Appendix A.

4.1. Operating model dynamics

Historical Period

The historical trajectory and magnitude of the Gulf of Maine cod stock was reconstructed by incorporating recruitment and fishing mortality time series (1982-2014) from the most recent stock assessment realizations (M = 0.2 and M-ramp) and calculating spawning stock biomass and catch as emergent properties. Historically, estimated recruitment decreased over time under both natural mortality scenarios from relatively strong recruitment in the late 1980s to the lowest estimated values in recent years (Figure 1). In M = 0.2 scenarios, recruitment was estimated to be lower and less variable from 1990 onward compared to the M-ramp assessment realization. Fishing mortality was estimated to be high during the 1990s and peaked in the mid-2010s at values close to (i.e., M-ramp assessment estimates) or exceeding F = 2.0 (i.e., M=0.2 assessment estimates; Figure 1). The simulated spawning stock biomass and catch trajectories emulated the trends estimated from the most recent stock assessments with spawning stock biomass and catch declining from highs in the early 1990s (NEFSC 2019). At the end of the historical time period reconstructions for both M=0.2 and M-ramp models, Gulf of Maine cod were at historically low values and stock status was overfished and overfishing was occurring. Thus, simulated cod stock trajectories differed between operating models with alternative natural mortality assumptions (i.e., M=0.2 and M-ramp), but within these scenarios the historical period was consistent across catch bias scenarios.

No Catch Bias

In scenarios that assumed perfect catch reporting (i.e., no bias), spawning stock biomass of Gulf of Maine cod was projected to steadily increase from historic low levels and reached a plateau after 15 years at approximately 33,389 mt in M = 0.2 models and 20,844 mt in M-ramp models (Table 7, Figure 2). The rebuilding response was a function of the significant reduction in advised fishing mortality under the sliding harvest control rule relative to historical levels, as well as the expectation of steady levels of recruitment in the future. For example, under no catch bias scenarios fishing mortality was less than or equal to 0.14 (75% of $F_{40\%}$) based on M=0.2 and 0.13 based on M-ramp operating models which is considerably lower than historical fishing mortality values which ranged from 0.4 to 2.2 for these models (Figure 1). The stock-recruit relationship drew from estimated recruitment during the last 20 years, which projects steady levels of recruitment unless spawning stock biomass was below the spawning stock biomass hinge point value (M=0.2 hinge point = 6,300 mt, M-ramp hinge point = 7,900 mt). M-ramp scenarios had higher expected future recruitment compared to M=0.2 scenarios based on the differences in estimated recruitment values that informed the stock-recruit relationship (Figure 1). The "true" catch of Gulf of Maine cod was also projected to increase over time under the no catch bias scenario, reaching an asymptote of approximately 3,614 mt in M=0.2 models and 1,840 mt in M-ramp models (Table 7, Figures 2).

Constant Catch Bias

Across constant catch bias scenarios, spawning stock biomass increased over the projection period, but the magnitude of the asymptote in biomass decreased with increasing levels of catch bias (Figure 2). For example, the asymptote of spawning stock biomass in the no bias scenario was 2.6 times greater than in the extreme bias scenario (200%) in the M=0.2 model. The catch bias scenarios in the M-ramp model exhibited a similar pattern, however the relative difference across scenarios was not as great. Projections of recruitment were similar across catch bias scenarios in M=0.2 models, but were higher and more variable in M-ramp model scenarios. In general, recruitment expectations were lower in the initial projection years (0-5 years) when spawning stock biomass was below the hinge point value in the stock-recruit relationship and subsequently increased to steady levels over the remaining projection period (Figure 2). "True" fishing mortality rates in the operating models increased across scenarios with increasing levels of catch bias, reflecting fishing above target levels prescribed by the harvest control rule (Figure 2). Values were consistent after the initial projection years in M=0.2 models, however, fishing mortality rates in M-ramp model catch bias scenarios declined slightly after peaking. Across catch bias scenarios, "true" catch (reported plus unreported) was low in the initial years of the projection period (0-5 yrs) under the sliding harvest control rule (Figure 2 and 3). In general, "true" catch was higher in scenarios with higher catch bias, however the magnitude of differences in catch across scenarios evolved over time as the impact of overfishing influenced the resource and ultimately impacted potential yield (Figures 3 and 6). For example, in M=0.2 scenarios, median "true" catch was highest in the scenario with extreme bias (200%) in the short (0-5 yrs) and medium (5-15 yrs) term, but in the long term catch was similar across catch bias scenarios based on the interaction between increasing fishing mortality and decreasing spawning stock biomass trajectories (i.e., a larger portion of the stock was caught under higher bias scenarios, Table 7, Figures 3 and 6).

Changepoint in Catch Bias

There was little difference in Gulf of Maine cod operating model trajectories simulated under constant and changepoint catch bias based on M = 0.2 operating models. The main difference in these scenarios was assessment performance and the perception of stock status (described in corresponding sections below). M-ramp operating models exhibited differences between constant and changepoint bias scenarios at higher catch bias levels and at medium to long time scales. In changepoint scenarios, there was a tendency for higher fishing mortality and "true catch" under these circumstances (Figures 2 and 3).

4.2. Assessment performance

No Catch Bias

Stock assessment trajectories of spawning stock biomass, recruitment, fishing mortality, and catch provided insight on the perceived stock dynamics of Gulf of Maine cod across catch bias scenarios (Figure 4). Comparison of the perceived stock trajectories estimated from the stock assessment and "true" operating model trajectories enabled us to quantify the relative error in assessment performance (Figure 5). Under the scenario of perfect catch reporting, the assessment models were fit to unbiased catch data and the assessment model was specified in a similar manner to the operating model. This represented a "self-test" wherein an estimation model has similar structural assumptions to the operating model, as compared to a "cross test" where there is a misspecification of the model (Deroba et al. 2015). Spawning stock bias, recruitment, and fishing mortality estimates from the assessment demonstrated good agreement with the "true" operating model values with percent relative error near zero (Figure 5). The assessment demonstrated similar accurate performance in estimating the "true" stock trajectories for M = 0.2 and M-ramp operating models (Figure 5).

Constant Catch Bias

Under scenarios of constant catch bias, stock assessments were fit to biased total catch information, as well as information that more accurately reflected stock dynamics (i.e., the survey index of abundance and age composition information from the survey and catch). Estimated stock trajectories differed from the "true" stock trajectories of the operating model in constant catch bias scenarios (Figure 4). Across scenarios with increased levels of bias, the assessment tended to increasingly underestimate spawning stock biomass and recruitment (Figure 5). For example, estimated spawning stock biomass was considerably lower than "true" operating model values under the extreme bias scenario, with the estimated trajectory remaining close to historic low levels over the projection period (Figure 4). The relative error estimates of the stock assessment were constant over time and similar in magnitude between M=0.2 and M-ramp operating models (Figure 5). Percent relative error estimates of recruitment and spawning stock biomass ranged from underestimation on the order of -32% in scenarios of moderate bias to -67% in scenarios with extreme bias. Across scenarios, the stock assessment exhibited little bias in the estimation of fishing mortality. This suggests that the age composition information provided to the assessment was sufficient to estimate fishing mortality, despite misreporting of the magnitude of total catch. High weighting of the index age composition within our scenarios, which provided accurate magnitude and age composition information, contributed to this outcome. These scenarios simulated constant bias in catch information and resulted in constant bias in assessment performance over the projection period. The estimated catch in the stock assessment was considerably lower than "true" catch in the operating model reflecting the difference between reported and unaccounted for catch (Table 7, Figure 6). Because unaccounted for catch was assumed to reflect discarding, reported catch can be considered that catch which provides economic value to the fishery as compared to unaccounted for catch which is discarded (Figure 1 and 4). Over the medium to long-term of the projection period, lower catch bias scenarios ultimately exhibited higher reported catch due to long-term impacts of greater than intended catch on stock biomass and potential yield (Figure 6). Retrospective analysis of stock assessment results at fiver year intervals over the span of the projection period provided insight on issues with retrospective patterns. Retrospective inconsistencies were negligible under scenarios of constant catch bias (Figure 7).

Changepoint in Catch Bias

Assessment performance differed under the changepoint catch bias scenarios compared to constant catch bias scenarios. Implementing a changepoint in catch bias in 2015 introduced a trend in assessment error, with little error in the estimation of recruitment and spawning stock biomass early in the projection period (i.e., years 1-10) followed by subsequent increasing levels of assessment error (Figure 5). Scenarios with higher bias in catch reporting exhibited the highest levels of underestimation in spawning stock biomass and recruitment by the end of the projection period (Figure 5). The same trends were observed for scenarios based on the M = 0.2 and M-ramp operating models, but the trend in underestimation of spawning stock biomass and recruitment started slightly later in M-ramp models (Figure 5). The lag in the impact of imposed catch bias on spawning stock biomass and recruitment relates to age structure and the time it takes for all extant year-classes to transition from partially biased catch histories to entirely biased catch histories. In the initial years of the projection, fishing mortality was increasingly underestimated as bias in catch reporting scenarios increased, but relative error subsequently decreased after 10-15 years (Figure 5). Similarly, this pattern relates to age structure as the introduction of bias causes an initial discontinuity in the progression of age classes, however, estimation of fishing mortality improves with the transition to an entirely biased catch history (i.e., similar to constant catch bias scenarios).

Relative error measures characterized the overall agreement between estimated and “true” stock trajectories (Figure 5), however, because this metric integrated bias over the span of each assessment time series it can obscure more subtle patterns that may exist within assessments, such as trends in terminal years of the assessment. Estimated stock trajectories for the final assessment in the projection period showed patterns of increasing spawning stock biomass and decreasing fishing mortality in the last several years of the projection period (Figure 4). A retrospective analysis of stock assessments over the projection period provided insight on large inconsistencies in the terminal years of the assessment (i.e. 5-10 years). In scenarios that assumed a changepoint in catch bias, retrospective analysis revealed consistent increases in updated estimates of fishing mortality and consistent decreases in updated estimates of spawning stock biomass in these scenarios (Figure 8).

4.3. Management performance

No Catch Bias

In scenarios that assumed perfect catch reporting (i.e., no bias), biological reference points provide insight as to the "true" $F_{40\%}$ and $SSB_{F40\%}$ for Gulf of Maine cod. The F_{MSY} proxy was similar between M = 0.2 and M-ramp ($F_{40\%}$ ~ 0.18) operating models, however, $SSB_{F40\%}$ values were higher for M-ramp compared to M = 0.2 operating models (Table 7, Figure 9). This pattern was driven by the lower recruitment assumptions that informed the M=0.2 operating model. Note the subtle differences in true biological reference points between constant and changepoint scenarios reflect that these were calculated from recruitment realizations simulated from the true stock-recruit relationship (Figure 7). Interestingly, deterministic calculation of MSY-reference points for M=0.2 and M-ramp operating models indicate that the $F_{40\%}$ and $SSB_{F40\%}$ are considerably less than the deterministic F_{MSY} and SSB_{MSY} (M=0.2: F_{MSY}=0.3, SSB_{MSY} =13,751 mt, and MSY =2,804 mt; M-ramp: F_{MSY}=0.3, SSB_{MSY}=26,548 mt, and MSY = 5,413 mt).

Stock status determination was equivalent between the "true" operating model and stock assessment perception in the no catch bias scenario due to the accuracy of the assessment under these scenarios. Scenarios without bias in catch did not exhibit overfishing at any point during the projection period due to the prescribed fishing mortality target at 75% of $F_{40\%}$, or less, as defined in the sliding harvest control rule (Figure 10). Comparison of the "true" spawning stock biomass to the "true" $SSB_{F40\%}$ in M=0.2 scenarios demonstrated rebuilding above the SSB_{MSY} proxy under the no catch bias scenario in the medium to long term. However, biomass remained overfished ($<SSB_{threshold}$) and below the SSB_{MSY} proxy in M-ramp operating model scenarios which related to the higher expected future recruitment and SSB_{MSY} proxy (Figure 10).

Constant Catch Bias

Bias in reported catch has the potential to impact the realization of sustainable fisheries management goals through impacts on the stock assessment and biological reference point estimates that inform determination of catch advice through harvest control rules. Estimation of the F_{MSY} proxy remained essentially the same across constant catch bias scenarios and operating models (Table 7, Figure 9). This was expected based on the approach to calculation. However, estimation of $SSB_{F40\%}$ differed across catch bias scenarios for each operating model. Estimated $SSB_{F40\%}$ values decreased with increasing bias in catch and were lower in M = 0.2 compared to M-ramp model scenarios (Table 7, Figure 9). This pattern was driven by increased underestimation of recruitment with increased catch bias and the recruitment assumptions of the different operating models. The decreasing trend in estimates of the SSB_{MSY} proxy with increasing catch bias resulted in a lower bar for measuring overfished status of the stock and can lead to a misperception of the productivity of the stock (e.g., MSY perceived to be lower; Figure 7).

Comparison of the "true" fishing mortality and spawning stock biomass to the "true" biological reference points for the operating model provided an accurate perception of stock status.

Overfishing did not occur in the short-term across catch bias scenarios and natural mortality realizations. However, overfishing occurred after approximately 5-10 years in M = 0.2 models with moderate to extreme catch bias and in M-ramp models with large to extreme catch bias (Figure 10). Comparison of the "true" spawning stock biomass to the "true" $SSB_{F40\%}$ in M=0.2 scenarios demonstrated rebuilding to the SSB_{MSY} proxy under the moderate catch bias (50%) scenario in the medium term. Biomass increased above the $SSB_{threshold}$ under the large catch bias scenario (125%) in M=0.2 scenarios, but was consistently less than the SSB_{MSY} proxy. Spawning stock biomass was generally at or below the $SSB_{threshold}$ under the extreme catch bias scenario (200%) in M=0.2 scenarios. Stock status remained overfished (i.e., below $SSB_{threshold}$) under all M-ramp scenarios (Figure 10).

Comparison of the estimated fishing mortality and spawning stock biomass to the estimated biological reference points provided insight on perceived stock status. For scenarios of constant catch bias, estimated stock status was generally the same as the "true" stock status. This consistency was due to the combined effect of underestimated assessment values and underestimated biological reference points under constant catch bias scenarios which resulted in similar ratios (e.g. estimated F/F_{MSY} proxy) and stock status determination to operating models (Figure 9 and 10).

Changepoint in Catch Bias

Similar to the constant catch bias scenarios, estimation of the F_{MSY} proxy did not change across levels of catch bias or natural mortality realizations ($F_{40\%}$= 0.18; Figure 9). However, SSB_{MSY} values differed between M = 0.2 and M-ramp models, with higher values estimated under the M-ramp assumption. SSB_{MSY} values demonstrated a similar decline with increasing catch bias, but were generally higher across changepoint catch bias scenarios compared to constant catch bias scenarios (Table 7, Figure 9).

Comparison of the "true" fishing mortality and spawning stock biomass to the "true" biological reference points for the operating model revealed similarities with stock status under constant catch bias scenarios. Overfishing generally did not occur in the short-term across catch bias scenarios but occurred across scenarios with catch bias after approximately 5-10 years in M = 0.2 and M-ramp models (Figure 10). In the M = 0.2 model, rebuilding to the SSB_{MSY} proxy occurred in the moderate catch bias scenario (50%) in the medium term. Biomass increased above the overfished threshold under the large catch bias scenario (125%) and remained close to the threshold under the extreme catch bias scenario (200%) in M=0.2 scenarios, but neither scenario rebuilt to the SSB_{MSY} proxy. All of the catch bias scenarios based on the M-ramp model remained overfished over the projection period.

Comparison of estimated fishing mortality and spawning stock biomass to the estimated biological reference points for changepoint catch bias scenarios revealed differences from the "true" stock status. The biggest differences were at the end of the projected time period, when there was a change in perception of stock status in M=0.2 models to no overfishing across scenarios and a change in status to rebuilt in moderate catch bias scenario and not overfished in the extreme catch bias scenario (Figure 10). Because of the retrospective pattern under the changepoint scenarios, there was a tendency for updated estimates of spawning stock biomass to decrease and for updated estimates of fishing mortality to increase, which impacted estimated $F/F_{MSY\ proxy}$ and $SSB/SSB_{MSY\ proxy}$ ratios and lead to an overly optimistic perception of stock status at the end of the time series. This same pattern is observed in M-ramp models, however, the perception of overfished status did not change due to the high $SSB_{threshold}$ values in these scenarios.

5. Discussion

Through simulation testing, we demonstrated that inaccurate catch information has the potential to impact stock assessment and management performance of Gulf of Maine cod with resulting impacts on stock trajectories. Under scenarios of no bias in catch reporting, we find that rebuilding the Gulf of Maine cod stock was accelerated and reached a higher magnitude. The no catch bias scenarios were characterized by accurate stock assessment performance and effective management as evidenced by the stock transitioning from overfished and overfishing status to a rebuilt stock with no overfishing over the projection period in M=0.2 operating models. It is also important to note that scenarios with no bias in catch attained the highest level of reported catch which is the component of direct economic relevance to the fishery (Figure 6). We recognize that the no catch bias scenarios underestimate the true uncertainty in the Gulf of Maine cod assessment, because it assumes that the population dynamics are perfectly known, the estimation model is perfectly specified, and all catch components, including recreational catch, are well-estimated. Despite these assumptions, the no catch bias scenarios offer a reference for comparing the performance of biased catch scenarios. Scenarios of increasing catch bias generally exhibited lower spawning stock biomass, lower reported catch, and higher “true” catch (i.e., reported and unreported catch).

Scenarios that assumed Gulf of Maine cod have higher natural mortality (M-ramp), did not achieve the same rebuilding and management outcomes as observed under the M=0.2 assumption, because of the inconsistency in the assumed natural mortality rate projected forward in the operating model (M = 0.4) and the natural mortality rate assumed in the reference point model (M = 0.2). These scenarios exhibited lower spawning biomass and catch levels related to the higher overall mortality experienced by cod under these scenarios, despite higher expectations of recruitment. In addition, the assumed higher recruitment in M-ramp scenarios resulted a higher SSB_{MSY} proxy and $SSB_{Threshold}$ value for determination of overfished status, resulting in the stock consistently determined to be overfished.

We found that assessment performance was unbiased under the perfect catch reporting scenarios (i.e., no catch bias). Under scenarios of constant catch bias, assessments increasingly underestimated recruitment and spawning stock biomass with increasing catch bias while fishing mortality estimates remained unbiased. Constant catch bias scenarios simulated a constant level of bias in catch information, such that the trends in stock dynamics were captured accurately, but the magnitude was not. Under scenarios with a changepoint in catch bias, assessments initially performed well for 10-15 years after bias was introduced and then performance increasingly degraded. The impact of bias in catch information on assessment performance is consistent with other studies (Rudd and Branch 2016) which have shown constant under-reporting results in consistent underestimation of biomass, but that trends in reporting can result in more complex patterns of assessment error.

Constant catch bias scenarios did not demonstrate significant retrospective patterns, but changepoint catch bias scenarios exhibited retrospective patterns with a tendency to decrease updated estimates of spawning stock biomass and to increase updated estimates of fishing mortality. Retrospective patterns were evident from the beginning of the projection period in the changepoint scenarios (Figure 8). Our simulation results align with previous simulations that indicate changes in the level of catch accounting in the assessment is a known factor contributing to retrospective patterns (e.g., Legault 2009). The retrospective patterns produced in the changepoint scenarios are similar to those observed for many groundfish stocks in recent years, including Gulf of Maine cod (e.g., decrease in updated estimates of SSB; Weidenmann and Jensen 2018, 2019). However, the biases in SSB derived from these simulation analyses are generally opposite of the 'bias' that is often erroneously inferred from retrospective patterns (Cadrin 2020). SSB was underestimated when compared to the "true" values in the operating model but interpreting retrospective patterns as bias would suggest that SSB is overestimated. Our simulation results are similar to those from Hurtado-Ferro et al. (2015), who concluded that the direction and magnitude of retrospective patterns are not related to true bias. It is important to note that this model framework allows us to make inferences about biased assessment estimates from our simulations due to our ability to compare estimated and "true" values, but we cannot draw the same type of inference from retrospective analyses which compare across assessments. The management procedure that we simulated does not include the retrospective adjustments that are applied to many groundfish stock assessments and catch projections (e.g., NEFSC 2019). Based on the retrospective analysis and the simulation testing, the underestimation of SSB would be even greater if a retrospective adjustment was applied.

These simulations illustrate that, in some cases, the effectiveness of management measures can be compromised by inaccurate catch information. We observed how biased assessment performance can influence estimated biomass-based reference points and stock estimates, potentially influencing the perception of stock status. Constant catch bias scenarios exhibited bias in the estimation of the magnitude of both spawning stock biomass and the $SSB_{F40\%}$, which effectively resulted in unbiased estimates of stock status as the ratio of $SSB/SSB_{F40\%}$ remained the same. However, changepoint catch bias scenarios introduced a trend in catch bias, which impacted this ratio and resulted in differences between the "true" and estimated stock status.

Scenarios with higher bias in catch reporting were more likely to exhibit overfishing and overfished status during the projection period. However, our scenarios would suggest that low catch bias (<50%) would achieve reasonable management performance, largely because of the precautionary management procedure (e.g., the proxy reference point is considerably less than the true F_{MSY} value, and target catch is 75% of $F_{40\%}$). Thus, these scenarios might be viewed as a conservative assessment of the potential impact of catch bias in catch reporting. We tested a harvest control rule with a precautionary fishing mortality target (F_{target} = 75% of $F_{40\%}$) that decreased when the stock became overfished. The sliding harvest control rule used here is close to what is used for Gulf of Maine cod, but may allow for lower catch levels than would be deemed acceptable by management. It is important to note, that the levels of fishing mortality projected under even extreme catch bias (F ~ 0.47) are considerably lower than observed values estimated in recent years for the Gulf of Maine cod stock (Figure 1).

Alternatively, the expectations of future productivity of Gulf of Maine cod could be viewed as overly optimistic, conferring a high degree of resilience to the impacts of catch misreporting in these scenarios. We projected moderate levels of recruitment into the future across scenarios which are higher than the most recent estimates over the past 5-10 years which are the lowest in the time series. The parameterization of the stock-recruit relationship for Gulf of Maine cod was such that there was little influence of declining spawning stock biomass on production of recruits. In addition, a recent analysis suggests lower reproductive potential of the Gulf of Maine cod stock due to associations between recruitment and warming waters in the region which we have not been accounted for here (Fogarty et al. 2008, Pershing et al. 2015).

We applied the same selectivity curve in modeling both reported and unreported catch in these simulations. This implies there was no change in the size/age composition of the total catch as catch bias increased. We anticipate that significant changes in selectivity would introduce error to estimation of fishing mortality rates. Highgrading, the act of selecting larger fish and discarding smaller fish, is one potential scenario that could be occurring for Gulf of Maine cod. A shift in size/age composition toward larger reported and smaller unreported catch would likely lead to error in the estimation of fishing mortality (Hurtado-Ferro et al. 2014). Currently, we don’t have information to support a change in selectivity, but this could be explored in the future using this modeling framework.

It is important to recognize the caveats and limitations of this analysis. We sought to understand the impact of misreported catch by isolating this factor as a key determinate of the structure of our scenarios. We know many other factors have potential to influence assessment and management performance. For example, we tested the impact of catch bias in the context of a correctly specified assessment models. Estimation model misspecification has the potential to introduce misperception of population dynamics and management advice (e.g., Deroba et al. 2015, Hurtado-Ferro et al. 2015, Weston 2018). In addition, further testing of the impact of catch bias scenarios could include other aspects of imperfect management implementation and different perceptions of stock dynamics (e.g., operating models with different perceptions of recruitment). Furthermore, future work could include enhanced simulation of fleets to allow for explicit modeling of the uncertainty and bias associated with catch reporting by fleet (e.g., commercial vs. recreational fleets). This would require partitioning catch, and approximating uncertainty and bias by fleets across years. The limited uncertainty captured in these scenarios may emphasize the signal of bias in catch reporting. It is important to note that low levels of catch bias may have minimal impact in the context of other uncertainties in the system.

Simulations of the impact of bias in catch reporting focused on a constraining stock, Gulf of Maine cod, known to have incentives for discarding (NEFMC 2020). Thus, these simulations can provide insight on the impact of unaccounted for catch on other groundfish stocks with similar low stock status and considered to have discard incentives (e.g., Eastern Georges Bank cod, yellowtail flounder). Furthermore, scenarios run without bias in catch reporting can provide insight on the performance of the stock assessment and management process in the context of accurate catch information and thus can provide insight on fishery management performance for stocks with low or no discard incentives (e.g., haddock, pollock, redfish). Undoubtedly, there would be differences based on specific aspects of groundfish life history. For example, stocks with higher productivity expectations would exhibit higher resilience to catch misreporting.

These simulations demonstrate the potential impact of bias in catch accounting and can provide guidance to managers on the anticipated magnitude and direction of the impact of this factor in isolation. Our analysis suggests that improvement of catch reporting has the potential to improve stock assessment and management performance and contribute to achieving rebuilding plans. Results suggest that high to extreme bias in catch reporting was detrimental to sustainable fisheries management. However, catch reporting bias <50% had more limited impacts on assessment and management performance because of risk averse management (e.g., target fishing mortality at 75% of $F_{40\%}$). Thus, the costs of improved monitoring need to be weighed against the desired level of improvement in assessment and management outcomes. However, improved catch reporting does not ensure improved biological, assessment, and management performance due to all the other factors described above.

Summary of Findings

- Scenarios with no catch bias exhibited accelerated rebuilding of the Gulf of Maine cod stock and were characterized by accurate stock assessment performance and effective management as evidenced by the stock transitioning to no overfishing and rebuilding during the projection period.
- Scenarios that assumed Gulf of Maine cod have higher natural mortality (M-ramp), did not achieve the same rebuilding and management outcomes as observed under the M=0.2 assumption. This related to the higher overall mortality experienced by cod under these scenarios and the inconsistency in the assumed natural mortality rate in the operating model and the reference point model.
- Under scenarios of constant catch bias, assessments exhibited consistent levels of underestimated recruitment and spawning stock biomass with underestimation increasing with increased bias in catch reporting. Fishing mortality estimates remained unbiased because they were informed by unbiased age composition data.

- Under scenarios with a changepoint in catch bias, assessments initially performed well for 10-15 years and then performance increasingly degraded.
- Retrospective inconsistency (i.e., decrease in updated estimates of spawning stock biomass and increase in updated estimates of fishing mortality) resulted from changepoint catch bias scenarios.
- Estimated stock status reflected true stock status determinations under constant catch bias scenarios. However, changepoint catch bias scenarios exhibited frequent instances of misperception of stock status.
- Results suggest that large to extreme bias in catch reporting was detrimental to sustainable management, however, catch reporting bias <50% had more limited impacts on assessment and management performance in the context of risk averse management.
- It is important to recognize the caveats and limitations of this analysis and that the results are contingent on the specification of the models and scenarios.
- These simulations demonstrate the potential impact of bias in catch accounting and can provide guidance to managers on the anticipated magnitude and direction of the impact of this factor.

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Tables

Table 1. Description of equations and symbols used in simulating the population dynamics of Gulf of Maine cod in an age-structured operating model.

Eqn. 1	$$N_{a,t} = \begin{cases} N_{1,t} & \text{if } a = 1 \\ N_{a-1,t-1}e^{-[\mathrm{M}+F_t(s_{a-1})]} & \text{if } 1 < a < x \\ N_{a-1,t-1}e^{-[M+F_t(s_{a-1})]} + N_{a,\mathrm{t}-1}e^{-[\mathrm{M}+F_t(s_a)]} & \text{if } a = x \end{cases}$$	
Eqn. 2	$$SSB_t = \sum_{a=1}^{a=x} N_{a,t}W_{a,t}P_{a,t}$$	
Eqn. 3	$$N_{1,t} \begin{cases} c_R \times ecdf(R_{obs}) & \text{if } SSB_t \geq SSB_* \\ c_R \times \frac{SSB_t}{SSB_*}\left(ecdf(R_{obs})\right) & \text{if } SSB_t < SSB_* \end{cases}$$	
Eqn. 4	$$C_{a,t}^{N} = \frac{\Phi_{a,t}^{F}F_t}{\Phi_{a,t}^{F}F_t + M}N_{a,t}(1 - e^{-\Phi_{a,t}^{F}F_t - M})$$	
Symbols used in equations	$N_{a,t}$	abundance of fish at age *a* at time *t*
	M	natural mortality
	F_t	time-varying fishing mortality at time *t*
	s_a	selectivity to the fishery at age *a*
	x	plus group
	SSB_t	spawning stock biomass at time *t* (mT)
	$W_{a,t}$	average weight-at-age, *a* of fish at time *t*
	$P_{a,t}$	fraction of fish of age, *a* that are mature at time *t*
	c_R	conversion coefficient for input recruitment to absolute numbers
	SSB_*	spawning stock biomass hinge value
	$ecdf(R_{obs})$	sample from empirical cumulative distribution of historic observed recruitments (R_{obs}) 1998-2018
	$C_{a,t}^{N}$	catch of age, *a* fish in time *t* in numbers
	$\Phi_{a,t}^{F}$	selectivity of age, *a* in time *t*

Table 2. Associated parameter names, symbols and input values used in the Gulf of Maine code operating model.

Parameter	Symbol	Value	Source (model)
Natural mortality (M = 0.2 scenarios)	M	0.2	NEFSC 2019 (ASAP)
Natural mortality (M-ramp scenarios)	M	0.2-0.4	NEFSC 2019 (ASAP)
Conversion coefficient	c_R	1000	NEFSC 2019 (AGEPRO)
Spawning stock biomass hinge value (M = 0.2 scenarios)	SSB_*	6300	NEFSC 2019 (AGEPRO)
Spawning stock biomass hinge value (M-ramp scenarios)	SSB_*	7900	NEFSC 2019 (AGEPRO)
Fishery catchability	q^F	1	Assumed
Survey catchability	q^I	1	NEFSC 2019 (ASAP)
Survey timing	st	0.5	Assumed
Catch weight observation error		0.05	NEFSC 2019 (ASAP)
Index observation error		0.05	NEFSC 2019 (ASAP)
Recruitment process error		0.01	Assumed

Table 3. Gulf of Maine cod operating model parameter input vectors at age.

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9+	Source (model)
Initial numbers-at-age	15000	17000	6000	3500	2000	200	300	150	100	NEFSC 2019 (ASAP)
Weight-at-age	0.057	0.365	0.908	1.662	2.426	3.307	4.09	5.927	10.375	NEFSC 2019 (ASAP/AGEPRO)
Maturity-at-age	0.087	0.318	0.697	0.919	0.982	0.996	0.999	1	1	NEFSC 2019 (AGEPRO)
Fishery selectivity-at-age	0.013	0.066	0.271	0.663	0.912	0.982	0.997	1	1	NEFSC 2019 (AGEPRO)
Fishery selectivity-at-age (M-ramp)	0.009	0.051	0.241	0.651	0.917	0.985	0.997	1	1	NEFSC 2019 (AGEPRO)
Survey selectivity-at-age	0.038	0.134	0.289	0.531	0.778	1	1	1	1	NEFSC 2019 (ASAP)

Table 4. Description of equations and symbols in the observation model to generate simulated catch and index data.

Eqn. 5	$$I_{a,t}^{N} = \Phi_{a,t}^{I} e^{(-\Phi_{a,t}^{I} F_t - M) st}$$	
Eqn. 6	$$C_{a,t}^{W} = C_{a,t}^{N} W_a$$	
Eqn. 7	$$\hat{C}_t^{W} = C_t^{W} \omega$$	
Symbols used in equations	$I_{a,t}^{N}$	survey catch in numbers for age *a* in time *t*
	$\Phi_{a,t}^{I}$	survey selectivity at age, *a* in time *t*
	st	survey timing, given as proportion of the year that has elapsed
	$\Phi_{a,t}^{F}$	fishery selectivity of age, *a* in time *t*
	C_a^{W}	catch weight at age *a*
	$\hat{C}_t^{W}$	adjusted catch weight-at-age with bias at time *t*
	ω	observation bias on catch weight

Table 5. Description of equations and symbols used to calculate biological reference points from the stock assessment in the management procedure.

Eqn. 8	$$\frac{SSB}{R}_{F^*} = \sum_{a=0}^{a=A} e^{-\Phi_a^F F^* - M}\, \theta_a W_a$$	
Eqn. 9	$$SPR_{F^*} = \frac{[\frac{SSB}{R}_{F=0}]}{[\frac{SSB}{R}_{F=F^*}]}$$	
Eqn. 10	$$\hat{C}_t = C_t^W + (C_t^W \beta)$$	
Symbols used in equations	$\frac{SSB}{R}_{F^*}$	estimated spawning stock biomass per recruit at fishing mortality level F^* for an average individual
	W_a	weight at age
	θ_a	maturity at age
	SPR_{F^*}	spawning potential ratio (F^* = 0.4)
	$\frac{SSB}{R}_{F=0}$	spawning stock biomass per recruit when F = 0
	$\hat{C}_t$	adjusted total catch weight with bias at time t
	C_t^W	total catch weight at time t
	β	Implementation bias on total catch

Table 6. Scenario testing specifications.

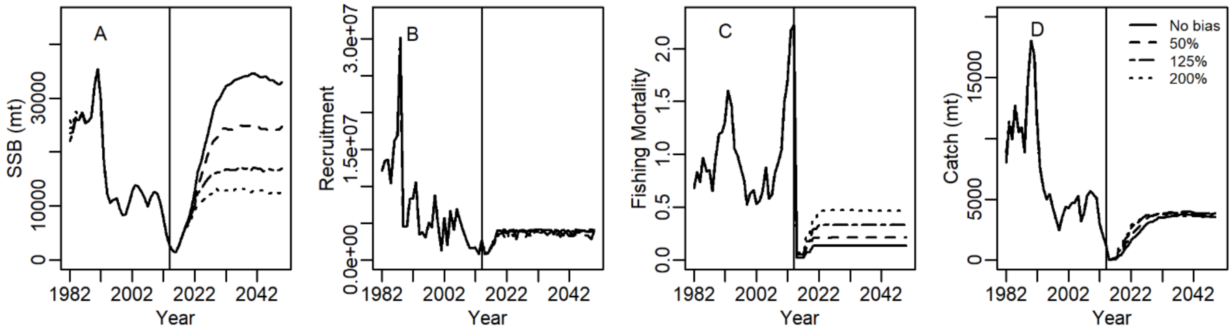
OM/assessment natural mortality	Timing of catch bias	MP start year	HCR	Catch bias scenarios
M = 0.2	Constant bias over time	2015	Sliding	No bias Moderate bias (50%) Large bias (125%) Extreme bias (200%)
M-ramp				No bias Moderate bias (50%) Large bias (125%) Extreme bias (200%)
M = 0.2	Changepoint where bias is 0 prior to 2015, then ranges from 0-200% into future	2015	Sliding	No bias Moderate bias (50%) Large bias (125%) Extreme bias (200%)
M-ramp				No bias Moderate bias (50%) Large bias (125%) Extreme bias (200%)
M = 0.2	Constant bias over time	2015	Constant	No bias Moderate bias (50%) Large bias (125%) Extreme bias (200%)
M-ramp				No bias Moderate bias (50%) Large bias (125%) Extreme bias (200%)
M = 0.2	Changepoint where bias is 0 prior to 2015, then ranges from 0-200% into future	2015	Constant	No bias Moderate bias (50%) Large bias (125%) Extreme bias (200%)
M-ramp				No bias Moderate bias (50%) Large bias (125%) Extreme bias (200%)

Table 7 Summary of median operating model and estimation model values for spawning stock biomass, recruitment, fishing mortality and catch across short (1-5 years), medium (6-15), and long (16-36) time scales of the projection period (2015-2050). Biological reference point proxies ($SSB_{F40\%}$ and $F_{40\%}$) are reported for "no bias" scenarios which represent the "true" biological reference point proxies for operating models and for biased catch scenarios.

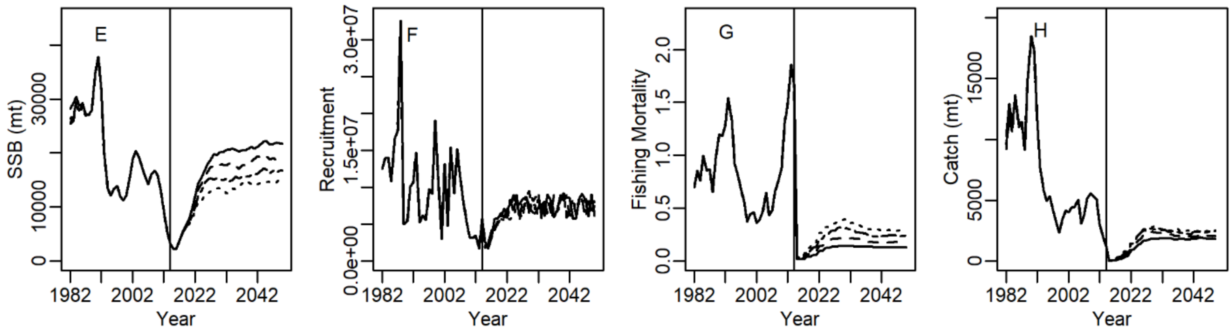
	Operating Model Values												Stock Assessment Model Values													
Scenarios	Median SSB			Median Recruitment			Median F			Median Catch			Median SSB			Median Recruitment			Median F			Median Catch			Biological Reference Points	
	Short	Med.	Long	Short	Med.	Long	Short	Med.	Long	Short	Med.	Long	Short	Med.	Long	Short	Med.	Long	Short	Med.	Long	Short	Med.	Long	$SSB_{40\%}$	$F_{40\%}$
Constant catch bias, sliding harvest control rule																										
M = 0.2																										
No bias	2843	19500	33389	1919850	3931682	4050602	0.02	0.14	0.14	70	2248	3614	2973	19895	35095	2054401	3903036	4050240	0.02	0.13	0.13	71	1987	3585	26632	0.18
Moderate bias	2826	16454	24330	1808146	3858570	3941042	0.04	0.21	0.21	114	2771	3883	1958	11241	16841	1167508	2571887	2597604	0.04	0.21	0.21	75	1669	2605	17435	0.18
Large bias	2838	13638	16799	1721631	3860380	3806988	0.06	0.34	0.34	157	3198	3838	1259	5993	7486	763422	1639883	1611111	0.05	0.33	0.33	69	1311	1691	11309	0.18
Extreme bias	2817	11017	12861	1871676	3928808	3907216	0.07	0.47	0.47	205	3290	3740	929	3718	4253	632102	1220745	1254345	0.07	0.46	0.46	68	1041	1228	8474	0.18
Mramp																										
No bias	3858	16155	20844	3265188	7668253	7775012	0.02	0.13	0.13	53	1375	1840	4154	16691	21813	3449855	7534137	7425541	0.01	0.11	0.13	53	1138	1859	54822	0.19
Moderate bias	3823	14877	18385	3934389	6738670	7607981	0.02	0.18	0.18	77	1757	2088	2696	10475	12512	2770527	4358923	5217020	0.02	0.15	0.18	52	985	1397	36142	0.19
Large bias	3778	13732	15972	4221748	6922611	7931987	0.04	0.26	0.24	117	2218	2410	1744	6130	7110	1898661	3149525	3303294	0.04	0.22	0.24	52	797	1065	23500	0.19
Extreme bias	3814	11699	14338	3450310	6094533	7878026	0.05	0.32	0.30	156	2162	2482	1291	3927	4729	1237871	1993563	2422260	0.05	0.29	0.29	51	621	823	17482	0.19
Changepoint bias, sliding harvest control rule																										
M = 0.2																										
No bias	2874	19235	33325	1624279	3985338	3799949	0.02	0.14	0.14	74	2233	3619	2968	19819	34698	1687589	3708393	3868610	0.02	0.13	0.13	73	1951	3552	26330	0.18
Moderate bias	2855	17530	23945	1788832	3485835	3792604	0.04	0.21	0.21	104	2933	3787	2051	12158	18304	1230337	2471302	2825097	0.03	0.20	0.19	70	1772	2519	23572	0.18
Large bias	2834	13653	17330	1830815	3888752	3935338	0.05	0.33	0.33	157	3201	3916	1411	6428	8511	793628	1683110	1921510	0.05	0.31	0.29	68	1306	1722	19278	0.18
Extreme bias	2810	10758	13087	1700121	4020223	3923885	0.07	0.47	0.46	202	3215	3740	1307	3929	4719	576646	1270517	1375509	0.05	0.41	0.41	67	1010	1239	15733	0.18
M ramp																										
No bias	3841	16572	20463	3997027	7230148	7501452	0.02	0.13	0.13	52	1447	1765	4057	16836	20909	3964504	7267831	7656873	0.01	0.11	0.13	41	1199	1791	54742	0.19
Moderate bias	3820	15461	17739	4170649	7718805	7739959	0.02	0.19	0.21	80	1895	2281	3081	11442	13966	2666312	5114974	6424120	0.02	0.15	0.17	43	1053	1509	48660	0.18
Large bias	3802	13377	14551	4059534	6497978	7840662	0.04	0.31	0.33	118	2417	2666	2095	6644	7525	1939082	3057595	4137185	0.03	0.22	0.26	41	913	1161	42134	0.18
Extreme bias	3773	11714	11997	3411726	6938872	7018307	0.05	0.42	0.44	151	2700	2757	1660	4349	4820	1229800	2258890	2948847	0.04	0.30	0.35	40	745	908	39155	0.18
Constant catch bias, constant F harvest control rule																										
M = 0.2																										
No bias	2757	17963	32406	1813266	3819987	3749459	0.14	0.14	0.14	388	2119	3532	2841	18368	34847	1813957	3795508	3885254	0.13	0.13	0.13	387	1800	3522	26197	0.18
Moderate bias	2682	14065	24870	1204347	4025061	3932761	0.21	0.21	0.21	544	2420	3940	1823	9777	17025	869635	2728804	2554017	0.21	0.21	0.21	367	1402	2621	17185	0.18
Large bias	2592	10439	16902	1241207	3834926	3869306	0.33	0.33	0.34	758	2592	3858	1143	4589	7523	568721	1633643	1640972	0.33	0.33	0.33	331	991	1686	10939	0.18
Extreme bias	2477	7505	13160	1412547	3800248	4071749	0.46	0.47	0.47	910	2320	3832	817	2520	4315	448558	1128940	1303809	0.46	0.47	0.46	298	684	1251	8088	0.18
M ramp																										
No bias	3726	13719	21078	2856463	5996744	8351844	0.14	0.14	0.14	399	1305	1928	3888	14443	21725	3040095	6376929	8078436	0.13	0.13	0.13	402	1167	1915	54702	0.19
Moderate bias	3567	11210	16951	3454123	6655706	6791926	0.21	0.22	0.22	553	1540	2238	2499	7640	11479	2175057	4071038	4592176	0.21	0.21	0.21	375	914	1504	35267	0.19
Large bias	3448	8411	13822	3729471	6258392	6605893	0.33	0.34	0.34	767	1670	2601	1540	3761	6095	1570687	2802819	3036133	0.33	0.33	0.34	341	663	1147	22508	0.19
Extreme bias	3369	7104	11098	3415208	5494714	6265484	0.47	0.47	0.47	953	1790	2669	1113	2370	3682	1093347	1728486	2109339	0.46	0.47	0.47	318	525	872	15790	0.19
Changepoint bias, constant F																										
M = 0.2																										
No bias	2729	17070	32452	1748268	3889186	3933803	0.14	0.14	0.14	384	2015	3519	2789	17327	33812	1744015	3824139	3911901	0.13	0.13	0.13	388	1984	3494	25978	0.18
Moderate bias	2696	14173	24715	1667258	3959138	4038400	0.21	0.21	0.21	548	2410	3902	1892	10042	18075	1088772	2640009	2939418	0.20	0.20	0.19	366	1633	2626	22997	0.18
Large bias	2581	10405	17211	1717525	3726750	3880403	0.33	0.33	0.33	746	2572	3854	1374	4922	8197	799125	1606126	1952773	0.29	0.30	0.28	332	1110	1706	17619	0.18
Extreme bias	2448	7641	12932	1552774	3217493	3847276	0.46	0.46	0.45	902	2334	3672	1248	2736	4702	487234	1056880	1372514	0.38	0.41	0.40	299	779	1207	14418	0.18
M ramp																										
No bias	3677	13622	20258	3045233	6582255	6760788	0.14	0.14	0.14	393	1304	1847	3859	14108	20827	3112142	6854629	6890137	0.13	0.13	0.13	484	1424	1847	54477	0.19
Moderate bias	3613	11372	17478	4136873	6904089	8059737	0.21	0.21	0.21	560	1585	2296	2630	8329	13576	2957538	4891732	6147636	0.19	0.19	0.18	452	1144	1546	47187	0.18
Large bias	3461	8439	14139	2797547	5680496	7791125	0.34	0.33	0.33	772	1644	2648	1733	4124	7111	1321584	2582232	3907300	0.30	0.30	0.28	386	798	1161	33768	0.18
Extreme bias	3375	6628	11232	2513535	5677377	6155019	0.47	0.46	0.46	952	1644	2668	1517	2315	4211	939490	1887357	2821601	0.41	0.40	0.40	338	592	890	27249	0.18

Figures

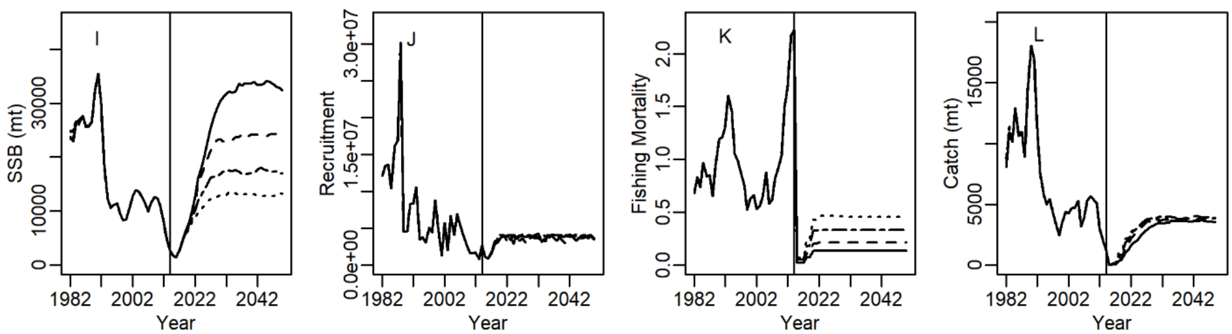
Constant catch bias, M = 0.2, sliding harvest control rule



Constant catch bias, M-ramp, sliding harvest control rule



Changepoint catch bias, M = 0.2, sliding harvest control rule



Changepoint catch bias, M-ramp, sliding harvest control rule

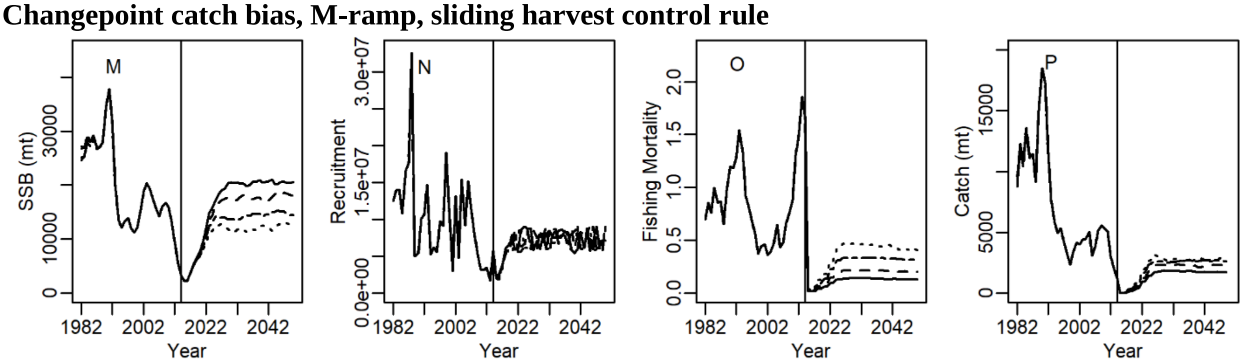


Figure 1. Time series of median operating model spawning stock biomass, recruitment, fishing mortality, and catch from 100 simulations of scenarios with no catch bias, moderate bias (50%), large bias (125%), and extreme bias in catch reporting (200%) under M = 0.2 with constant bias (A-D), M-ramp with constant bias (E-H), M = 0.2 with 2015 changepoint bias (I-L), and M-ramp with 2015 changepoint catch bias (M-P). Vertical black line indicates the start of the projection period (2015).

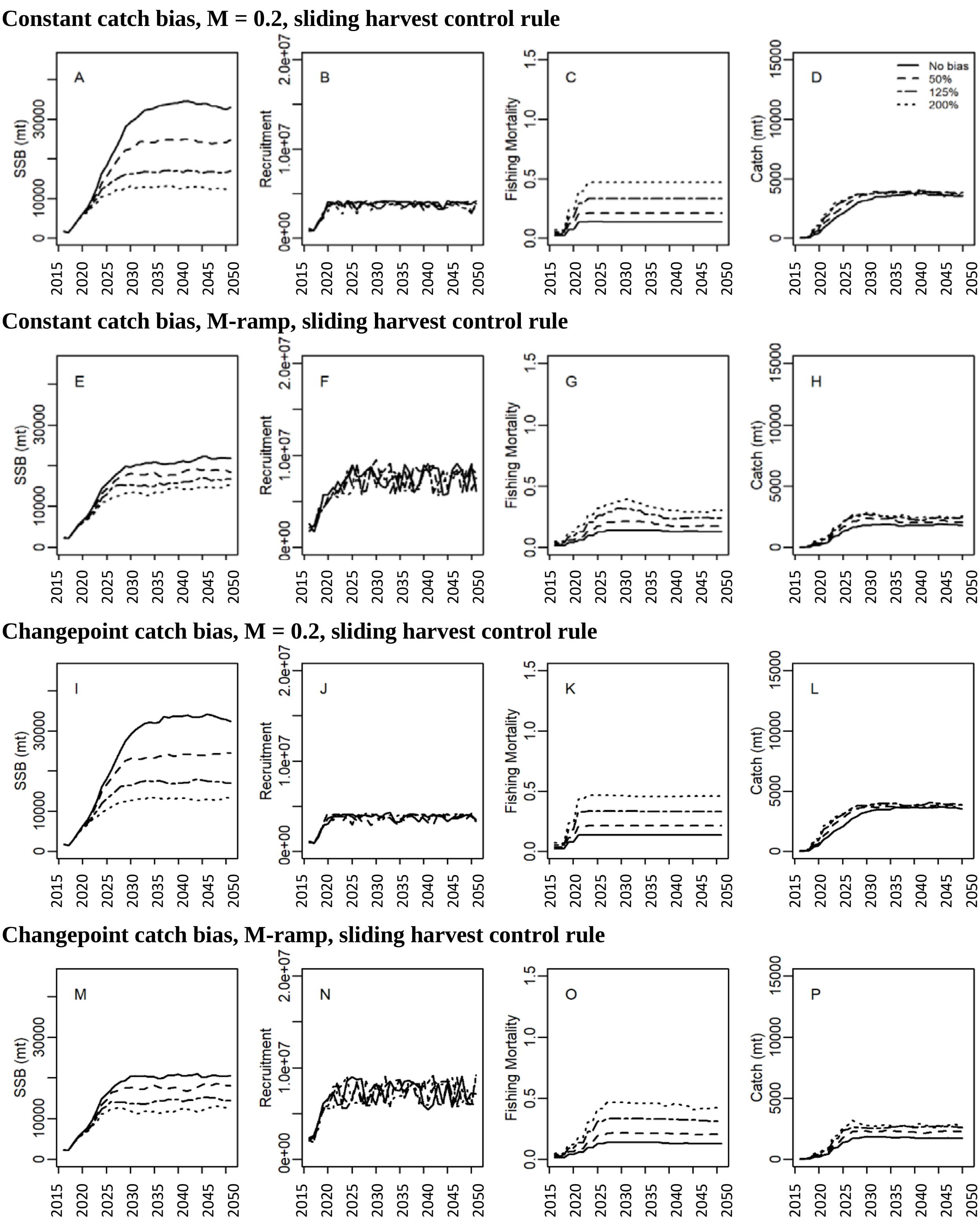
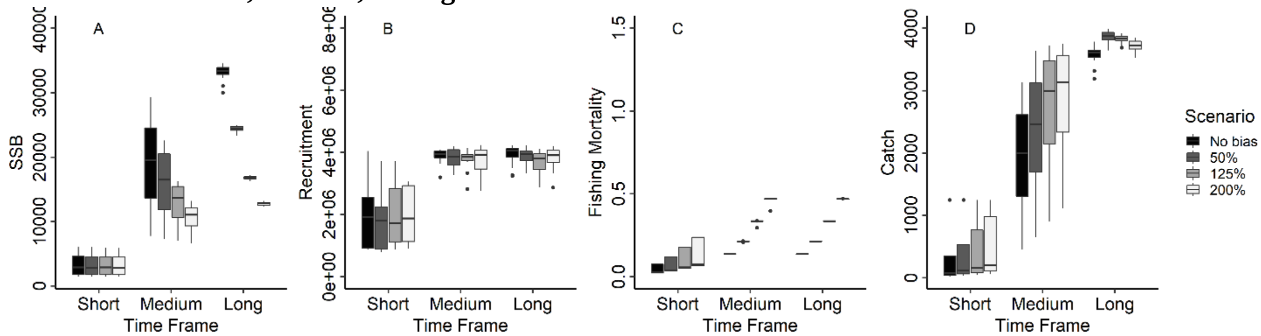
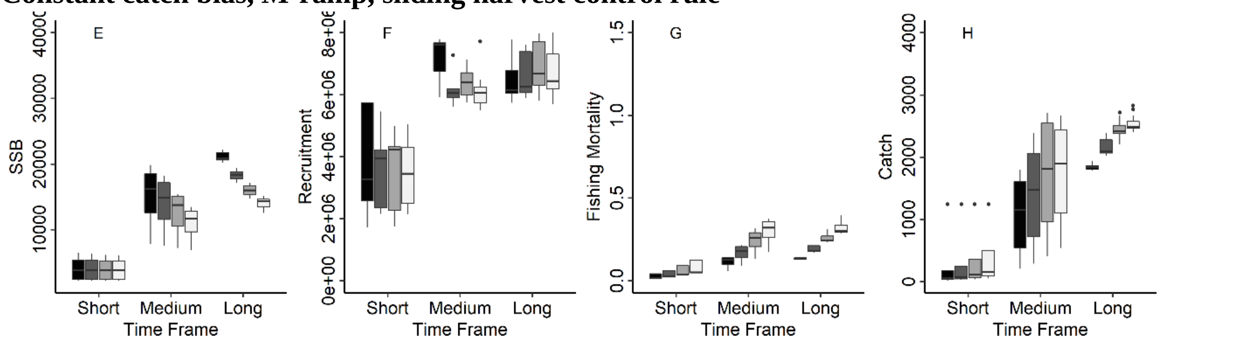


Figure 2. Time series of projected (2015-2050) median operating model spawning stock biomass, recruitment, fishing mortality, and catch from 100 simulations of scenarios with no catch bias, moderate bias (50%), large bias (125%), and extreme bias in catch reporting (200%) under M = 0.2 with constant bias (A-D), M-ramp with constant bias (E-H), M = 0.2 with 2015 changepoint bias (I-L), and M-ramp with 2015 changepoint catch bias (M-P).

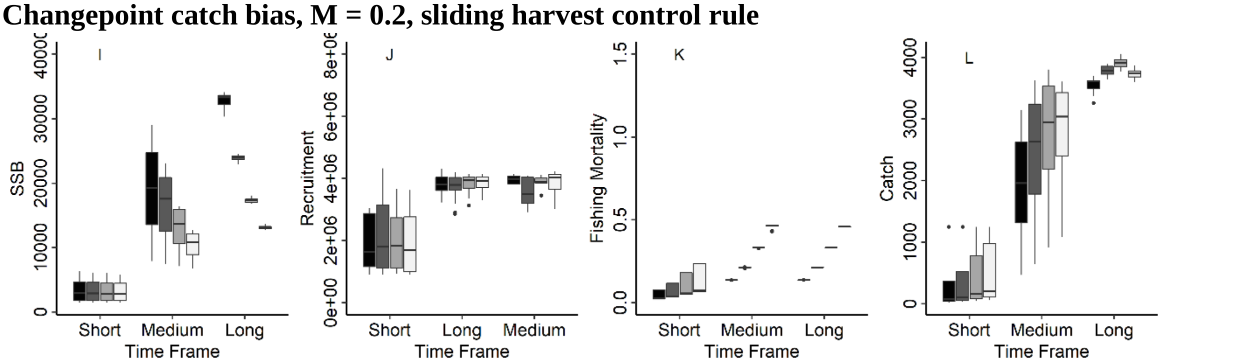
Constant catch bias, M = 0.2, sliding harvest control rule



Constant catch bias, M-ramp, sliding harvest control rule



Changepoint catch bias, M = 0.2, sliding harvest control rule



Changepoint catch bias, M-ramp, sliding harvest control rule

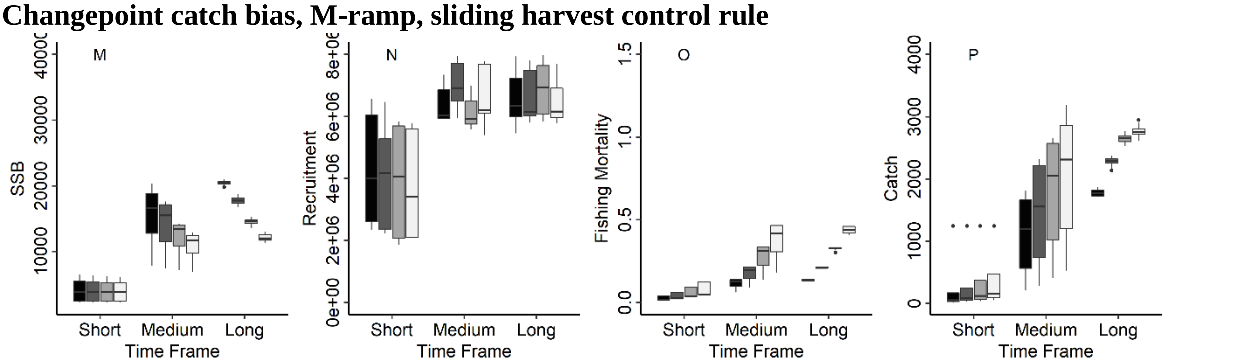
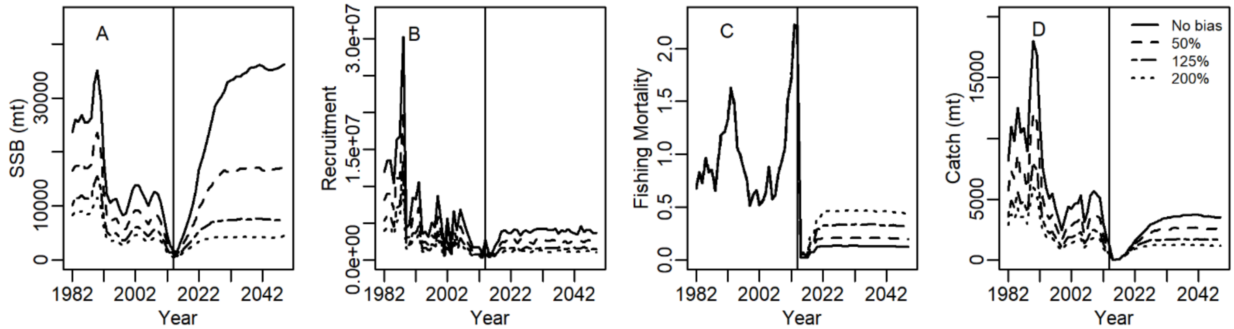
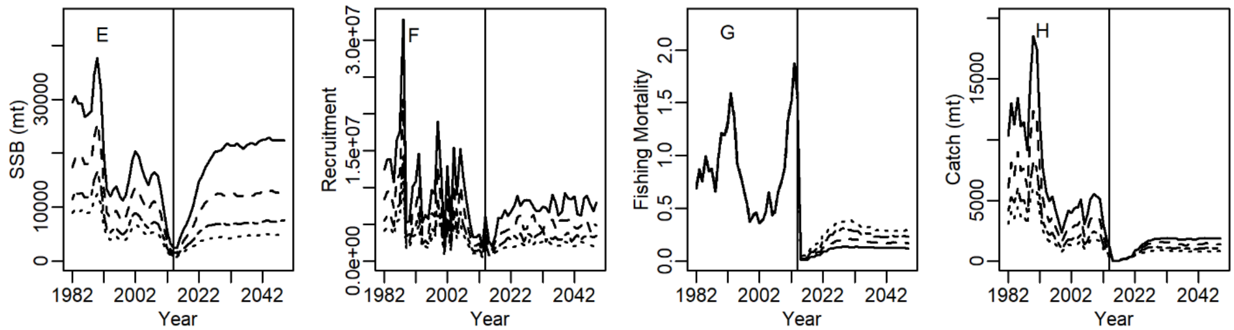


Figure 3. Boxplots of operating model spawning stock biomass, recruitment, fishing mortality, and catch (mt) across 100 simulations for each scenario under constant catch bias with M = 0.2 (A-D), constant bias with M-ramp (E-H), changepoint catch bias with M = 0.2 (I-L) and changepoint catch bias with M-ramp (M-P) in the short term (1-5 projected years), medium term (6-15 projected years), and long term (16-36 projected years).

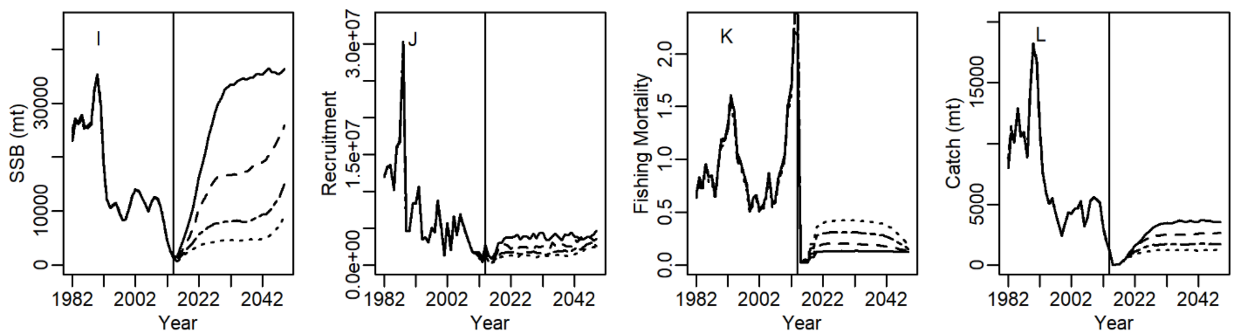
Constant catch bias, M = 0.2, sliding harvest control rule



Constant catch bias, M-ramp, sliding harvest control rule



Changepoint catch bias, M = 0.2, sliding harvest control rule



Changepoint catch bias, M-ramp, sliding harvest control rule

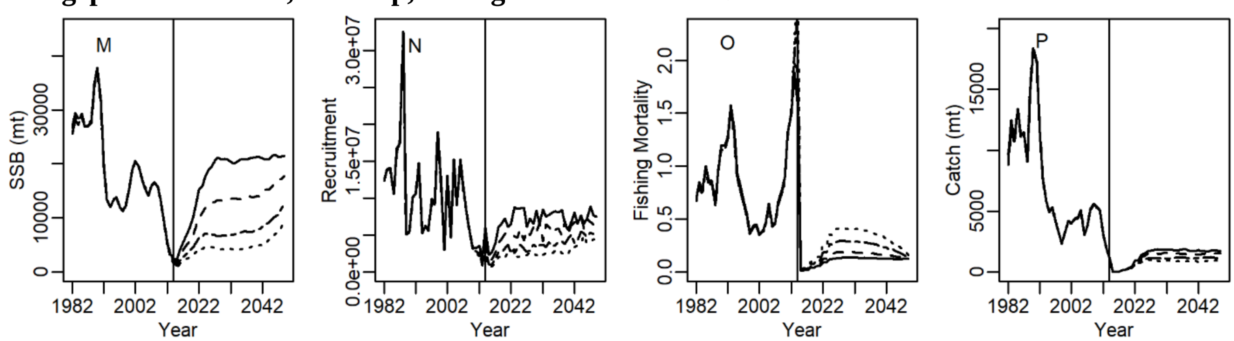
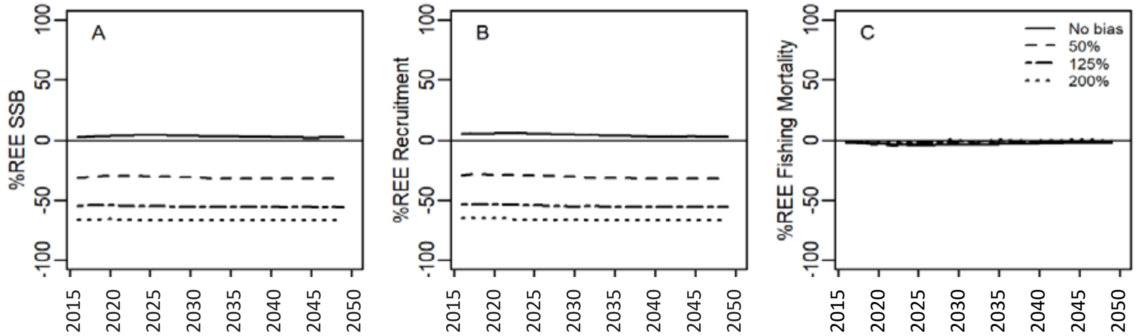
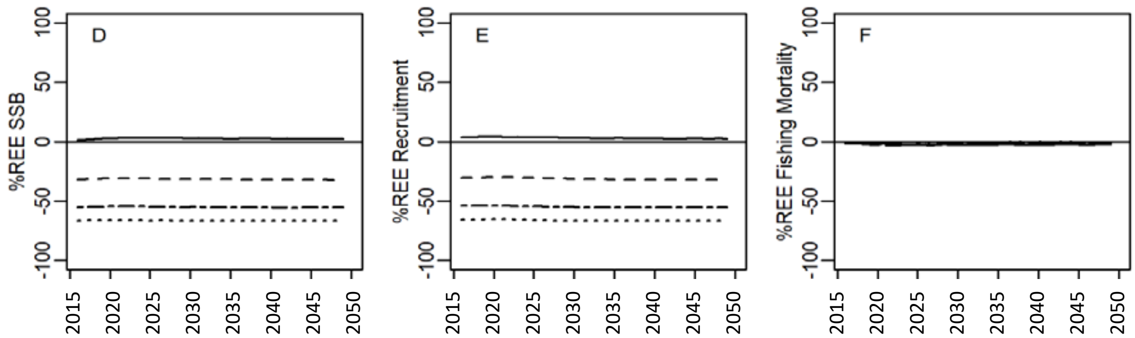


Figure 4. Median of estimated spawning stock biomass, recruitment, fishing mortality, and catch from last stock assessment in the projected time series (100 simulations). Scenarios were simulated with no catch bias, moderate bias (50%), large bias (125%), and extreme bias in catch reporting (200%) under M = 0.2 with constant bias (A-D), M-ramp with constant bias (E-H), M = 0.2 with 2015 changepoint catch bias (I-L), and M-ramp with 2015 changepoint catch bias (M-P). Vertical black line indicates the start of the projection period (2015).

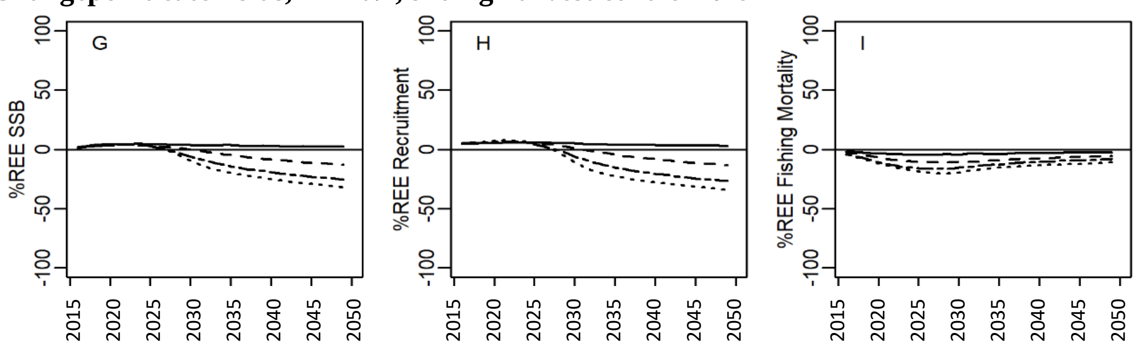
Constant catch bias, M = 0.2, sliding harvest control rule



Constant catch bias, M-ramp, sliding harvest control rule



Changepoint catch bias, M = 0.2, sliding harvest control rule



Changepoint catch bias, M-ramp, sliding harvest control rule

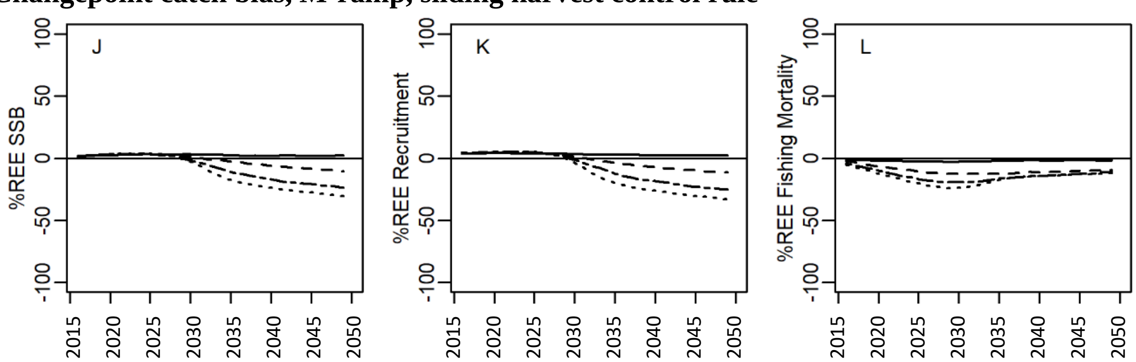


Figure 5. Time series of median percentage relative error estimates (%REE) comparing assessment estimates to operating model values for spawning stock biomass, recruitment, and fishing mortality across 100 simulations for each scenario under constant catch bias with M = 0.2 (A-C), constant bias with M-ramp (D-F), changepoint catch bias with M = 0.2 (G-I) and changepoint catch bias with M-ramp (J-L). The horizontal black line is to reference zero bias.

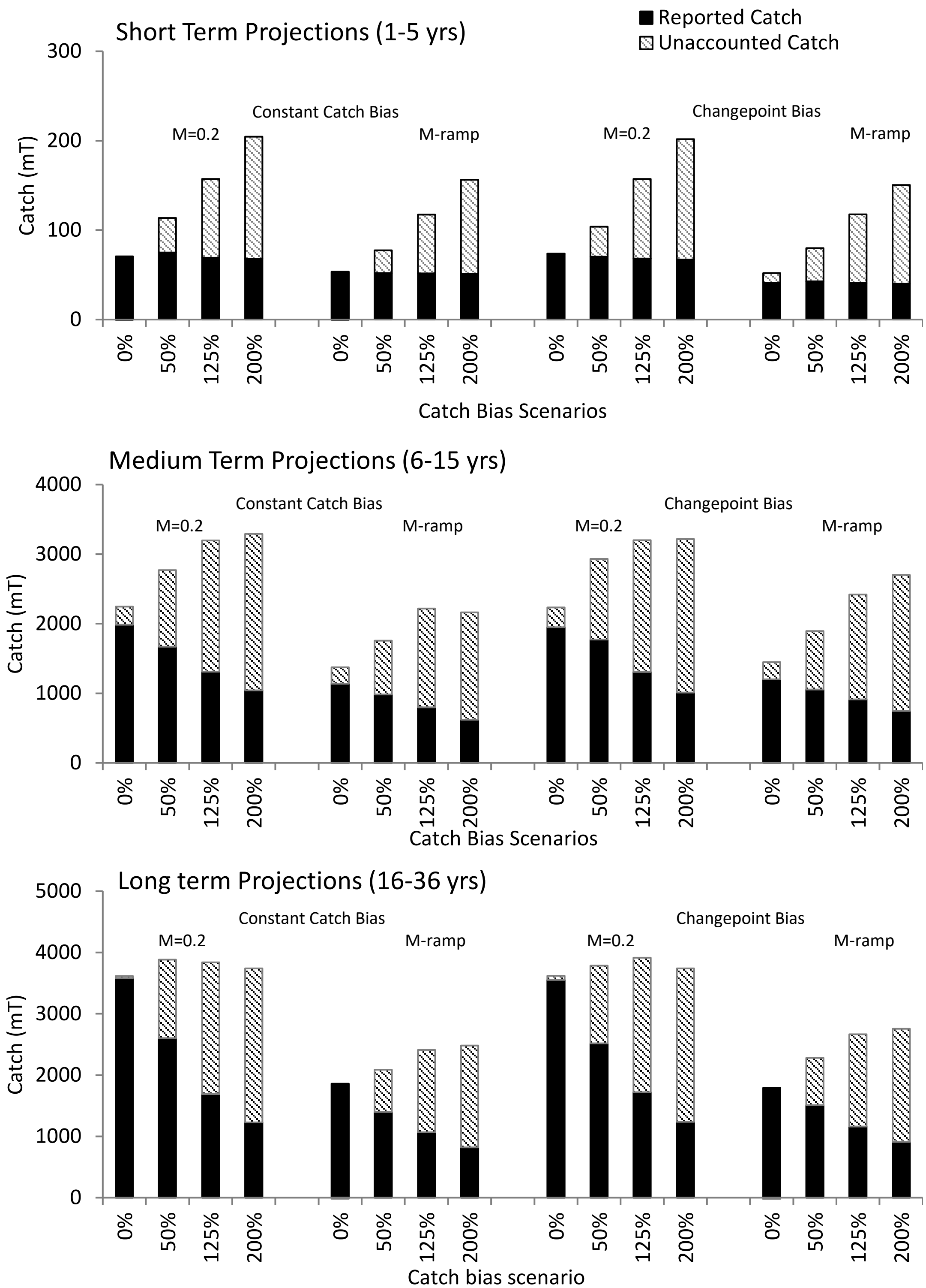


Figure 6. Median reported and unaccounted catch (together equating to "true" catch) across 100 simulations of catch bias scenarios for each scenario under constant and changepoint catch bias for M = 0.2 and M-ramp operating models in the short term (1-5 projected years), medium term (6-15 projected years), and long term (16-36 projected years).

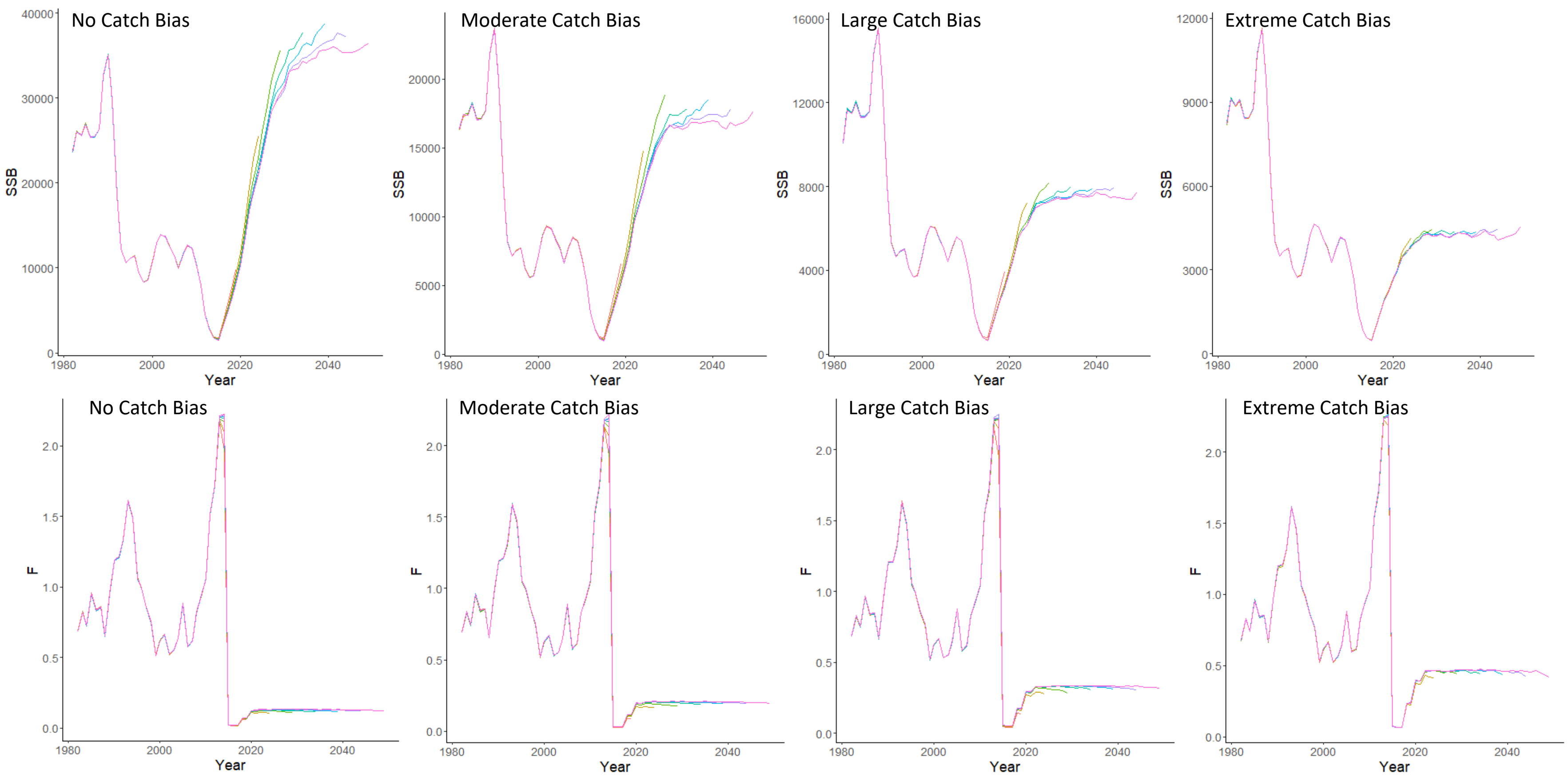


Figure 7: Retrospective evaluation of stock assessment results every five years over the span of projection period (2015-2050) assuming constant catch bias under M=0.2 operating models and a sliding harvest control rule. Panels from left to right show results for scenarios with increased catch bias**.**

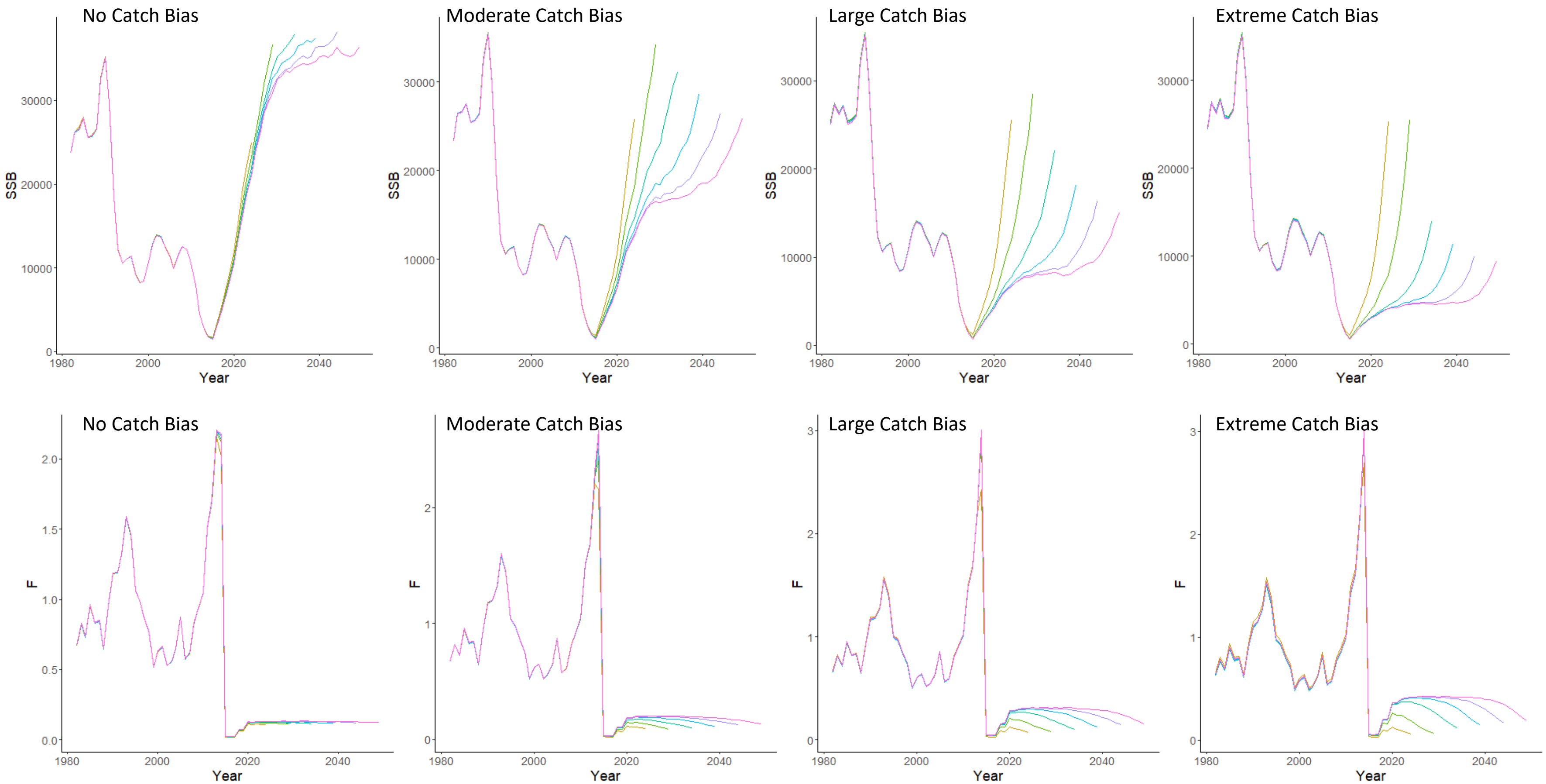
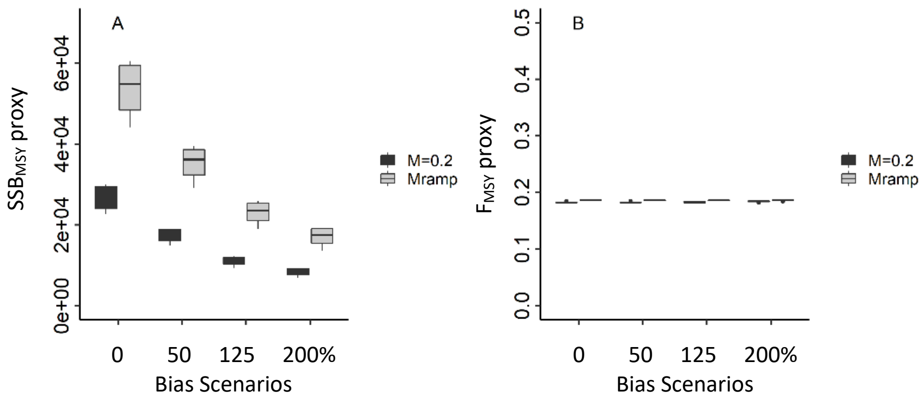


Figure 8: Retrospective evaluation of stock assessment results every five years over the span of projection period (2015-2050) assuming a changepoint in catch bias under M=0.2 operating models and a sliding harvest control rule. Panels from left to right show results for scenarios with increased catch bias**.**

Constant catch bias, sliding harvest control rule



Changepoint catch bias, sliding harvest control rule

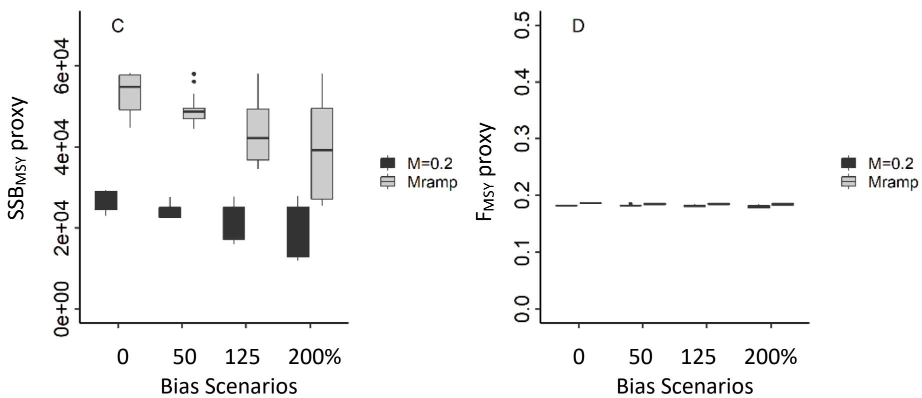
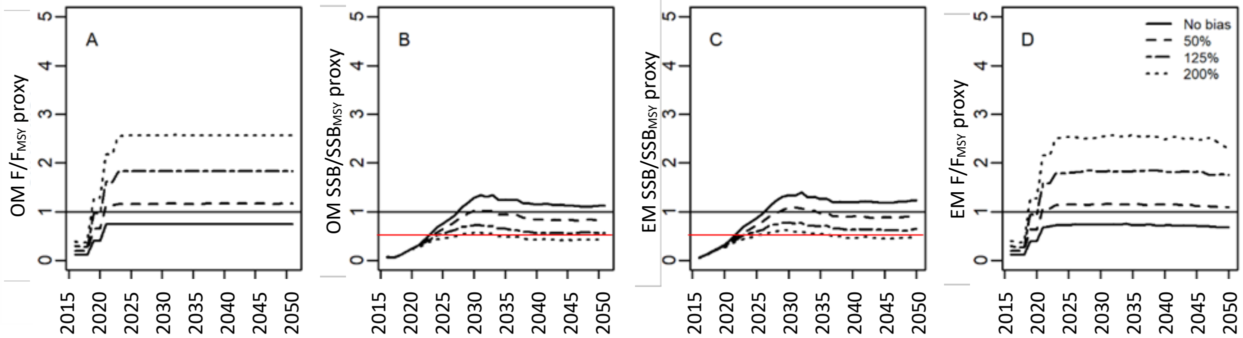
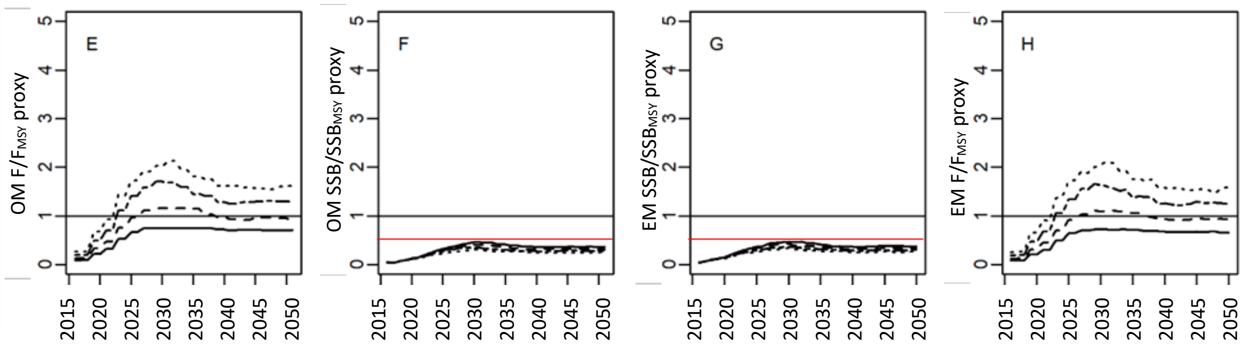


Figure 9: Boxplots of spawning stock biomass ($SSB_{F40\%}$) and fishing mortality ($F_{40\%}$) biological reference point values for M = 0.2 and M-ramp realizations under contant catch bias (A, B) and changepoint catch bias (C, D) across catch bias scenarios. Note that M-ramp biological reference points were calculated assuming M= 0.2.

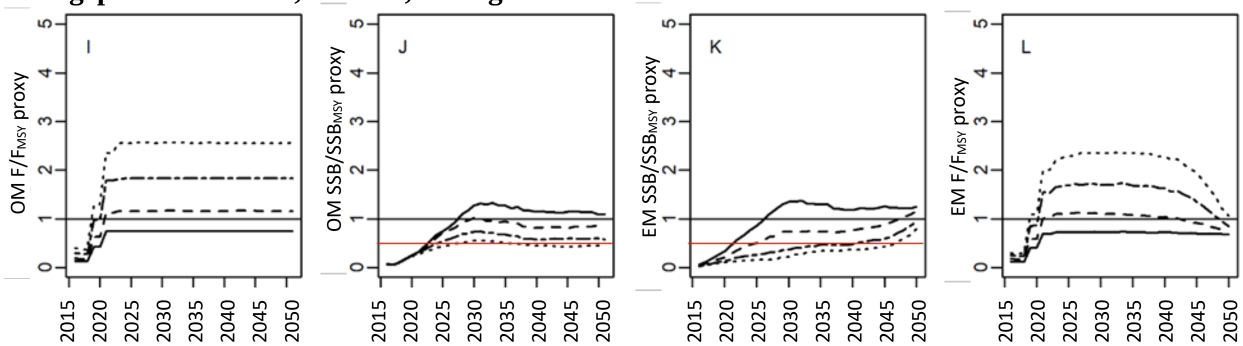
Constant catch bias, M = 0.2, sliding harvest control rule



Constant catch bias, M-ramp, sliding harvest control rule



Changepoint catch bias, M = 0.2, sliding harvest control rule



Changepoint catch bias, M-ramp, sliding harvest control rule

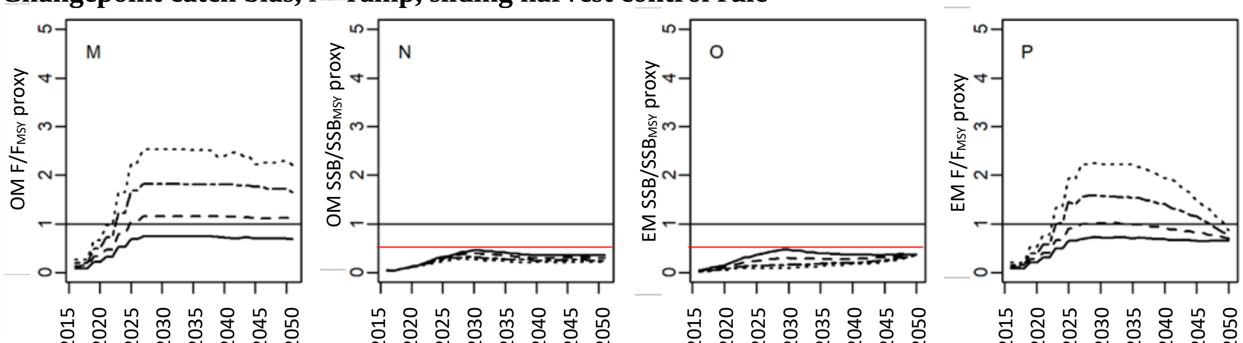


Figure 10: Left panels: Operating model (OM) fishing mortality and spawning stock biomass values relative to "true" proxy reference points (Black lines are relative to $F_{40\%}$ and $SSB_{F40\%}$, red line is relative to 0.5 $SSB_{F40\%}$. **Right panels:** Stock assessment estimates (EM) of spawning stock biomass and fishing mortality relative to the estimated biological reference point proxies. Results are from 100 simulations of scenarios.

Appendix A: Constant F harvest control rule simulation results

To understand the implications of underestimated catch scenarios under an alternative harvest control rule, we ran all catch bias scenarios under a constant fishing mortality harvest control rule (75% $F_{40\%}$, Figure A1). These simulations also included testing under alternative operating models (M = 0.2 and M-ramp) and alternative bias structure (constant and changepoint catch bias). The sliding harvest control rule reduced fishing mortality target values with lower spawning stock biomass, whereas the constant harvest control rule maintained the same level of fishing mortality regardless of stock size (Figure A1). In general, the impacts of catch bias scenarios were similar across the alternative harvest control rules with some key differences in the performance of the sliding and constant harvest control rules in the short-term (1-5 projection years). Under the constant fishing mortality harvest control rule, operating models exhibited higher fishing mortality and catch, and lower spawning stock biomass in the short term compared to simulations under the sliding harvest control rule. This led to slightly lower spawning stock biomass and catch levels in the medium term, but similar values over the long term. The patterns of assessment and management performance under the constant fishing mortality harvest control rule were consistent with the performance observed under the sliding harvest control rule. The similar outcomes of testing catch bias scenarios across alternative harvest control rules support the robustness of our findings.

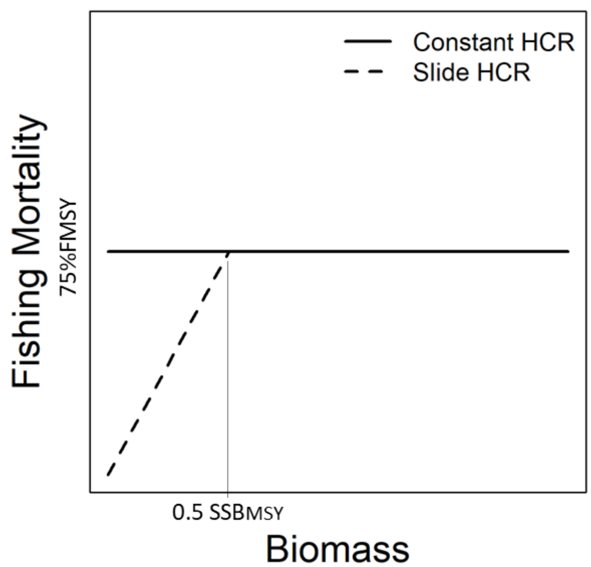
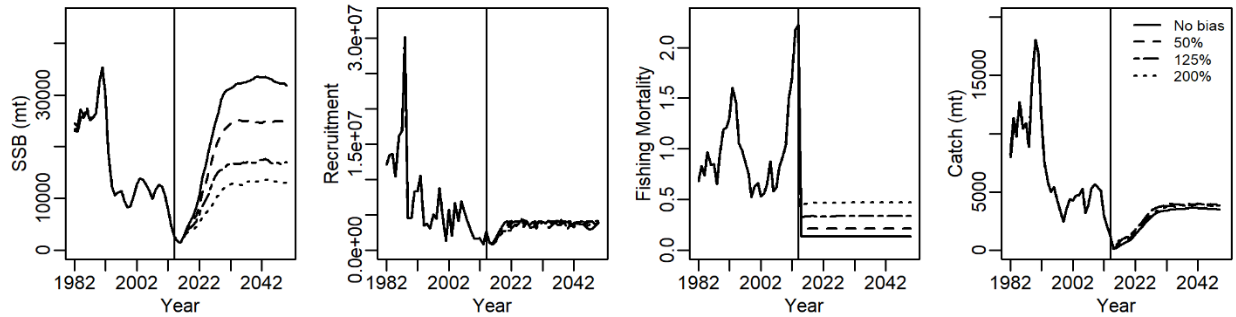
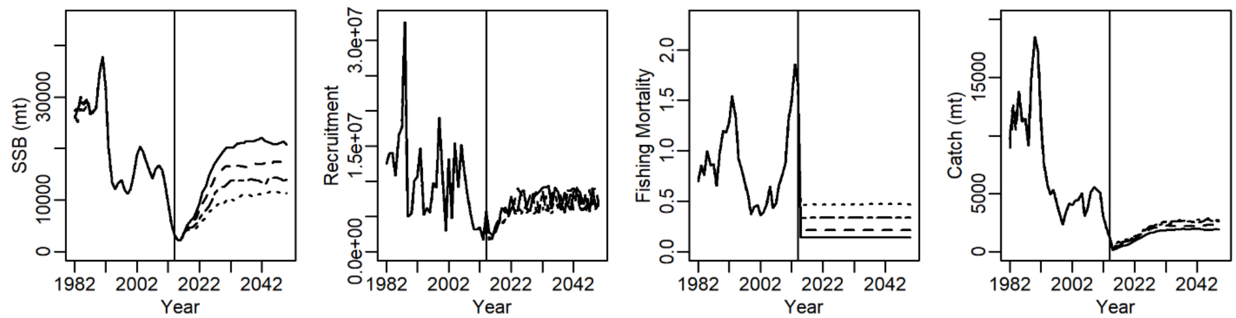


Figure A1: Depiction of sliding harvest control rule and constant fishing mortality harvest control rule used in analysis.

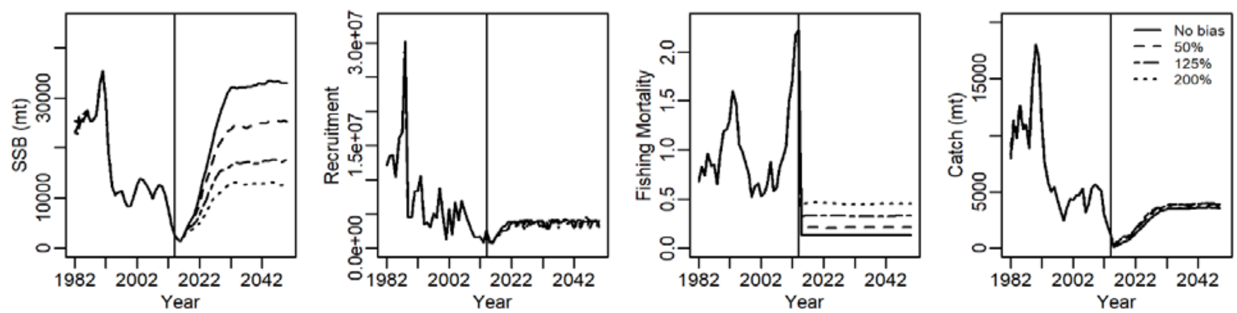
Constant catch bias, M = 0.2, constant F harvest control rule



Constant catch bias, M-ramp, constant F harvest control rule



Changepoint catch bias, M = 0.2, constant F harvest control rule



Changepoint catch bias, M-ramp, constant F harvest control rule

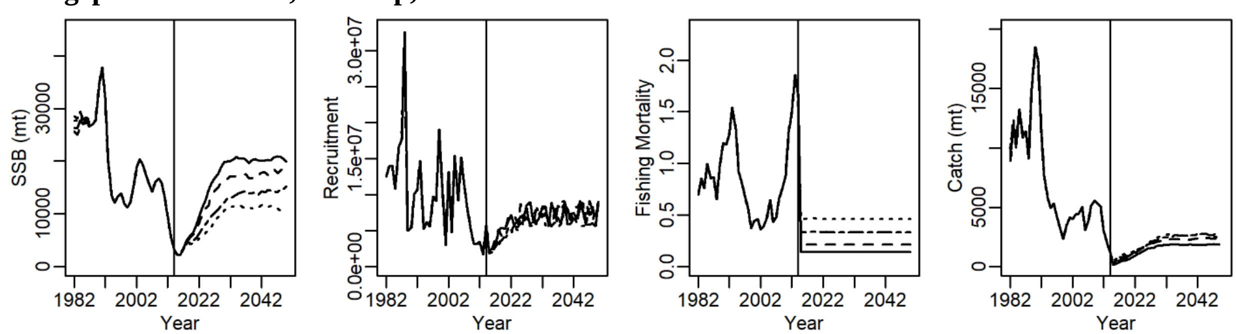
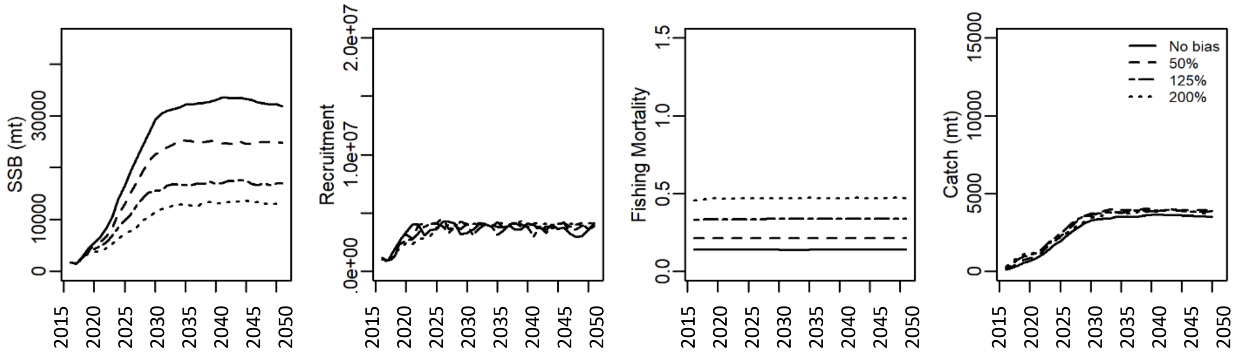
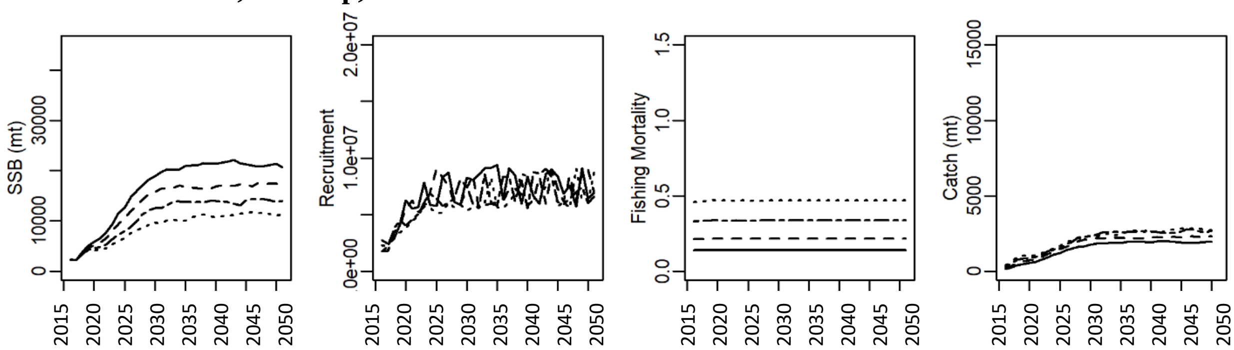


Figure A2. Time series of median operating model spawning stock biomass, recruitment, fishing mortality, catch from 100 simulations of scenarios with no catch bias, moderate bias (50%), large bias (125%), and extreme bias in catch reporting (200%) under M = 0.2 and M-ramp with constant and changepoint catch bias using a constant fishing mortality harvest control rule.

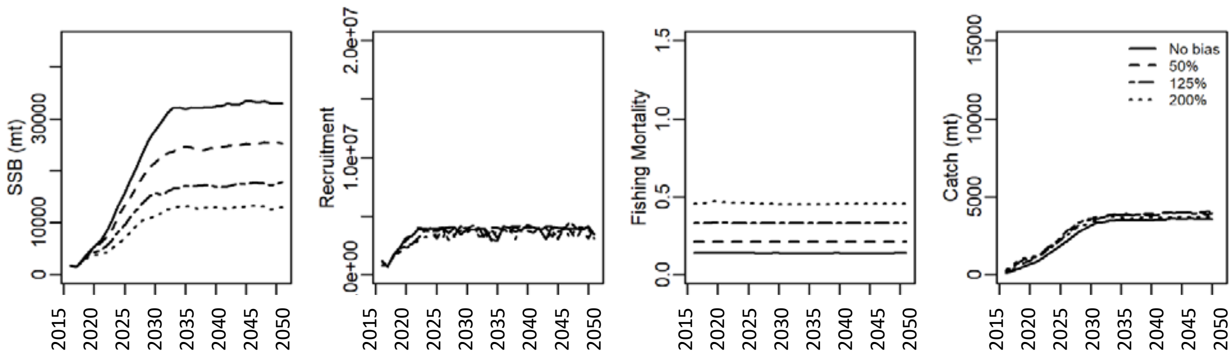
Constant catch bias, M = 0.2, constant F harvest control rule



Constant catch bias, M-ramp, constant F harvest control rule



Changepoint catch bias, M = 0.2, constant F harvest control rule



Changepoint catch bias, M-ramp, constant F harvest control rule

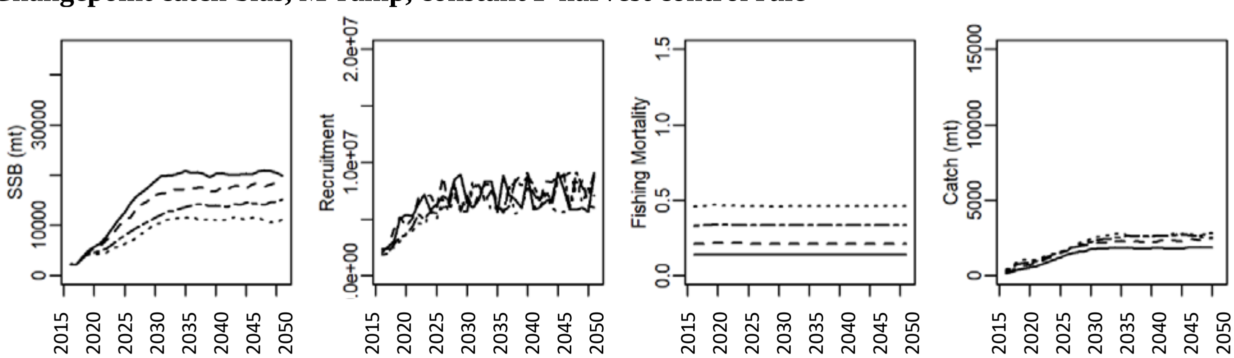
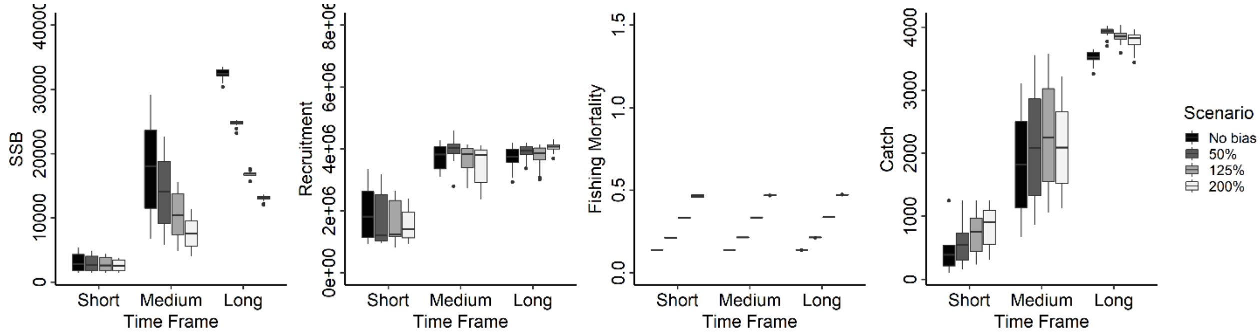
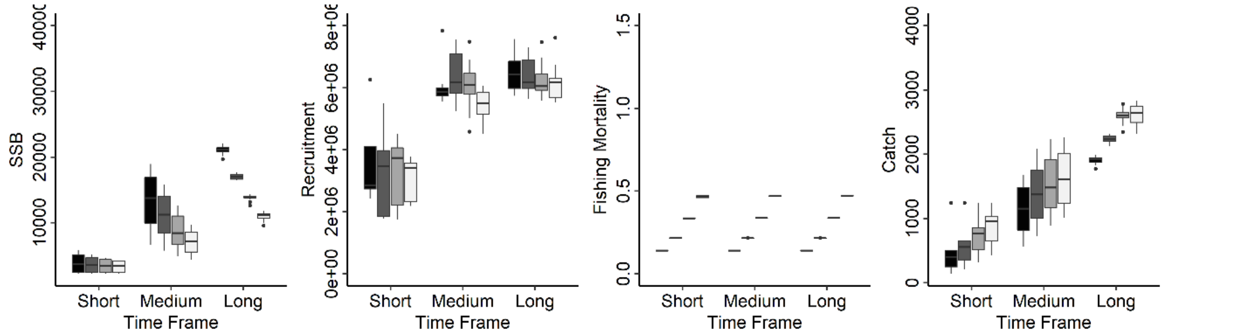


Figure A3. Time series of median operating model spawning stock biomass, recruitment, fishing mortality, and catch from 100 simulations of scenarios with no catch bias, moderate bias (50%), large bias (125%), and extreme bias in catch reporting (200%) under M = 0.2 and M-ramp with constant and changepoint catch bias using a constant fishing mortality harvest control rule.

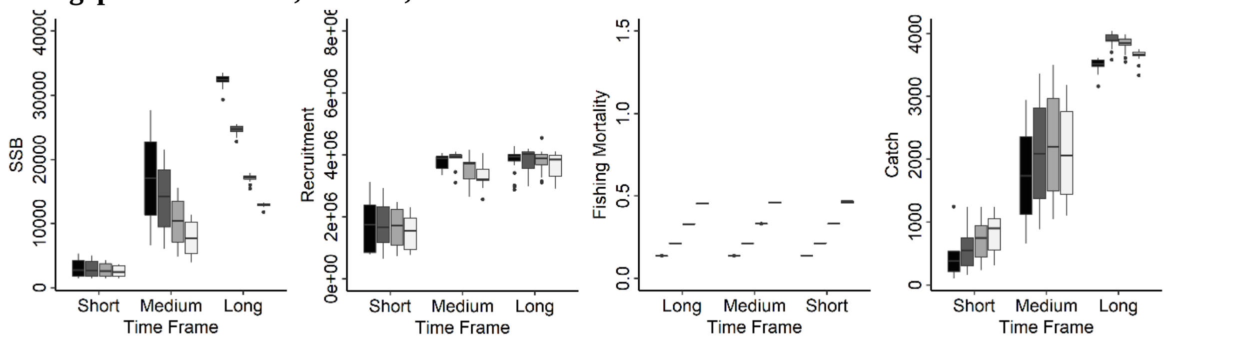
Constant catch bias, M = 0.2, constant F harvest control rule



Constant catch bias, M-ramp, constant F harvest control rule



Changepoint catch bias, M = 0.2, constant F harvest control rule



Changepoint catch bias, M-ramp, constant F harvest control rule

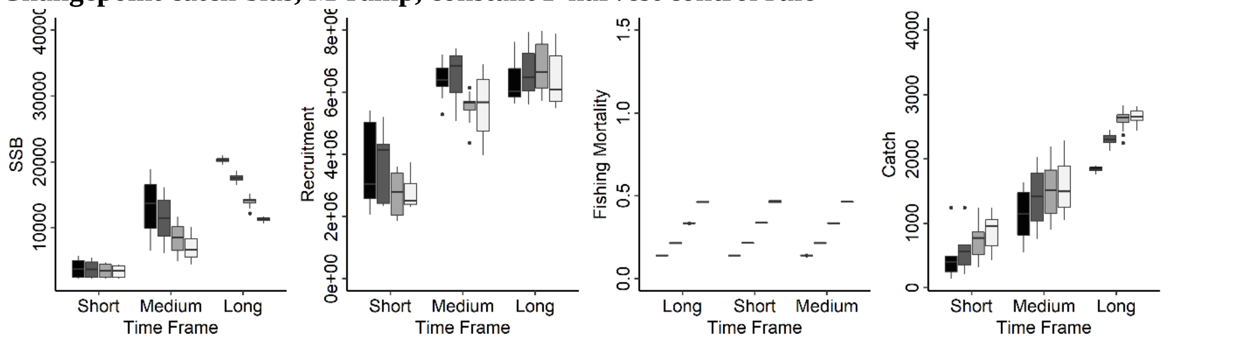
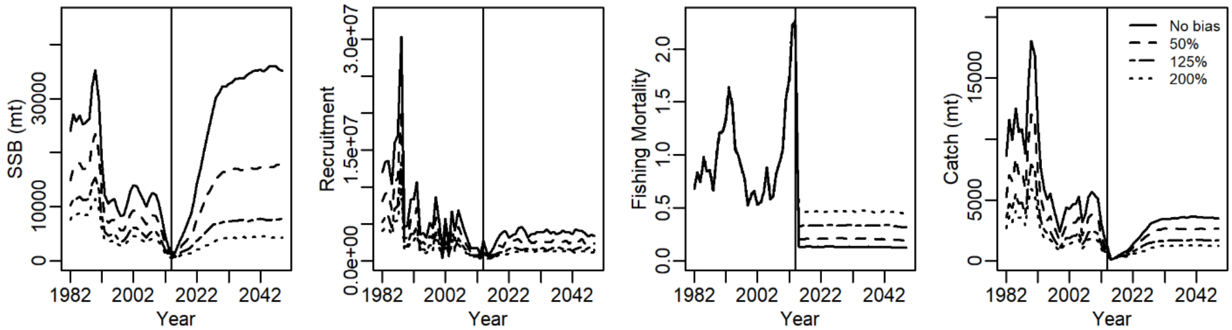
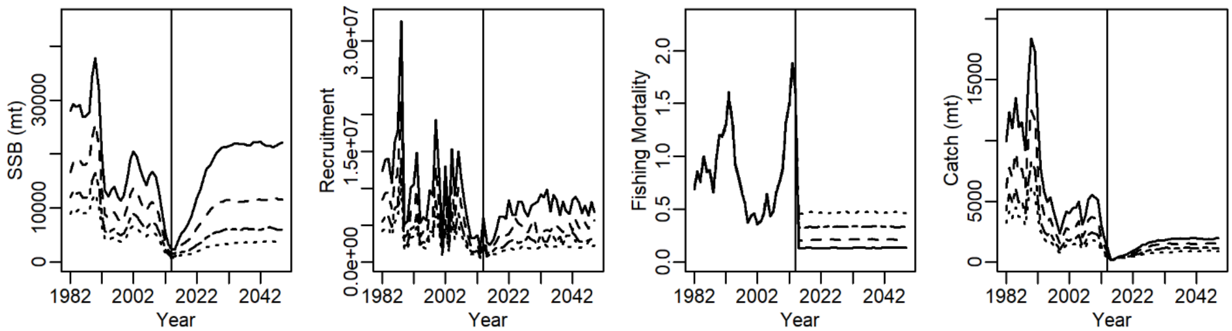


Figure A4. Boxplots of operating model spawning stock biomass, recruitment, fishing mortality, and catch (mt) across 100 simulations for each scenario under constant and changepoint catch bias with M = 0.2 and M-ramp using a constant fishing mortality harvest control rule in the short term (1-5 projected years), medium term (6-15 projected years), and long term (16-36 projected years).

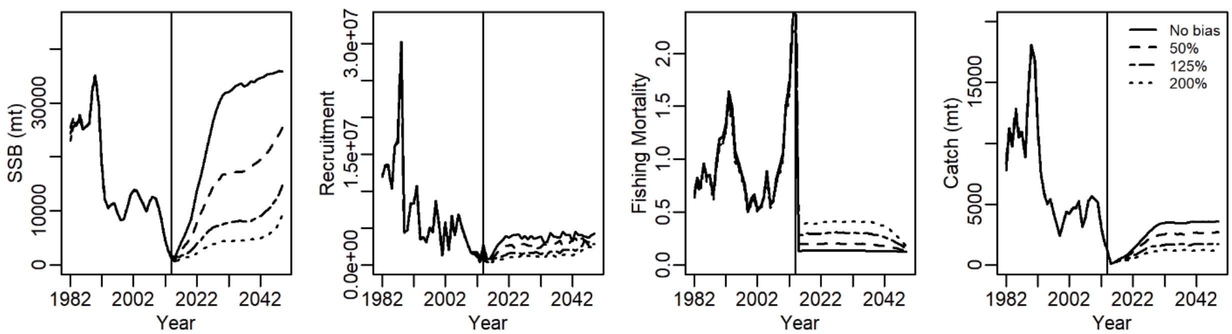
Constant catch bias, M = 0.2, constant F harvest control rule



Constant catch bias, M-ramp, constant F harvest control rule



Changepoint catch bias, M = 0.2, constant F harvest control rule



Changepoint catch bias, M-ramp, constant F harvest control rule

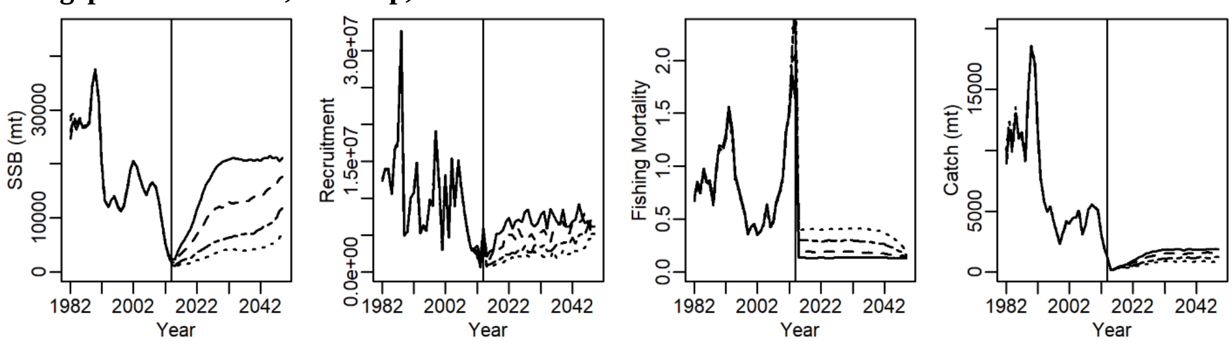
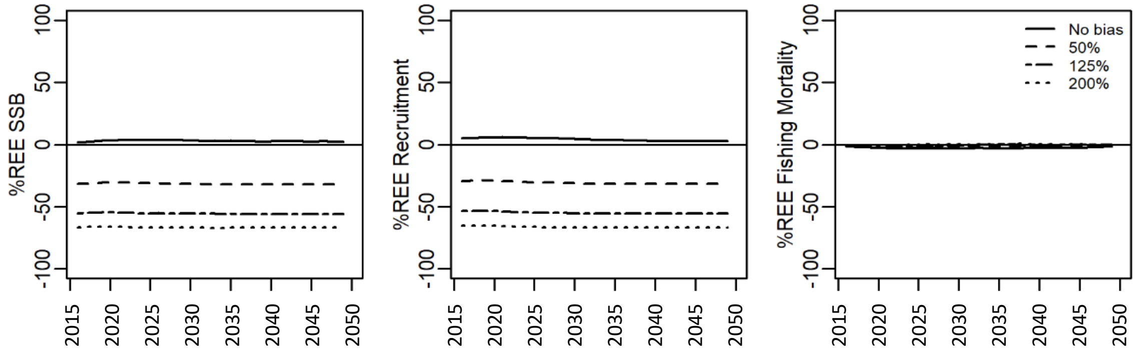
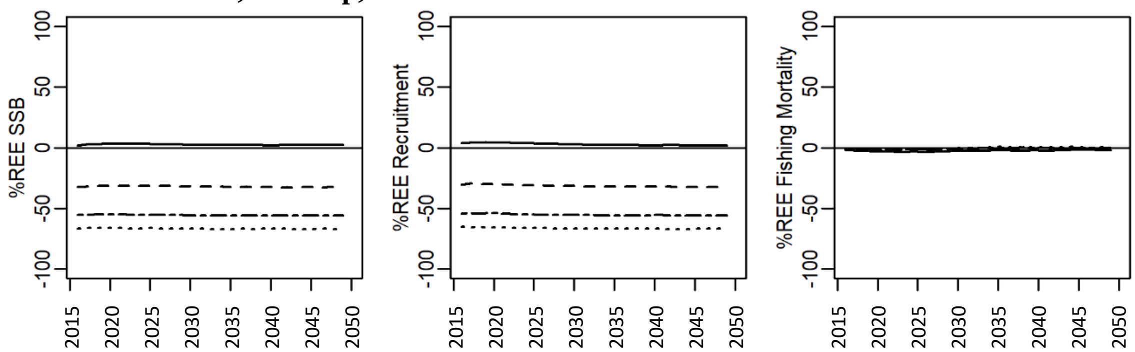


Figure A5. Time series of median estimated spawning stock biomass, recruitment, fishing mortality, and catch from last stock assessment in the projected time series (100 simulations). Scenarios were simulated with no catch bias, moderate bias (50%), large bias (125%), and extreme bias in catch reporting (200%) under M = 0.2 and M-ramp with constant and changepoint catch bias using a constant harvest control rule. Vertical black line indicates the start of the projection period (2015).

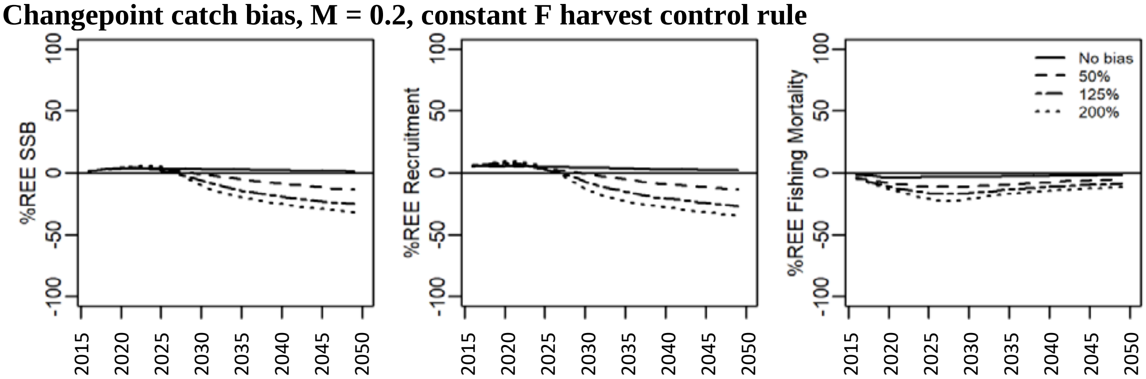
Constant catch bias, M = 0.2, constant F harvest control rule



Constant catch bias, M-ramp, constant F harvest control rule



Changepoint catch bias, M = 0.2, constant F harvest control rule



Changepoint catch bias, M-ramp, constant F harvest control rule

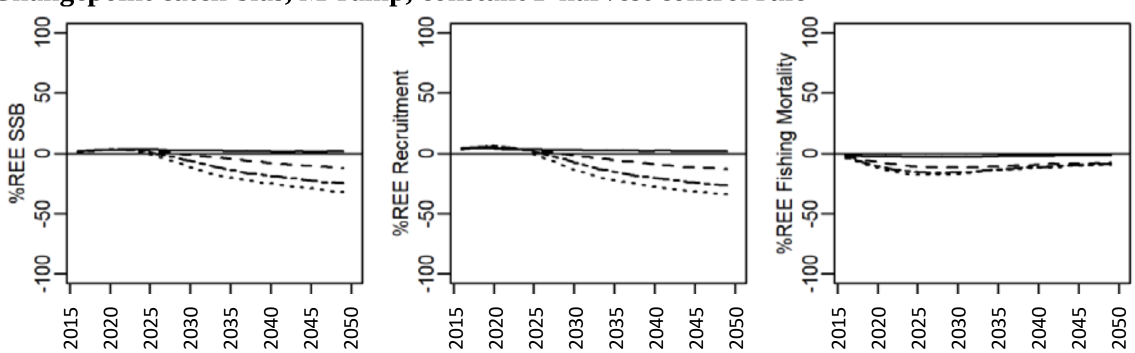


Figure A6. Time series of median percentage relative error estimates (%REE) comparing the average assessment to the operating model spawning stock biomass, recruitment, and fishing mortality across 100 simulations for each scenario with Constant and changepoint catch bias under M = 0.2 and M-ramp under a constant harvest control rule. The horizontal black line is to reference zero bias.

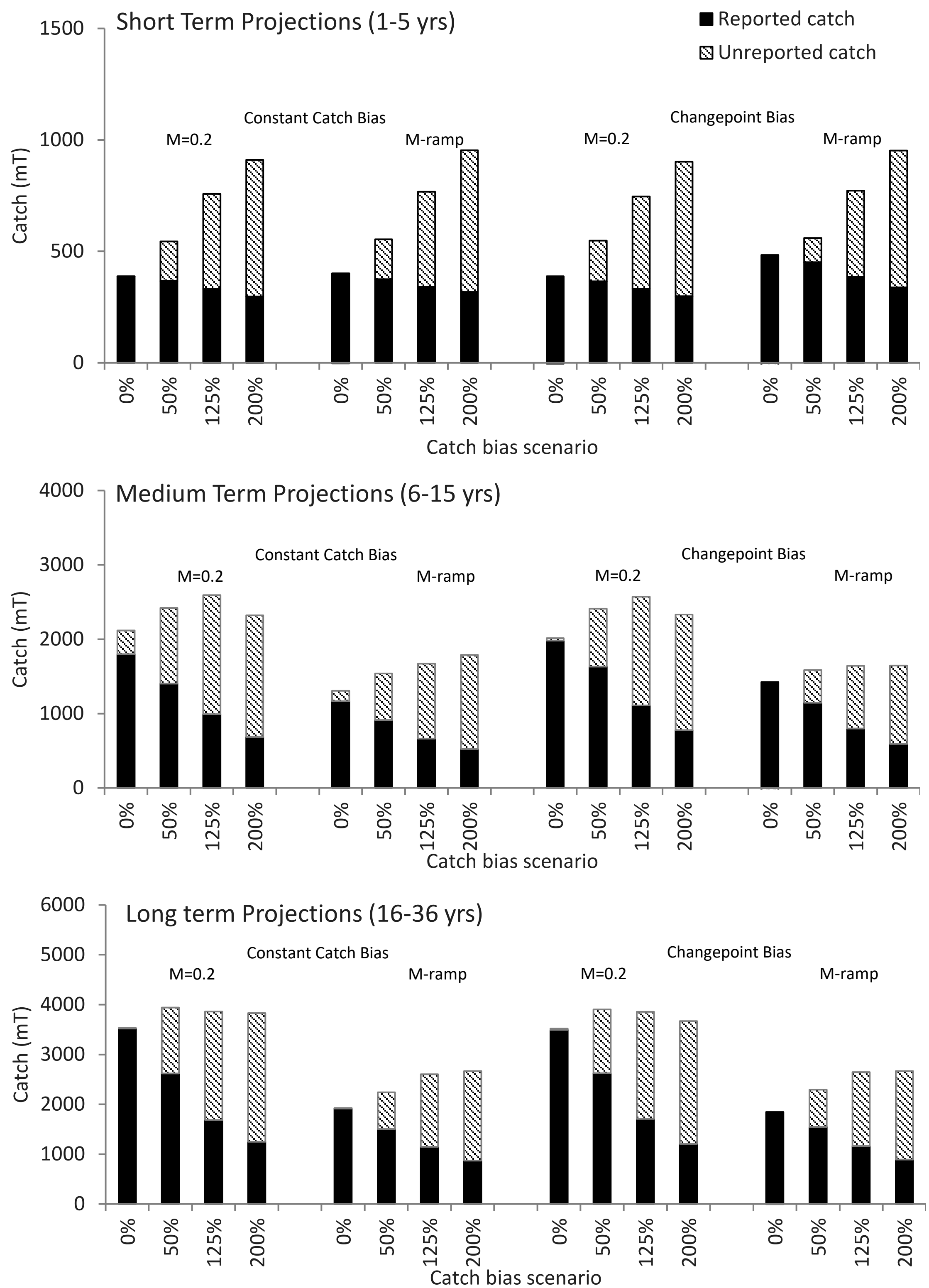
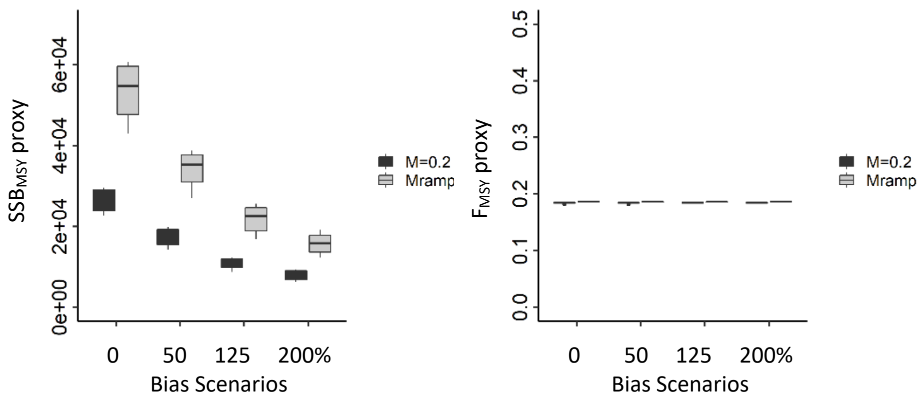


Figure A7. Median reported and unaccounted catch (together equating to "true" catch) across 100 simulations of catch bias scenarios for each scenario under constant and changepoint catch bias for M = 0.2 and M-ramp operating models in the short term (1-5 projected years), medium term (6-15 projected years), and long term (16-36 projected years).

Constant catch bias, constant F harvest control rule



Changepoint catch bias, constant F harvest control rule

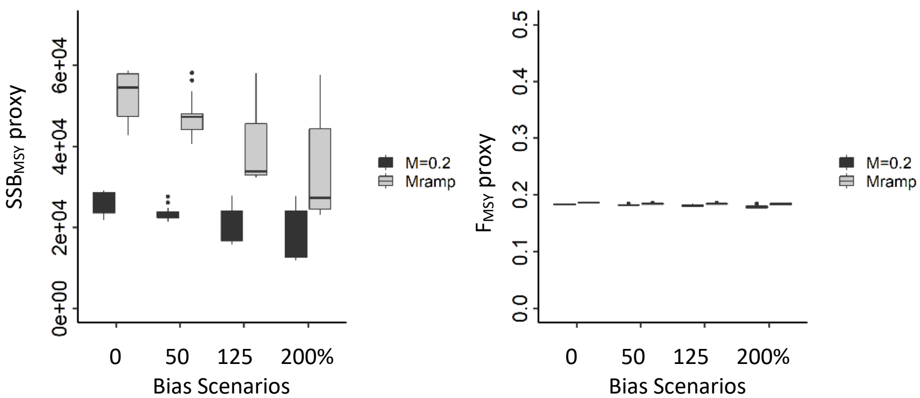
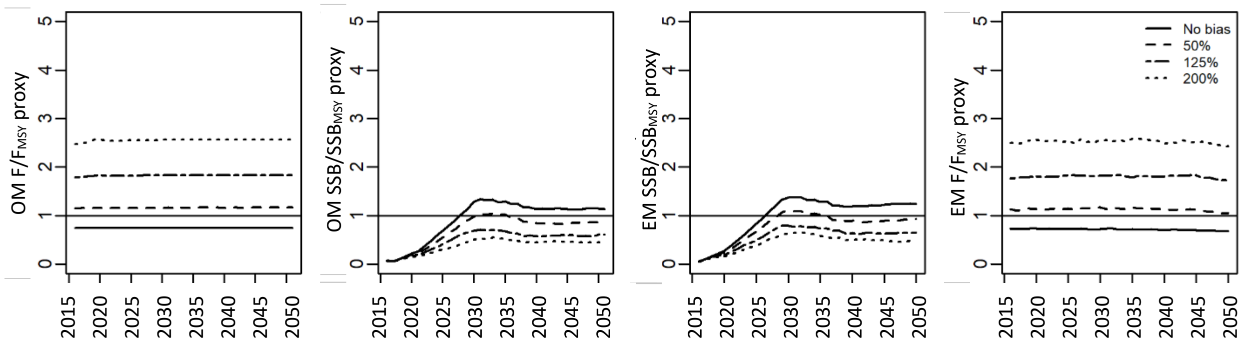
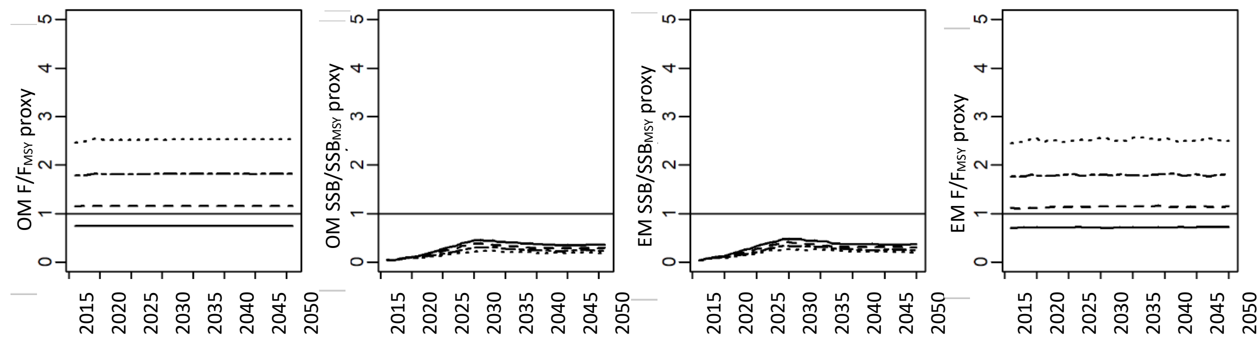


Figure A7: Boxplots of spawning stock biomass ($SSB_{F40\%}$) and fishing mortality ($F_{40\%}$) biological reference point values for M = 0.2 and M-ramp realizations under contant catch bias and changepoint catch bias across catch bias scenarios using a constant fishing mortality harvest control rule. Note that M-ramp biological reference points were calculated assuming M= 0.2.

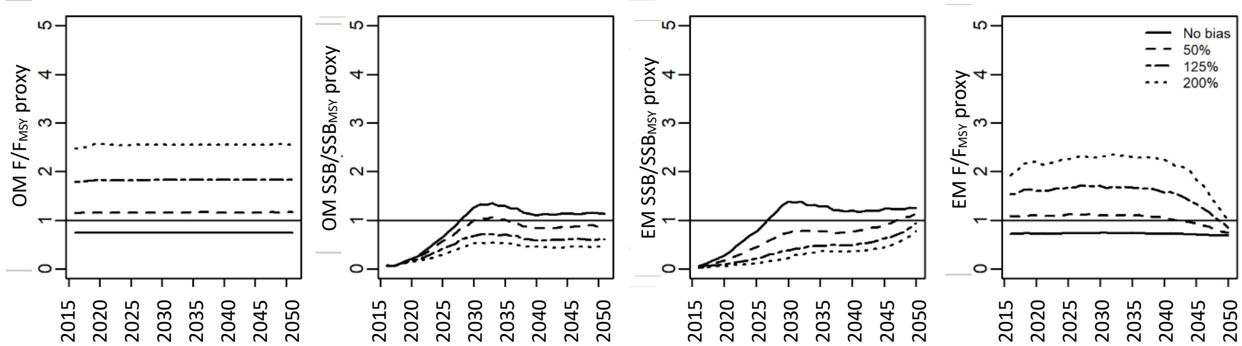
Constant catch bias, M = 0.2, constant F harvest control rule



Constant catch bias, M-ramp, constant F harvest control rule



Changepoint catch bias, M = 0.2, constant F harvest control rule



Changepoint catch bias, M-ramp, constant F harvest control rule

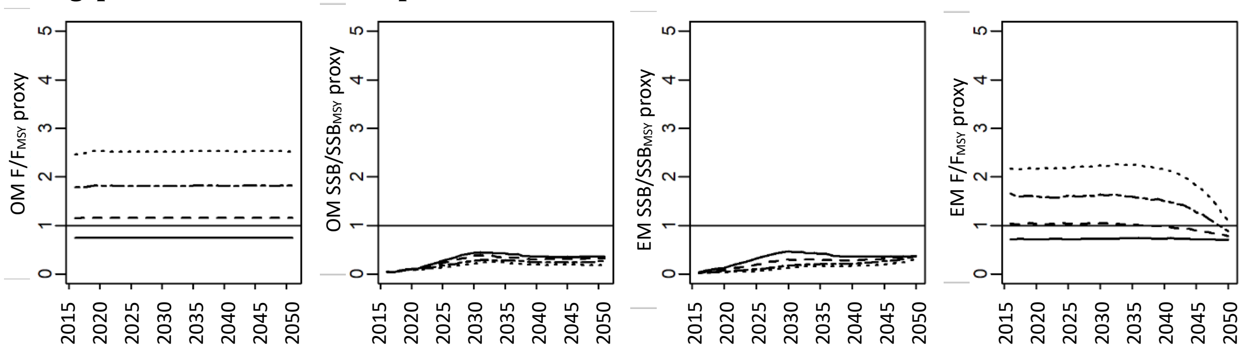


Figure A8. **Left panels:** Operating model (OM) fishing mortality and spawning stock biomass values relative to "true" proxy reference points (Black lines are relative to $F_{40\%}$ and $SSB_{F40\%}$, red line is relative to 0.5 $SSB_{F40\%}$. **Right panels:** Stock assessment estimates (EM) of spawning stock biomass and fishing mortality relative to the estimated biological reference point proxies. Results are from 100 simulations of scenarios.

Background:
Excerpt from Amendment 23 Draft Environment Impact Statement formal submission, March 4, 2020 (pg. 300-303)

<u>Magnitude of potential 2018 missing Gulf of Maine cod discards</u>

A sub-panel of the SSC reviewed PDT analyses showing evidence of an observer effect and concluded that observed trips are not representative of unobserved trips in the groundfish fishery (see Section 6.6.10.5 and Appendix V). However, the magnitude of the missing removals that results from illegal discards across the entire fishery was not quantified at the SSC review (the PDT does provide an estimate of potential magnitude of missing removals for GOM cod on gillnet trips; see Section 6.6.10.5.3 and Appendix V, "Predicting Gulf of Maine (GOM) cod catch on Northeast Multispecies (groundfish) sector trips: implications for observer bias and fishery catch accounting"). The reviewers did suggest that further investigation into quantifying the missing catch should be done.

Overall Approach - The concept behind the following analyses is to calculate potential landings in a target year by multiplying the landings per unit of effort (landings/day absent) from a reference year by the amount of effort (days absent) in the target year. In this analysis, the reference year is chosen as a year where the stock size is similar to the target year, but the ABC is larger. Under the assumption that landing rates (landings/days absent) are influenced by stock size, the landing rates would be expected to be similar for the reference year and target year. Based on analyses in Appendix V, a lower allowable catch would be expected to change fishing behavior. Fisherman could change fishing practices in a number of ways, but one possible response would be to increase discards of legal-sized fish. The landing rate in the reference year (with the higher ABC) could be multiplied by the total effort measure in the target year (with the lower ABC) to estimate a potential landings amount. This could be compared to the actual landings, and the difference can be considered a rough estimate of discards. Since all legal-sized fish are required to be landed in the sector system, this estimate could represent unaccounted for legal-sized discards.

Assumptions - There are several assumptions and limitations to this method:

- Landings per day absent is proportional to stock size and is constant during different years with similar stock sizes.
- Fishing practices are similar in the years that are compared (other than possible discarding). This assumption ignores changes in behavior that reduce the landings per unit of effort in the target year. As a result, the calculation can be viewed as a potential upper bound on the magnitude of uncounted legal-size discards.
- Landings are assumed to be known without error. Other sources of errors in landings amounts, such as stock area misreporting or dealer misreporting, are not estimated and assumed to be insignificant in this analysis.

GOM Cod Example - Using GOM cod as the focal stock, analyses investigated the potential magnitude for missing legal-sized discards in 2018. GOM cod was used as an example for two reasons:

- First, as a result of low ABCs, this stock was highly constraining from 2015 to 2018 which produces economic incentives for sector fishermen to discard legal-size fish (see Section 6.6.10.5.1 and Appendix V, "Modeling Discard Incentives for Northeast Multispecies (Groundfish) Stocks"). In 2012 the GOM cod ABC was 6,700 mt and in 2013 was lowered to 1,550 mt. The ABC became much more constraining after 2014 and was set at 703 mt in 2018.
- Second, the GOM cod spawning stock biomass (SSB) estimate, when the quota was less constraining in 2012 and 2013, was somewhat similar to the 2018 estimate (more so for 2012) when the quota should have been constraining. There is uncertainty in the SSB estimate from the

assessment due to within model retrospective issues and due to the assessment being based on two different model configurations (M=0.2 and M-ramp). The relative change in stock size over this time period (2012-2018) can be seen in Table 72, which shows the estimates of SSB from the 2019 GOM cod stock assessment.

This analysis makes assumptions in stock size over the period examined (2012-2018 or 2013-2018) occurred as described in the assessment and on levels of avoidance behavior of GOM cod by the fishery. There is considerable uncertainty surrounding a potential estimate of the magnitude of unreported legal-sized GOM cod discards.

Table 1 - SSB estimates for GOM cod from the M=0.2 and M-ramp model from the 2019 operational groundfish stock assessment. The rho adjusted SSB estimates are also shown for the terminal year of the assessment. The relative change in the SSB from 2012 and 2013 to the terminal year (2018) are shown on the right. An average of the estimated SSB changes is also given as an approximation for a stock size adjustment.

		SSB				SSB Relative Change				
year	ABC	m=0.2	rho adj	mramp	rho adj	m=0.2	rho adj	mramp	rho adj	Average
2011	9,012	6,723		8,009						
2012	6,700	3,524		4,221		1.06	0.70	0.91	0.71	0.84
2013	1,550	1,874		2,361		2.00	1.32	1.63	1.26	1.55
2014	1,550	1,263		1,809						
2015	386	1,439		2,164						
2016	500	2,258		3,023						
2017	500	3,051		3,593						
2018	703	3,752	2468	3,838	2976					

Data and Analysis - An overview of the data and analysis is summarized in this section.

- Data includes fishing year 2012, 2013, and 2018 large-mesh trawl gear sector groundfish trips or sub-trips that only occurred in the Gulf of Maine stock area. Therefore, trips with and without cod landings are included. Common pool trips are not included. Sub-trips outside of the Gulf of Maine stock area are also excluded. Data was pooled by fishing year.
- For fishing years 2012 and 2013, the ratio was calculated as the sum of all cod landings divided by the sum of all days absent in two ways:
  - First, the ratio calculated across all statistical reporting areas (SRA) and,
  - Second, the ratio calculated by each SRA with an expansion by SRA. Most Gulf of Maine stock area trips (~90%) are reported as single statistical area trips. For trips that reported effort in multiple statistical areas, the catch and effort was apportioned equally between each area, since time spent in each SRA is unknown (not reported).
- *Potential landings estimate*- The resulting ratio for each fishing year (2012 and 2013) was multiplied by the sum of all days absent in fishing year 2018 (∑days absent) to estimate the potential magnitude of discarding of legal-size GOM cod. This estimate only accounts for potential legal-size discards of GOM cod which should have been landed. Therefore, sublegal discards are not part of this calculation and hence referred as a “potential landings estimate”.
  - 2018 Potential Landings Estimate = {∑ 2012 GOM cod landings/∑ 2012 Days Absent (DA) }* Total 2018 Days Absent

    or
  - 2018 Potential Landings Estimate = {∑ 2013 GOM cod landings/∑ 2013 Days Absent (DA) }* Total 2018 Days Absent.

Results and Discussion - The magnitude of the missing landings (unreported discards of legal-sized cod) was summarized as a multiplier relative to the 2018 fishing year. The estimated multipliers calculated from 2012 or 2013 landings per days absent (LPUE) and applied to the total effort in 2018 (∑days absent) are shown in Table 73 (results at 100% for "Total" and "By Stat Area"). This estimate of an upper bound of the potential magnitude for missing legal-sized discards of GOM cod. The landings multipliers are relative to the total commercial landings for sector trawl trips in 2018. The sector trawl landings were 218 mt (480 thousand pounds) in 2018. Therefore, the potential landings estimate under a multiplier of 1.71 would be 373 mt.

Estimation of the multiplier by SRA was also done since there was spatial shift in fishing effort - inshore to offshore (for example NEFSC 2017) over this time period when cod became more constraining. This did result in the slight reduction in overall estimated multipliers, as expected (Table 73).

It's possible that the reduced ABC in 2018 led fishermen to reduce cod catches by fishing differently. The impact of such changes was evaluated with a sensitivity analysis that removed a proportion of the 2012 and 2013 trawl trips that had the greatest landings of GOM cod (Table 73). Lower percentages (25% and 50%) signify the 2012 and 2013 trips used to estimate the multipliers. For example, 25% of the highest cod landings trips were eliminated in estimation of the multiplier.

The multiplier estimate is sensitive to the unknown targeting and avoidance behavior in the overall fishery. The ability of the fishery to preferentially target certain stocks is a difficult factor to account for in estimating the bound of missing catch. The fleet's true ability to avoid constraining stocks on groundfish trips is not known. Likewise, true fishery avoidance behavior is unknown for constraining stocks when a trip is unobserved because of the potential targeting of non-constraining stocks in areas of high catch per unit effort (CPUE) that may also overlap areas where cod are caught. To help bound this issue, all of the trips (no targeting behavior change) were used in the estimator and also some of the highest cod landing trips (approximate a change in targeting behavior) were eliminated from the estimate. Not surprisingly, the estimate of potential missing cod is sensitive to the elimination of the trips that caught the highest amount of cod. For example, eliminating the top 50% of the total GOM cod landings trips from the estimator (landings per unit effort) in 2013 results in predicted landings below the actual reported landings. This estimate is not realistic since one would not expect actual landings to be below the reported landings. Using all trips in the estimator may also not be realistic but this may give a sense of a bound for the missing catch given all of the other assumptions.

Table 2 - Estimated multipliers calculated for all trips and for trips by statistical area. Sensitivity of the estimate to elimination of the top 25% and 50% of GOM cod trips is also shown.

	Total			By Stat Area		
year	100%	75%	50%	100%	75%	50%
2012	3.84	2.99	2.15	3.03	2.42	1.82
2013	1.71	1.32	0.92	1.67	1.32	0.95

For further refinement, the multipliers on missing GOM cod landings were adjusted by the relative average SSB change from the stock assessment (2012 SSB estimate/2018 SSB estimate = 0.84 and 2013 SSB estimate/2018 SSB estimate = 1.55). Adjusting for the change in SSB estimated by the assessment would bring the 2012 and 2013 estimates slightly closer together between years which can be seen in Table 74.

Table 3 - Estimated multipliers calculated for all trips and for trips by statistical area which were also adjusted for the relative average SSB change from the stock assessment (2012 = 0.84 and 2013 = 1.55).

	Total			By Stat Area						
year	100%	75%	50%	100%	75%	50%	Max	min	average	median
2012	3.24	2.53	1.82	2.56	2.04	1.54	3.24	1.54	2.31	2.29
2013	2.65	2.05		2.59	2.05					

In conclusion, the results of the analysis indicate a possible upper bound multiplier of 2.3 times GOM cod landings, roughly 1,100 thousand pounds (~498mt) of missing landings (or missing legal-sized discards), with an uncertainty range of 1.5 to 2.5, or about 700 thousand pounds to 1,200 thousand pounds (~317mt to 544mt). This estimate is perhaps a more realistic bound on the potential missing catch for GOM cod relative to multipliers that are much higher since total fishing effort will limit the potential for missing discards.

From: Thomas T [mailto:midnightsunjr@gmail.com]
Sent: Wednesday, September 16, 2020 10:59 AM
To: Tom Nies <tnies@nefmc.org>
Subject: I know this is kinda late but please accept this letter thank you

My name is tommy Testaverde jr. I'm a commercial fisherman from Gloucester and have been for the past 20 years. I have seen the ups and downs in this industry in the past two decades but mostly downs. Regulation after regulation, quota cut after quota cut, the sector scam agenda forced down our throats systematically dismantling the fleet little by little into what you see now which is nothing. People lost their careers there, livelihoods their, houses forced to start over when they should be thinking about retirement. Infrastructure lost turned into something else. Our groundfish market shift into low demand and low prices because of a imported fish takeover and a lack of education to the public about our vast sustainable healthy fish stock right here on our coast. But yet fishermen adapt to this chasing different species. Going further offshore. Trying new things. And for the most part the fleet made it work. But every time we do there is always someone trying to knock us back with a new rule or new quota cut. With this implication of 100% observer coverage that will not just accomplish that, but it will put people out of business when the cost shift to the industry. Last year my vessel had to lease $72,000 in quota to go fishing in a depressed fish market making pennies on the dollar on top of sector fees offload fees and a dozen other fees and bills to get one of these vessels to go out and harvest fish for public consumption. Now I get it the Carlos Raphael thing hurt us as a industry and more needs to be done about people like that. But a few bad apples don’t mean you should cut the tree down! 100% coverage is to say the least excessive to which that information collected doesn't really account for the stock assessment decisions. Our stocks are doing well except a few cod being the most notable but 100% coverage is not going to make the stock rebuild that's mother nature's decision and You don't need no degree in marine biology to see that you have been trying to get the stock rebuilt and NOTHING WORKS. Even if the fishery was shut down for 10 years, they wouldn't rebuild to the level your trying to achieve. Mabey you need to look into the lobster fishery and the millions and millions of traps that can catch cod and look into that discard rate with your observers. But to make the industry pay the observer companies to get the information that nmfs wants is criminal that is simply a shake down and is basically what the mafia did to businesses pay me so much a week for protection and your business won't burn down. This is what nmfs wants this is what enviros want and anybody else with this agenda then YOU NEED TO FUND IT!!!!! In life if there is something I want but I can't afford it well then I can't get it but with the budget that NMFS has for the year some $900 million and change and you say there is no funding available is comical. You need to find a way to pay for your! observers to come on our! vessels and collect information that you want! Were not scallopers we are not getting $10-$15 a pound for our product more like .50-$1.00 and were not a multi-million dollar company we are small family owned business trying to survive in a ever changing dynamic industry that in itself is hard enough but to force this on us which my vessel will have to pay $10-$15,000 a month just for observers fundamentally wrong. This is a shoveling dirt on the coffin situation and will put people out of business or possibly get people hurt or killed because of the extra cost that could go to yearly maintenance fixing their aging vessels but can't because of the cost of observers takes that money away and also it puts a stop into people's plans to replace their old vessels with new safer modern and efficient vessels because the observer cost alone is the same or more than a mortgage payment on a brand new 80ft steel boat. Please don't put me out of business and ending my family's 100-year fishing heritage in the New England groundfish fishery. please there has to be another way.

We have received 18 of the following cards which were received after the August 31 deadline

AMENDMENT 23 IS OFF COURSE!
START OVER!

Monitoring is important to the successful management of **ALL** fisheries but it must not come at the cost of decimating the iconic groundfish fishery!

COVID-19 has shown me how critical it is for my local community to have a reliable locally harvested source of healthy protein. As a New England resident, I am lucky to have access to the seafood sustainably caught by the small independent groundfish fleet. In its own words, Amendment 23 will force fishermen out of business and provide a windfall "to more efficient vessels with lower operating costs and higher profits."

A diverse groundfish fleet is critical to the continuation of this iconic fishery currently written Amendment 23 will decimate the fleet until only a few large corporations remain. Amendment 23 fails to strike the necessary balance needed to preserve our local fishing community. Be Fair! Start Over!

From: Troy Brock commercial fishermen

NAME/FISHING VESSEL	CITY, STATE
Michael Walsh	Lakeville, MA
Yvette Alexander	Harpswell, ME
Nick Hathorne	Harpswell, ME
Clay Munsey	Harpswell, ME
Gary Hawkes	Harpswell, ME
Brae Harley	West Bath, ME
Joshua Peters	Lakeville, MA
Shawna Roy	Wiscasset, ME
Sarah Wilson	New Bedford, MA
Andrew Walsh	Stoughton, MA
Markus & Tammy Lieman	Naples, ME
Robert Felix	Rockland, ME
N. Bogin	Gloucester, MA
Amanda Hawkes	Harpswell, ME
Cody Gilliam	Harpswell, ME
Tracey Kelly	Scituate, MA
Troy Brock, Commercial Fishermen	
McKenna Family	Norwell, MA