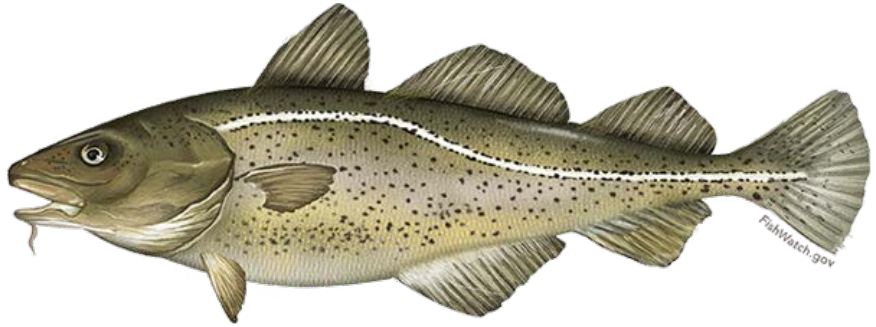
Overview of Atlantic Cod Research Track Stock Assessment Process

Lisa Kerr (Chair-Cod RTWG)

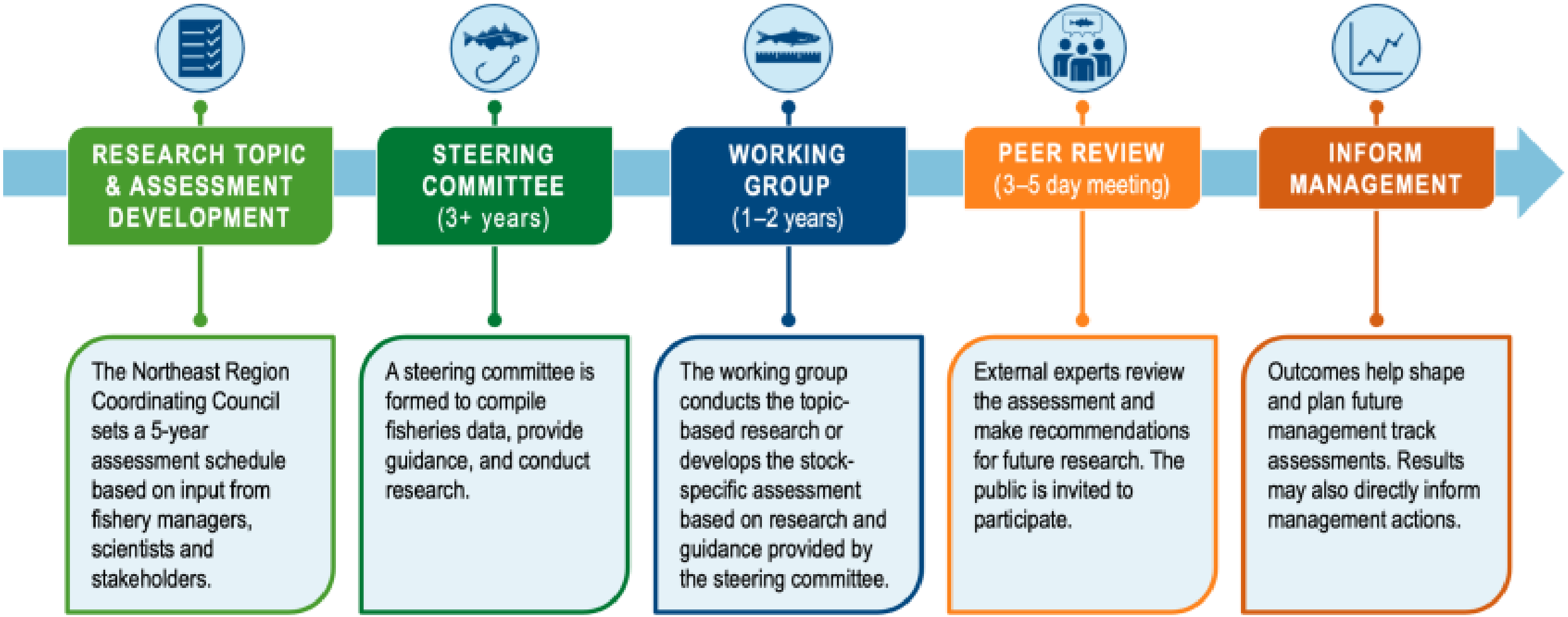
NEFMC Council Meeting

February 3, 2022



NOAA FISHERIES

RESEARCH TRACK STOCK ASSESSMENTS



Working Group Members

Lisa Kerr
(GMRI, Chair)

Charles Perretti
(NEFSC, GOM cod lead analyst)

Katherine Sosebee
(NEFSC, GB cod lead analyst)

Scott Large
(NEFSC)

Jamie Cournane
(NEFMC)

Kathy Cooper-MacDonald (DFO)

Steve Cadrin
(SMAST)

Alex Hansell
(NEFSC)

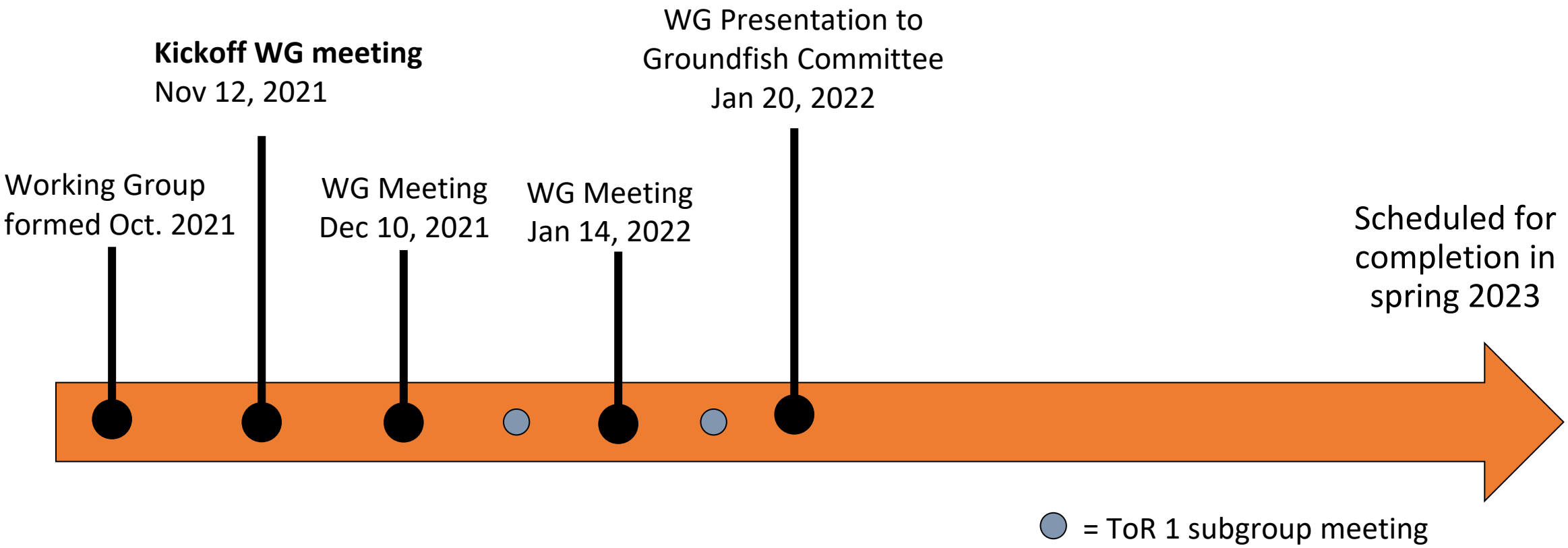
Rich McBride
(NEFSC)

Irene Andrushchenko
(Canada DFO)

Micah Dean
(MDMF)

+ many more participants

Atlantic Cod Research Track Timeline

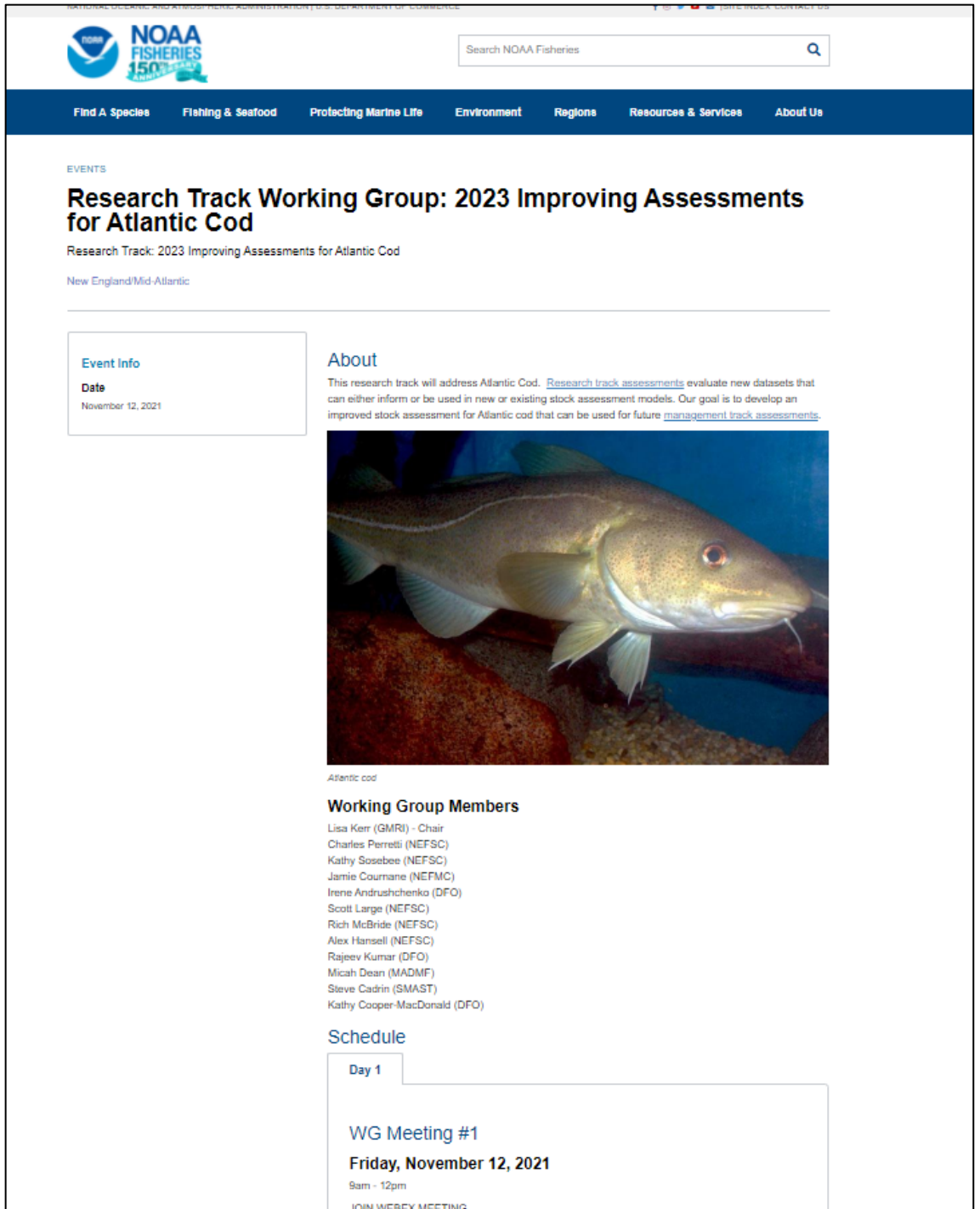


Upcoming WG Meetings

- February 11th 9am - 11am
- March 11th 9am - 11am
- April 8th 9am - 11am
- May 13th 9am - 11am
- June 10th 9am - 11am

Website Information

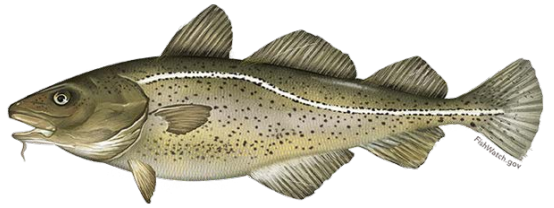
Meeting info will be posted here: https://www.fisheries.noaa.gov/new-england-mid-atlantic/population-assessments/research-track-stock-assessments



Stakeholder Engagement

- **Goal**: To give stakeholders a voice in the stock assessment process and opportunity for input through an open meeting.
- **Upcoming meeting:** We are planning a meeting on Feb. 9 (1-3 pm).
- **Other opportunities for engagement:** open WG meetings, continued updates with the Groundfish Committee and Council.
- Feel free to reach out with questions (lkerr@gmri.org).

Terms of Reference (TORs)



1. Identify relevant **ecosystem and climate influences** on the stock...
2. Estimate **catch** from all sources including landings and discards…
3. Present the **survey data** used in the assessment…
4. Use appropriate **assessment approach** to estimate annual fishing mortality, recruitment and stock biomass…
5. Update or redefine **status determination criteria**…
6. Define appropriate methods for producing **projections**…
7. Review, evaluate, and report on the status of **research recommendations**…
8. Develop a **backup assessment** approach…
9. **Stock structure** (under review by NRCC)

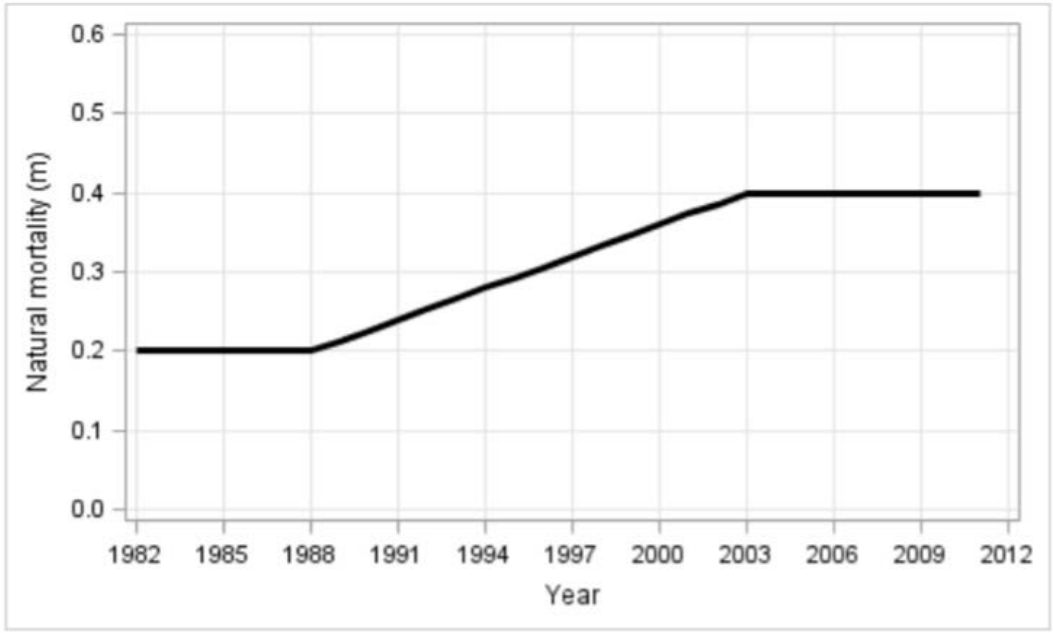
ToR 1: Ecosystem and climate influences

ToR 1: Identify relevant ecosystem and climate influences on the stock.

- Characterize the uncertainty in the relevant sources of data and their link to stock dynamics.
- Consider findings, as appropriate, in addressing other TORs.
- Report how the findings were considered under impacted TORs.

Current approach: Ecosystem and climate drivers are not explicitly modelled in the stock assessment.

- Accounted for implicitly for some aspects of stock dynamics.
- Focus on recent data in characterization of stock in projections (e.g., weight at age, assumption of natural mortality, recruitment)
- M-ramp model accounts for changing natural mortality, but not linked to mechanism.

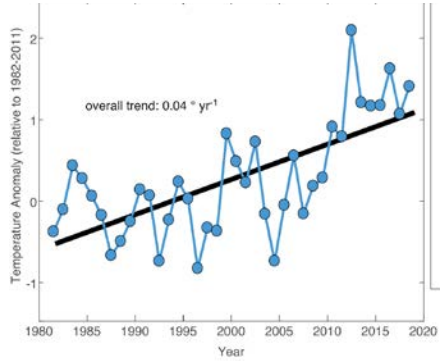


ToR 1: Ecosystem and climate influences

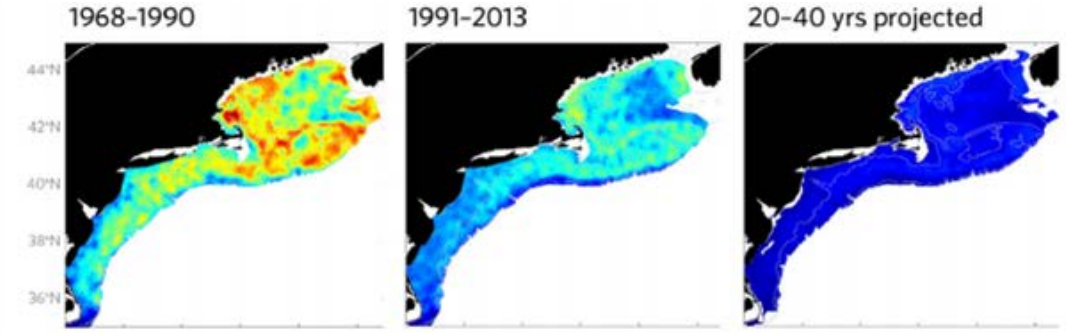
Possible Alternative Approaches and Considerations:

- Considerations of ecosystem and climate impacts on aspects of stock dynamics (e.g., recruitment, natural mortality, growth).
- Consideration of ecosystem and climate impacts on survey catchability.
- Consider the impact of changing ocean conditions on the new rebuilding plan for Atlantic cod.

Sea Surface Temperature in Gulf of Maine

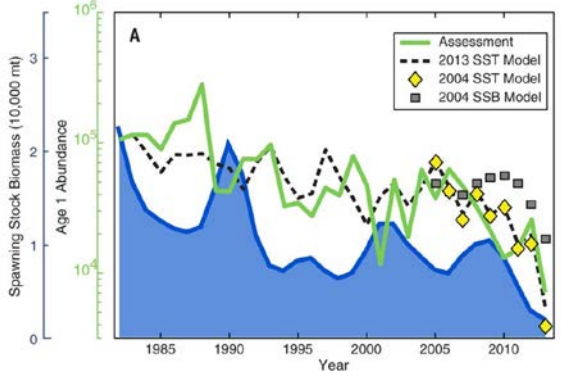


Atlantic Cod Habitat Suability



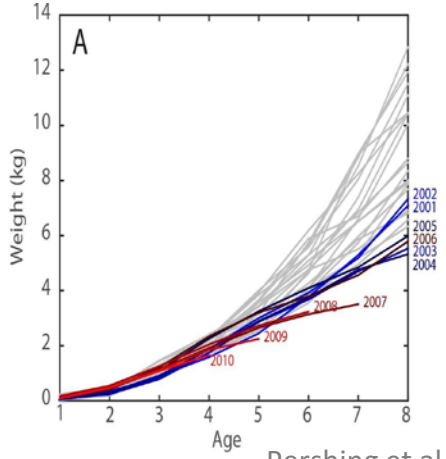
Kleisner et al. 2017

Gulf of Maine Atlantic Cod Recruitment



Fogarty et al. 2008, Pershing et al. 2015

Gulf of Maine Atlantic Cod Weight



Pershing et al. 2016

ToR 2: Fishery Data

ToR 2: Estimate catch from all sources including landings and discards.

- Describe the spatial and temporal distribution of landings, discards, and fishing effort.
- Characterize the uncertainty in these sources of data.

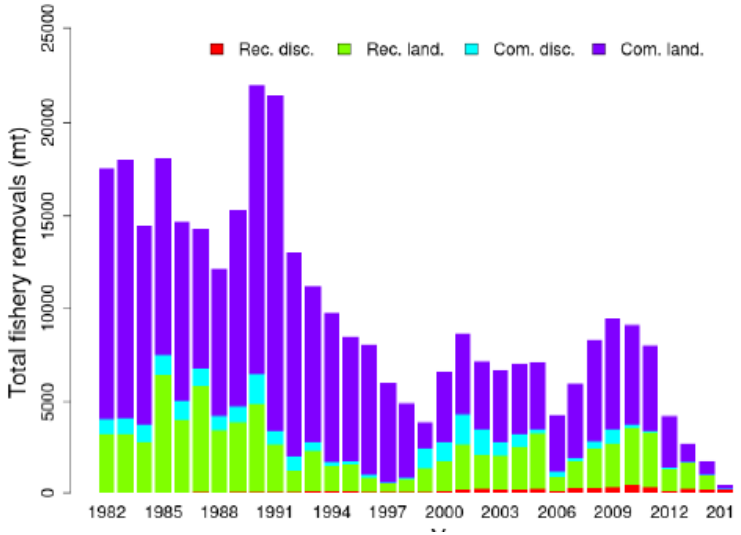
Current Approach:

Gulf of Maine: Commercial landings, Commercial discards, Recreational harvest, Recreational releases.

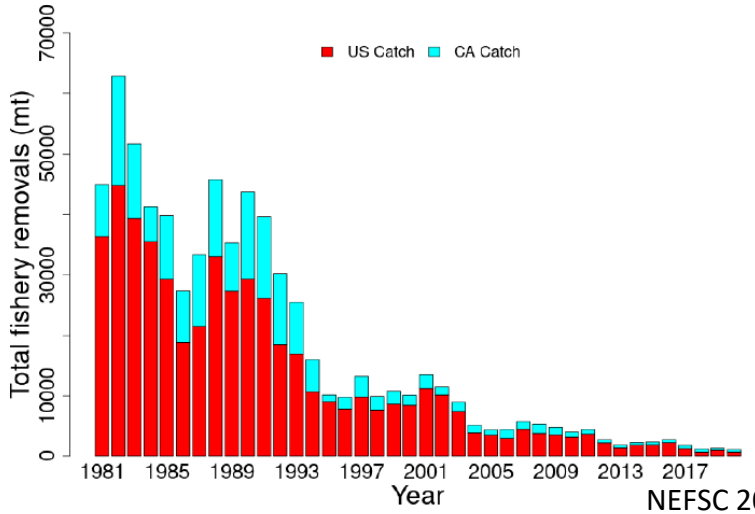
Georges Bank: US and Canadian catch

- Commercial landings
- Commercial discards
- Recreational landings
- Recreational discards

Gulf of Maine cod



Georges Bank cod



ToR 2: Fishery Data

Possible Alternative Approaches and Considerations:

- Evaluate discard mortality rate assumptions.
- Evaluate other sources of bycatch of cod (e.g., lobster fishery bycatch).
- Evaluate potential sources of missing catch.
- Evaluate commercial and recreational catch per unit effort.

ToR 3: Survey Data

ToR 3: Present the survey data used in the assessment (e.g., indices of relative or absolute abundance, recruitment, state surveys, age-length data, application of catchability and calibration studies, etc.) and provide a rationale for which data are used.

- Describe the spatial and temporal distribution of the data.
- Characterize the uncertainty in these sources of data.

Current Approach:

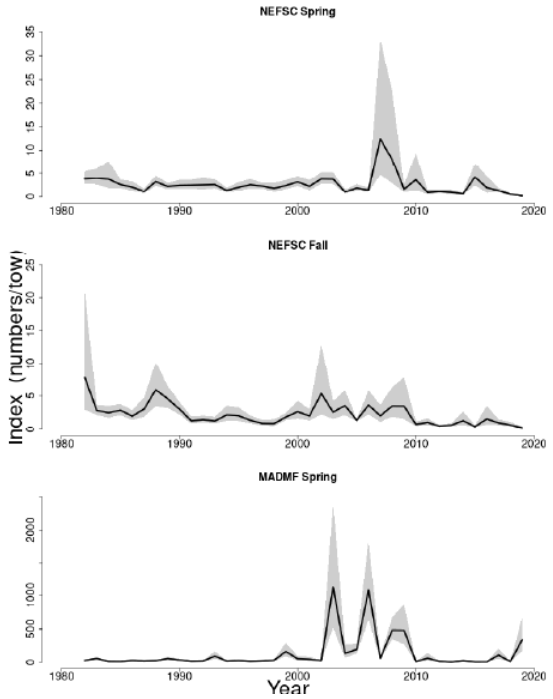
Gulf of Maine:

- NMFS spring and fall bottom trawl surveys
- Massachusetts Division of Marine Fisheries (MADMF) spring bottom trawl survey.

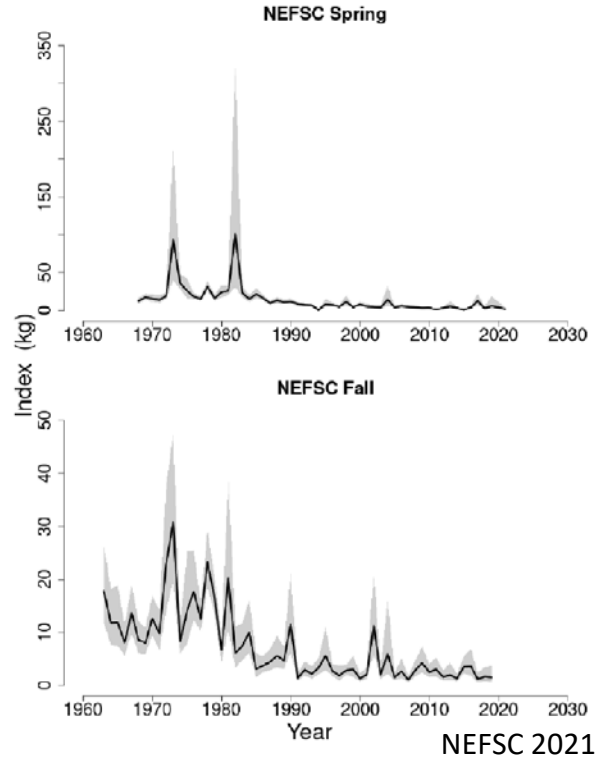
Georges Bank:

- NMFS spring and fall bottom trawl surveys

Gulf of Maine cod



Georges Bank cod

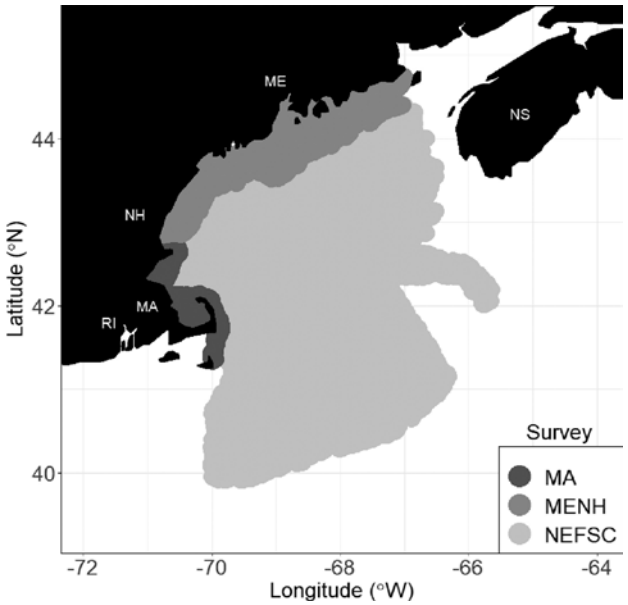


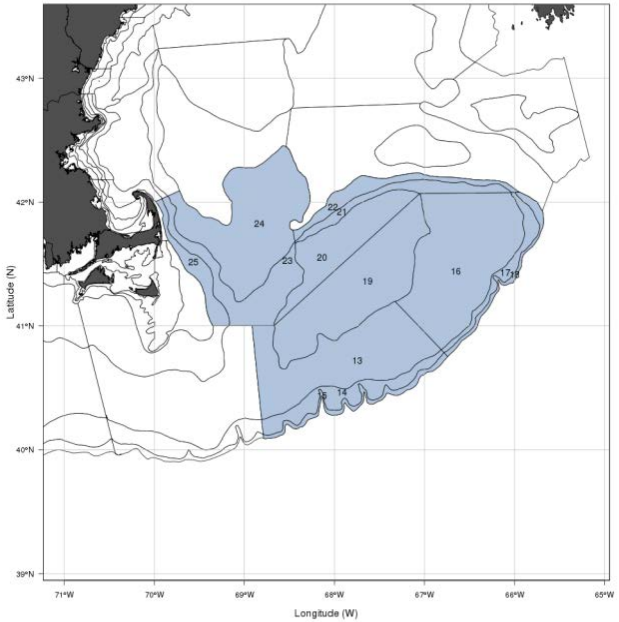
NEFSC 2021

ToR 3: Survey Data

Possible Alternative Approaches and Considerations:

- Consider use of other surveys (e.g., ME-NH trawl survey, sentinel survey, RI trawl survey, longline survey, video trawl survey, industry-based trawl survey).
- Treatment of missing survey data (2020)
- Address discontinuity between the spatial domains of survey data used for the assessment and the fishery (e.g., southern New England waters).
- Consideration of calibration approach- explore split AB and HB time series





ToR 4: Stock Assessment Models

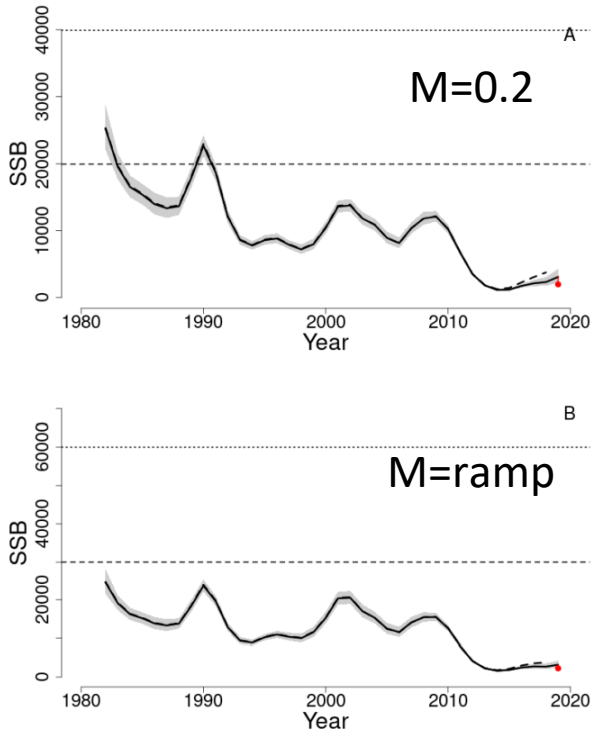
ToR 4: Use appropriate assessment approach to estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series, and estimate their uncertainty.

- Compare the time series of these estimates with those from the previously accepted assessment(s).
- Evaluate a suite of model fit diagnostics (e.g., residual patterns, sensitivity analyses, retrospective patterns), and
  (a) comment on likely causes of problematic issues, and
  (b), if possible and appropriate, account for those issues when providing scientific advice and evaluate the consequences of any correction(s) applied.

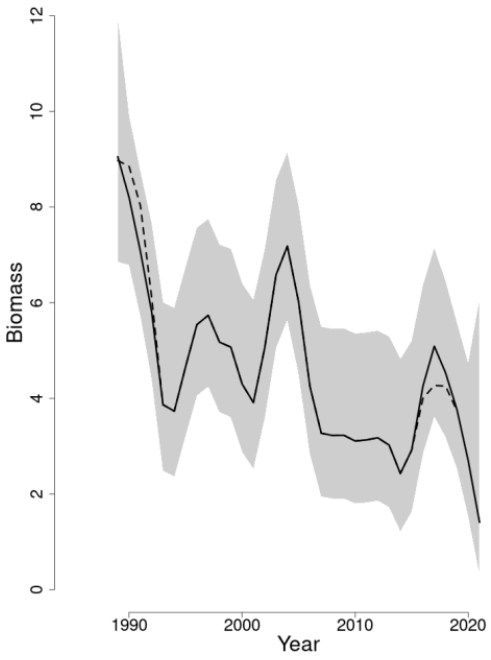
Current Approach:

- **Gulf of Maine cod**
  - SCAA model (ASAP)
  - Two accepted models for catch advice (M=0.2 and M-ramp)
  - Retrospective patterns (adjustment to M=0.2, no adjustment to M-ramp)
- **Georges Bank cod (whole area)**
  - Formerly SCAA model (2014), rejected for management advice due to large retrospective patterns
  - Plan B: Smoothed survey trends

Gulf of Maine cod



Georges Bank cod



ToR 4: Stock Assessment Models

Possible Alternative Approaches and Considerations:

- Alternative models: ASAP, WHAM
- Examine potential underlying causes of retrospective patterns.
- Can an analytical model replace the PlanBsmooth?
- Consider whether it is appropriate to continue with both the M = 0.2 and M-ramp models.
- Explore defining fishery selectivity by individual fleets (e.g., GoM recreational and commercial fleets)
- Examine areas of uncertainty including: stock structure, ecosystem effects, and the veracity of fishery catch data.

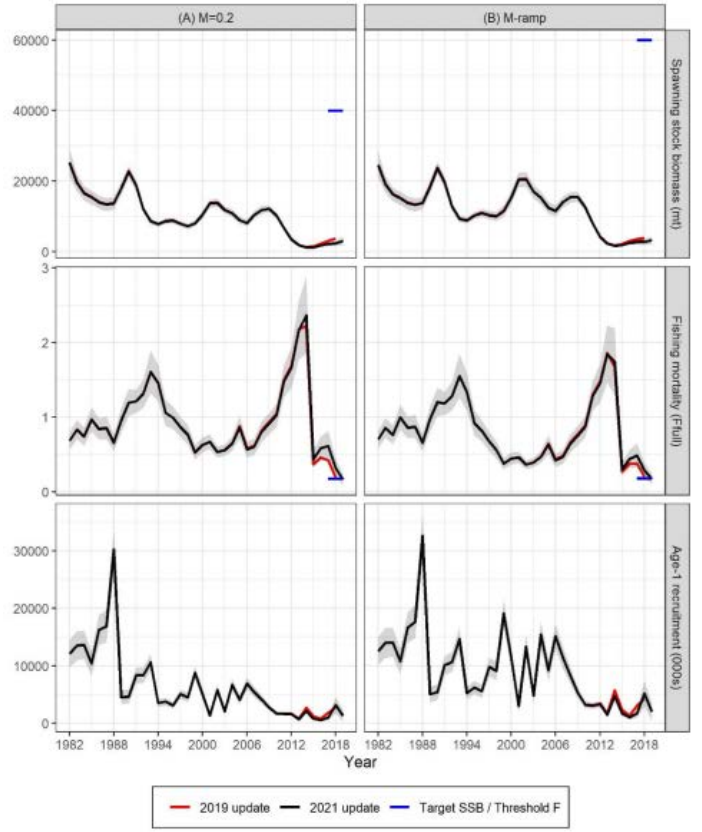
ToR 5: Status Determination Criteria

ToR 5: Update or redefine status determination criteria (SDC; point estimates or proxies for B_{MSY}, $B_{THRESHOLD}$, F_{MSY} and MSY reference points) and provide estimates of those criteria and their uncertainty, along with a description of the sources of uncertainty.

- If analytical model-based estimates are unavailable, consider recommending alternative measurable proxies for reference points.
- Compare estimates of current stock size and fishing mortality to existing, and any redefined, SDCs.

Current Approach:

- **Gulf of Maine Cod:** Overfishing threshold is the F_{MSY} proxy (F40%). The biomass target, (SSB_{MSY} proxy) was based on long-term stochastic projections of fishing at the FMSY proxy.
  - Recruitment sampled from 1982 - 2017.
  - Natural mortality assumed equal to 0.2
- **Georges Bank Cod:** No reference points.

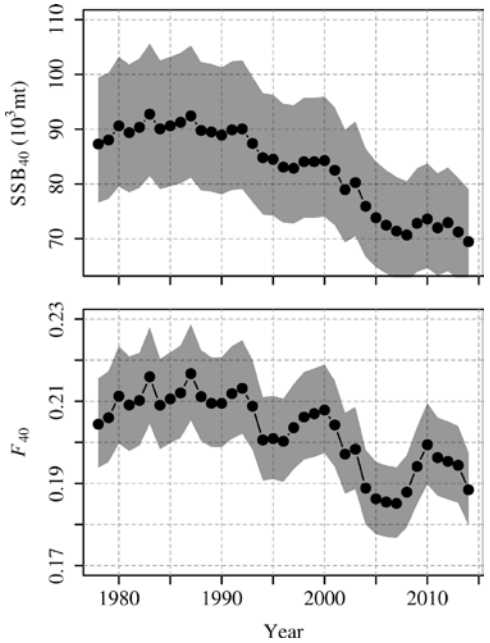


ToR 5: Status Determination Criteria

Possible Alternative Approaches and Considerations:

- Consider ways to adjust biological reference points to deal with changes in natural mortality.
- Evaluate the potential of the stock to recover under the current low productivity regime in the Gulf of Maine.
- Investigate question of how to define targets and thresholds given changing ocean conditions.

Biological reference points (F_{40} and SSB_{40}) from the state-space assessment model with temporal variation in maturity and growth.



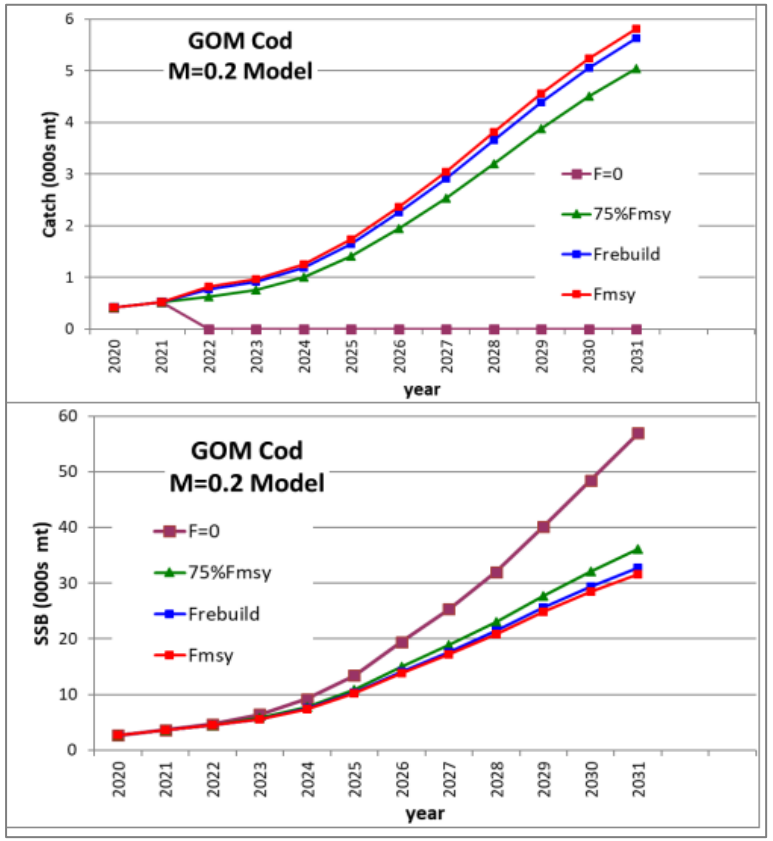
Miller et al. 2018

ToR 6: Projections

ToR 6: Define appropriate methods for producing projections; Provide justification for assumptions of fishery selectivity, weights at age, maturity, and recruitment; and comment on the reliability of resulting projections considering the effects of uncertainty and sensitivity to projection assumptions.

Current Approach

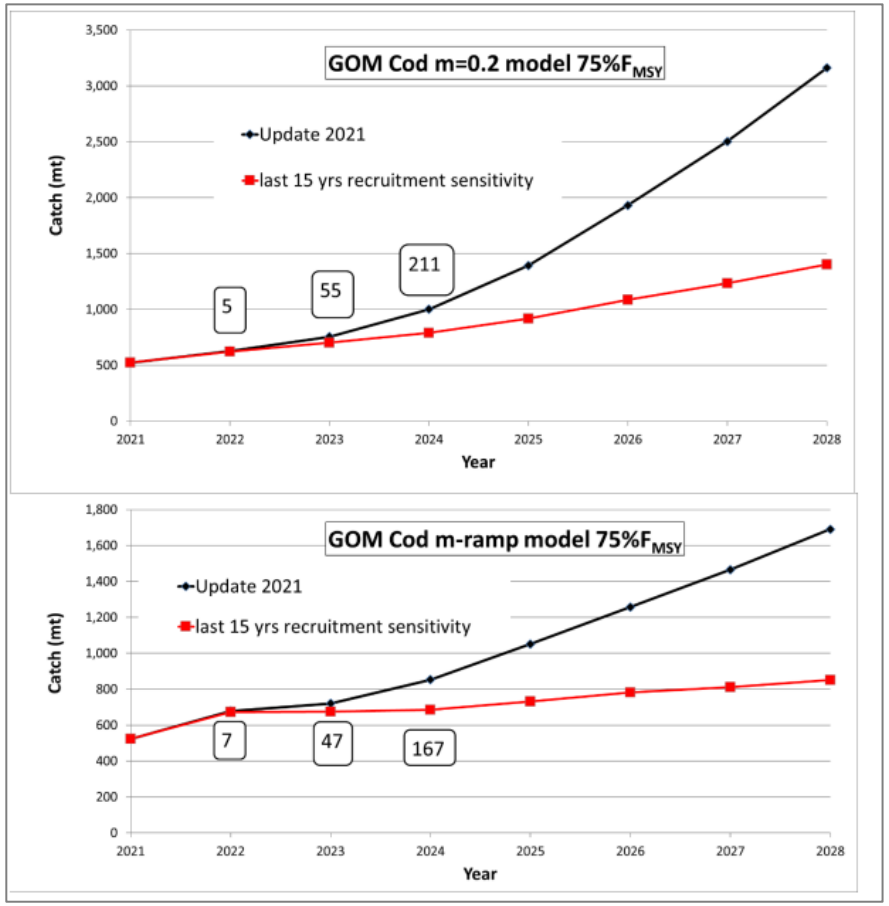
- **Gulf of Maine Cod:** Short term projections were based on a harvest scenario of fishing at the F_{MSY} proxy between 2022 and 2024.
  - Recruitment was sampled from a cumulative distribution function between 1982-2017. (2020 recruitment = geometric mean of the 2015-2019 estimates)
  - For the M-ramp model, projections are shown under the assumption of M=0.4 short-term natural mortality.
- **Georges Bank:** No projections computed with PlanBsmooth.



ToR 6: Projections

Possible Alternative Approaches and Considerations:

- Evaluate tendency for over-predictions of SSB in previous projections.
- Evaluate the appropriate recruitment time series, or autocorrelation factor, to use for the projections.
- Consider the impact of changing ocean conditions on aspects of stock productivity (natural mortality and recruitment) and its impact on the projections.



ToR 7: Research Recommendations.

ToR 7: Review, evaluate, and report on the status of research recommendations from the last assessment peer review, including recommendations provided by the prior assessment working group, peer review panel, and SSC.

- Identify new recommendations for future research, data collection, and assessment methodology.
- If any ecosystem influences from TOR 2 could not be considered quantitatively under that or other TORs, describe next steps for development, testing, and review of quantitative relationships and how they could best inform assessments.
- Prioritize research recommendations.

Documents Reviewed to Date:

- 2021 Management Track Peer Review Panel Report
- NEFSC 2021 Management Track Assessment Reports
- SSC report 2021
- Summary of May 20, 2021 Assessment Oversight Panel Meeting

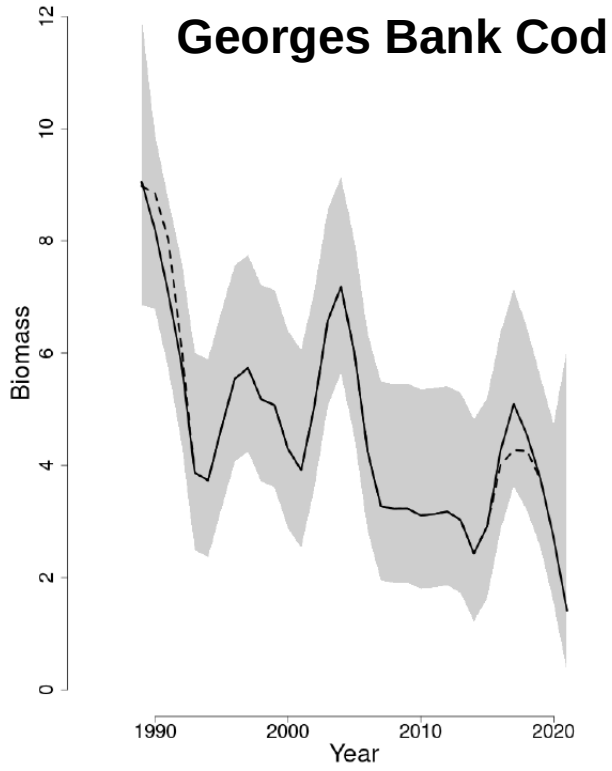
Atlantic Cod Research Recommendations				
Stock	**Research Recommendations**	**Relevant to ToR**	**Source**	**Response from WG**
Gulf of Maine Cod	**Survey Indices:** Use of the Longline survey, and other surveys, in the assessment	ToR 2	2021 Management Track Peer Review Panel Report	
Gulf of Maine Cod	**Assumptions of Assessment Model:** Defining fishery selectivity by individual fleets (e.g. recreational and commercial fleets) or allowing for an annual selectivity curve that accounts for the changing patterns as the catch composition shifts from commercial to recreational and recreational discards over time.	ToR 4	2021 Management Track Peer Review Panel Report	
Gulf of Maine Cod	**Catch Information:** Impact of underestimation of age-2 catch, particularly with regards to the recreational fishery or bycatch in lobster and other fisheries.	ToR 2	2021 Management Track Peer Review Panel Report	
Gulf of Maine Cod	**Assessment Model:** Consider whether it is appropriate to continue to both the M = 0.2 and M-ramp models (perhaps consider the potential for weighting the two-models like in an ensemble approach).	ToR 4	2021 Management Track Peer Review Panel Report	

ToR 8: Back-up Assessment Approach

ToR 8: Develop a backup assessment approach to providing scientific advice to managers if the proposed assessment approach does not pass peer review or the approved approach is rejected in a future management track assessment.

Current Approach:

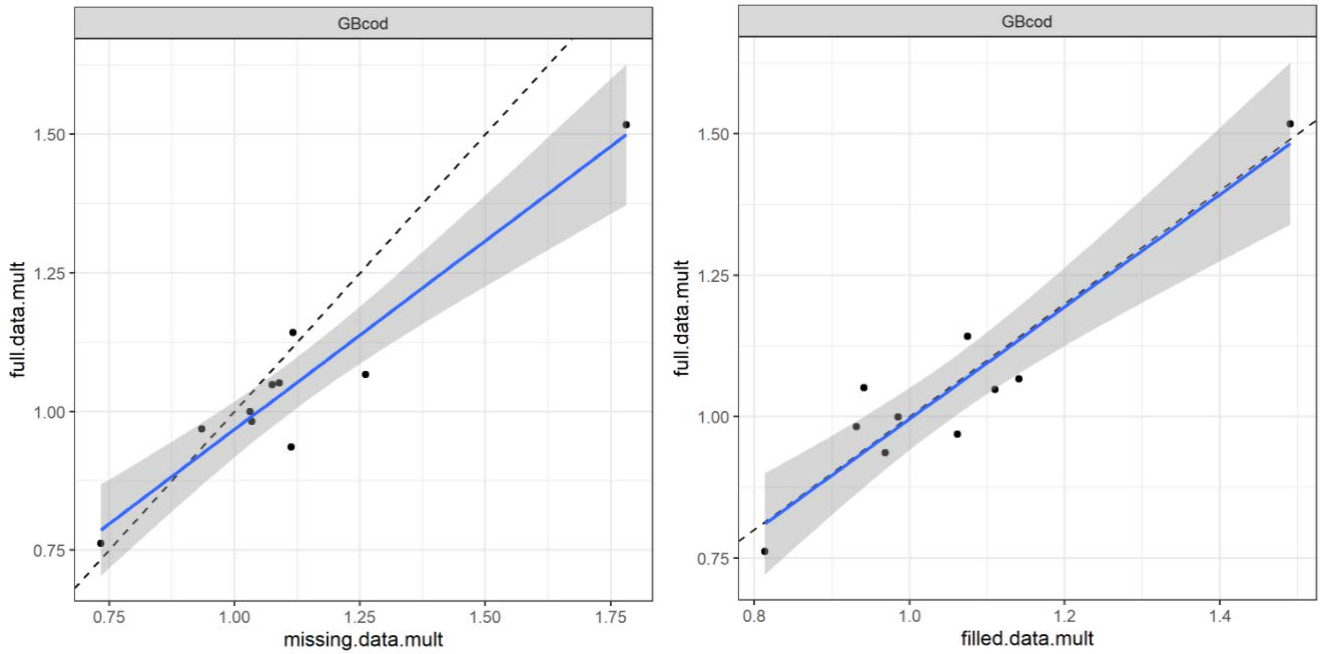
- Plan Bsmooth is applied to Georges Bank Cod
  - **PlanBsmooth** approach estimates the rate of change in the recent three years of the smoothed survey biomass. This multiplier is applied to the average of the recent three years of catch to produce the catch advice.
- TRAC: DLM tool application to E. Georges Bank cod



ToR 8: Back-up Assessment Approach

Possible Alternative Approaches and Considerations:

- Explore alternative methods.
- Evaluate uncertainties associated with missing data (2020 survey data) on Plan B method.
- Concern regarding potential for the PlanBsmooth approach to be chasing noise in the survey index, particularly for a stock at low abundance.



GitHub - cmlegault/PlanBsmooth_missing_data

Draft ToR 9: Stock Structure

Draft ToR 9: Apply the findings of the Atlantic Cod Stock Structure Working Group and consider what assessment approaches the available data can support in defining the appropriate scale of Atlantic cod stock assessment. Consider implications for management processes and other practical limitations in the final definition of stock boundaries.

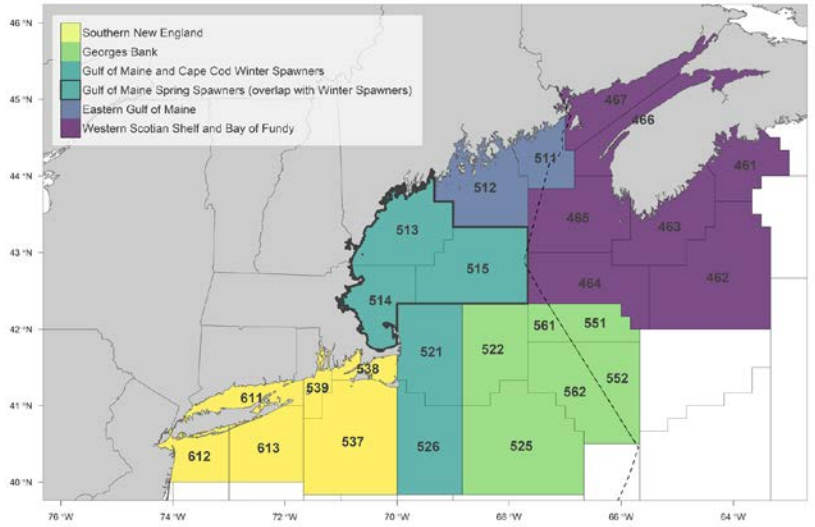
NOAA Technical Memorandum NMFS-NE-XXX

An Interdisciplinary Review of Atlantic Cod (*Gadus morhua*) Stock Structure in the Western North Atlantic Ocean

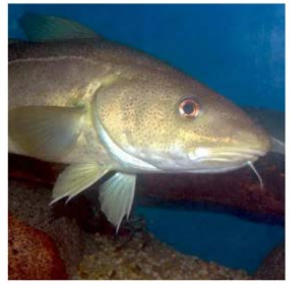
Richard S McBride[1] and R Kent Smedbol[2] (Editors)
[1]National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543
[2] Fisheries and Oceans Canada, Government of Canada

US DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Fisheries Science Center
Woods Hole, Massachusetts
Month Year

5 Biological Units



2021 Atlantic Cod Stock Structure Workshops



In 2020, a report by the Atlantic Cod Stock Structure Working Group (ACSSWG) concluded that the population structure of Atlantic Cod in New England waters consists of **five distinct biological stocks, instead of the two that are currently managed**. This conclusion requires a re-thinking of the current science and management approaches to the fishery. (Download a draft summary of the ACSSWG's peer-reviewed conclusions, here.)

These 2021 Atlantic Cod Stock Structure Workshops, supported by the New England Fishery Management Council (NEFMC), NOAA's Northeast Fisheries Science Center (NEFSC), and NH Sea Grant, present a two-pronged approach developed to incorporate new stock definitions into existing science and management structures. Workshops will focus on **(a) Science/Assessment Prospects** and **(b) Management**. Each workshop will feature presentations by technical experts followed by discussions open to the public (outlined below) to ensure complete information is available to best inform the cod stock assessment process.

Summary of Progress

Approach to ToRs		
1	**Larger-scale issues and recommendations that influence how we approach other ToRs**	ToR 7. Review, evaluate, and report on the status of research recommendations…
		ToR 9. Stock structure
		ToR 1. Identify relevant ecosystem and climate influences on the stock...
2	Data work	ToR 2. Estimate catch from all sources including landings and discards…
		ToR 3. Present the survey data used in the assessment…
3	Assessment work	ToR 4. Use appropriate assessment approach to estimate annual fishing mortality, recruitment and stock biomass…
		ToR 8. Develop a backup assessment approach…
4	Biological reference points and projections	ToR 5. Update or redefine status determination criteria…
		ToR 6. Define appropriate methods for producing projections…

Summary of Progress

ToR 1: Ecosystem and climate influences on stock

- Initial organizing meeting
- Follow-up meeting on defining work plan for literature review
- Initiated work on literature review

ToR 7: Research Recommendations

- Initiated synthesis of research recommendations

ToR 9: Stock Structure

- Reviewed Atlantic cod stock structure working group results
- Synthesized and reviewed data available to support stock assessments of Atlantic cod
- Submitted draft ToR 9 on Stock Structure to NRCC for review
- WG developed recommendations on spatial scale of assessment to be shared with NEFMC.

Summary of Progress: Synthesis of Data Availability

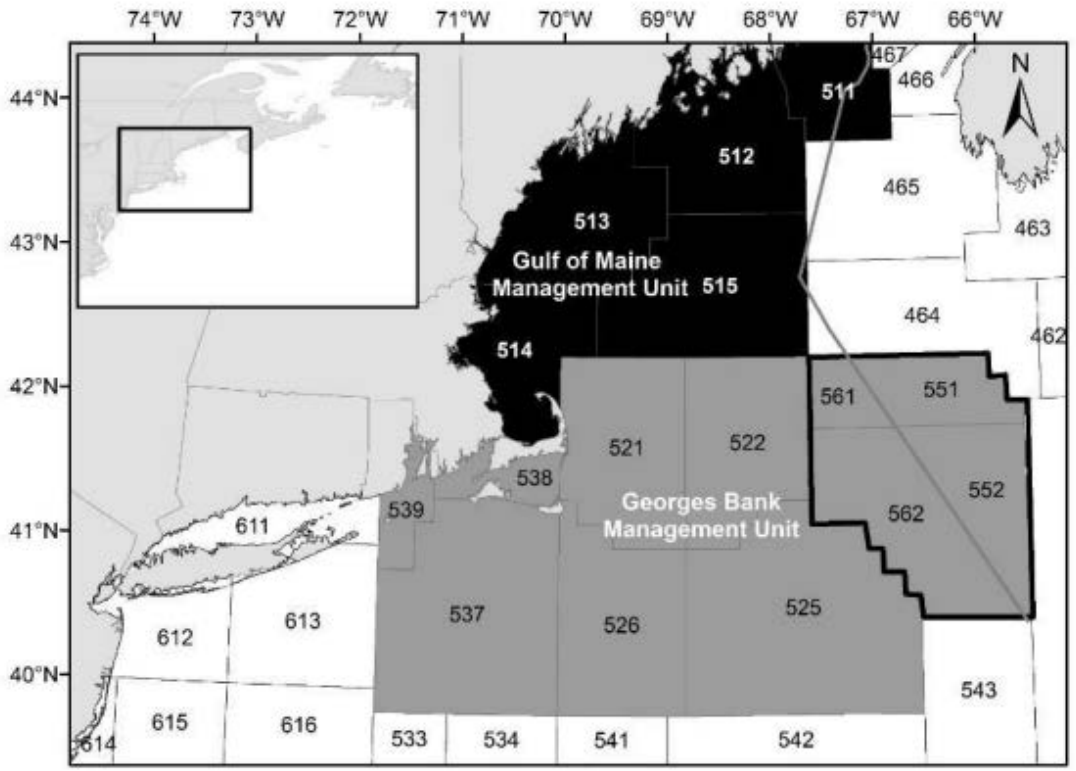
WG synthesized the data available to support assessments that increase the alignment between the scale of stock assessment and biological stock structure of cod.

- Indices of Abundance
- Fishery Catch Data
- Assessment Models

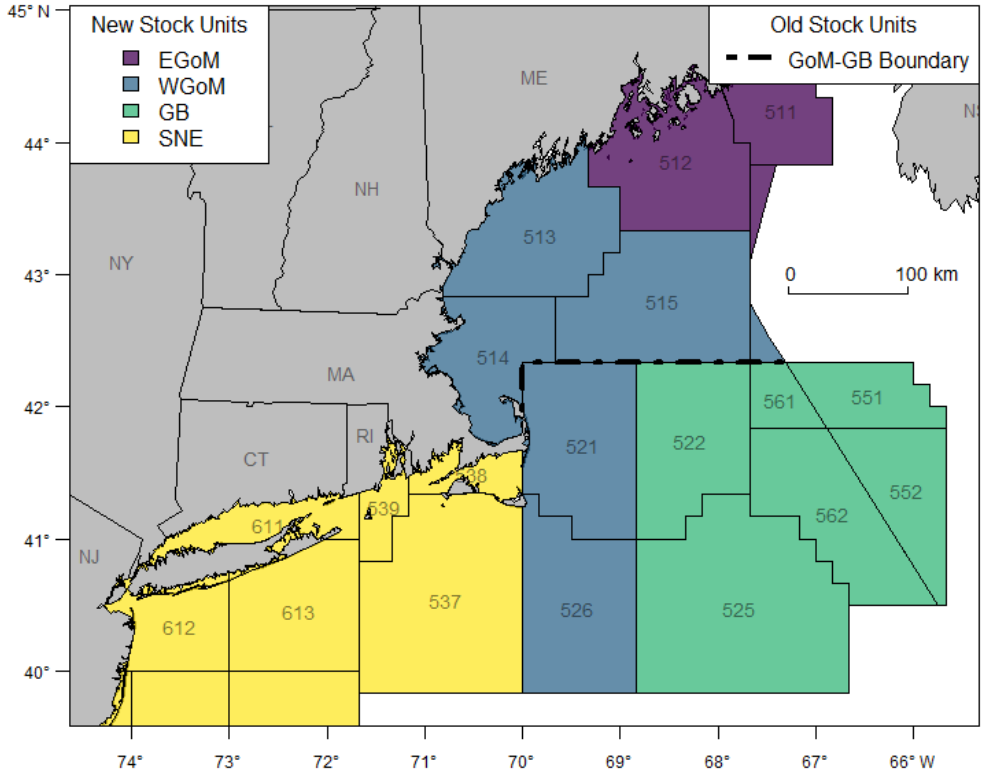
Biological Units	Indices of abundance			
	Data type	Data source	Ages sampled	Timespan
EGoM	Fishery independent	ME/NH trawl survey	Primarily ages 0 & 1	2000+
	Fishery independent	NMFS trawl survey	Ages 0-9+	1963+
	Fishery independent	Eastern Gulf of Maine Sentinel Survey	Primarily ages 1 - 4	2012+
	Fishery dependent	Commerical LPUE	Primarily ages 2-7	1996+ (prior to 1996 available)
WGoM (spring/winter)	Fishery independent	MADMF trawl survey	Primarily age 0	1978+
	Fishery independent	NMFS trawl survey	Ages 0-9+	1963+
	Fishery independent	ME/NH trawl survey	Primarily ages 0 & 1	2000+
	Fishery independent	NMFS Northern Shrimp Trawl Survey	Ages 0 - 9+	1984+
	Fishery independent	NMFS Bottom Longline Survey	Ages 1 - 9+	2014+
	Fishery independent	MADMF Cod Industry Based Survey	Ages 0 - 9+	2003-2007, 2016-2019
	Fishery dependent	Commerical Study fleet/Observer CPUE	Primarily ages 2-9	2010+
	Fishery dependent	Commercial LPUE	Primarily ages 2-9	1996+
	Fishery dependent	Open cod end survey	Ages 0+	2016-2022
	Fishery dependent	Recreational data-VTR		

Summary of Progress: WG Recommendations on Scale of Stock Assessment

Current: 2 Stock Units



Proposed: 4 Stock Units



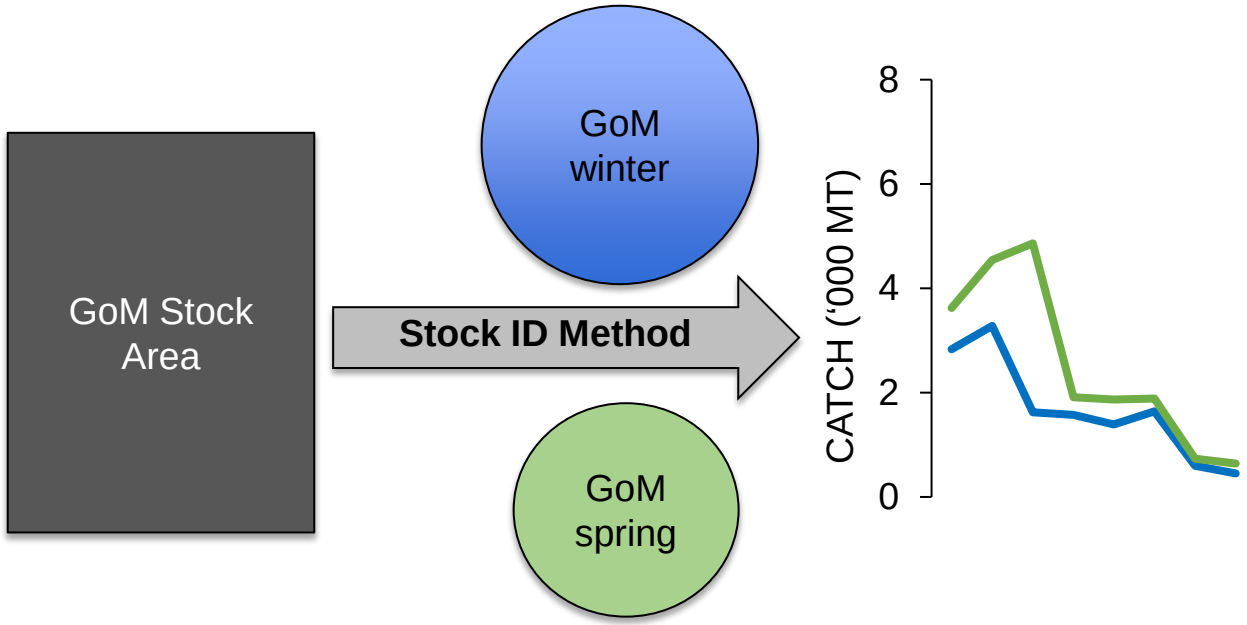
Goal: Improve alignment between the scale of cod stock assessment and biological stock structure.

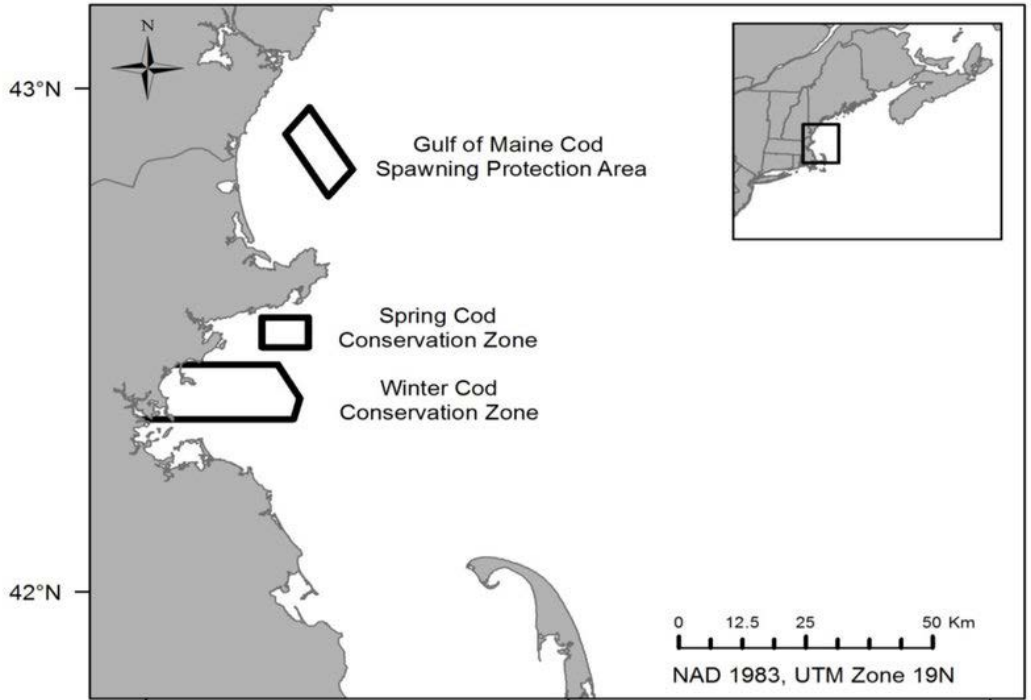
Summary of Progress: WG Recommendations on Mixed Stocks (Winter/Spring spawners)

Do we want to monitor ? Formally assess? Or manage to preserve population diversity?

Mixed stock composition: Application of stock ID to determine origin of fish which can inform assessment and management.

Spawning closures: time/area spawning closures aimed at aimed at preventing overexploitation of sub-populations when “lumped” in a management area.





Pathway for Decision Making on Cod Stock Structure

The goal is for this to be a joint decision made by the cod research track working group and the NEFMC, NEFSC, and GARFO with the working group leading the way on defining what is possible and there being ongoing communication across these entities to identify any issues early in the process.

Next Steps

- Stakeholder engagement meeting: Feb. 9 (1 – 3 pm)
- Next working group meeting: February 11, 2022

WG Approach to ToRs		
1	Larger-scale issues and recommendations that influence how we approach other ToRs	ToR 7. Review, evaluate, and report on the status of research recommendations…
		ToR 9. Stock structure
		ToR 1. Identify relevant ecosystem and climate influences on the stock...
2	Data work	ToR 3. Present the survey data used in the assessment…
		ToR 2. Estimate catch from all sources including landings and discards…