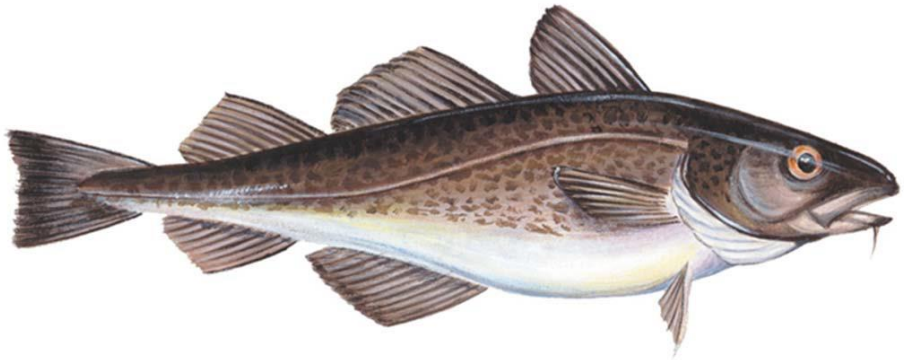
Technical Briefing



3Ps cod modeling framework & stock assessment

Newfoundland & Labrador
January 8, 2020

About this Meeting

Canadian Science Advisory Secretariat (CSAS) introduction.

CSAS Peer Review Process

- Objective is to provide sound, objective and impartial science advice.

- The issue of resource allocation is strictly a Resource Management consideration, and as such will not be part of the discussions at today's technical briefing.

- Resource allocation considerations will be discussed at the upcoming consultations led by DFO's Resource Managers.

Outline for today's Technical Briefing

- The Department's lead Stock Assessment Biologist for 3Ps cod will present the conclusions from the peer reviewed stock assessment meeting.

- Followed by question and answer period.

- Same presentation will then be given to media outlets.

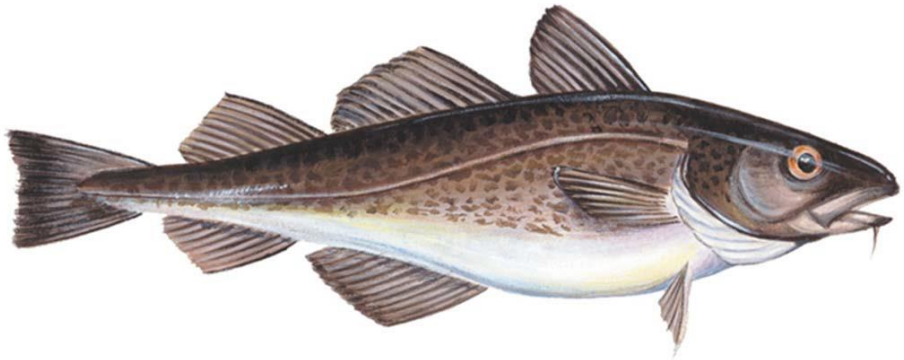
- To be added to the speakers list, please message Dale with the CSAS Office via WebEx chat forum or send her an e-mail.

- If you run into any technical difficulties, you can also e-mail or message Dale for assistance.

Guidelines for Respectful Meeting

1. Listen to the entire message, without interrupting.
2. Explain why you agree or disagree.
3. Maintain a respectful tone and volume when sharing opinions.
4. Be respectful of time when making comments.
5. Value the many different sources of knowledge in the room.
6. Turn off your webcam and mute your phone until ready ask a question during the Q&A period. If you're on a landline, you can mute your telephone by pressing *6 and unmute by pressing *7.

Technical Briefing



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Outline

- Purpose of this briefing
- Science advice & the precautionary approach
- New assessment model and Limit Reference Point
- Assessment of 3Ps cod
- Key factors
- Stock status
- Projections
- Advice & next steps

Purpose of this briefing

- In October 2019, DFO held a Canadian Science Advisory Secretariat (CSAS) modeling framework meeting to evaluate stock assessment models for 3Ps cod. Data inputs decided at a previous meeting.
- In November 2019, a regional peer review (RPR) meeting used the model to assess the status of the 3Ps cod stock.
- Both peer-reviewed meetings were attended and assessed by independent, external scientific reviewers.
- This presentation will describe the results of those meetings, as well as the advice provided to fisheries managers. **This stock is co-managed by Canada and France.**

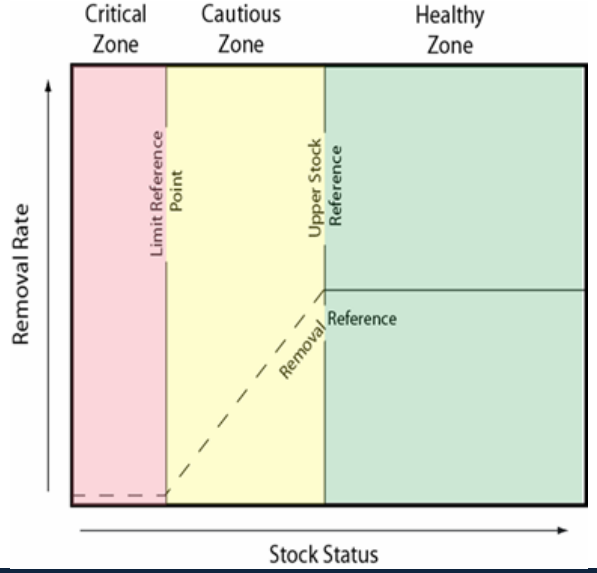
What is CSAS?

A national body that oversees the review and provision of science advice to inform DFO management decisions. Specifically, this group helps organize meetings where DFO scientists, biologists and others, including fish harvesters, university researchers, and other technical experts get together to review scientific information and help inform how commercial fish stocks are managed.

Science Advice & the Precautionary Approach

- The precautionary approach is a management framework used to determine catch limits and/or other management measures with the intention to:
  - keep removals moderate when stocks are healthy;
  - promote rebuilding when stocks are low; and,
  - ensure low risk of harm to the stocks.

- DFO science identifies the limit reference point and provides an estimate of stock size in relation to the precautionary approach framework.



- **Limit reference point:** boundary between the critical and cautious zones, and represents the stock status below which serious harm is occurring to the stock. Fishing is to be kept to the lowest possible level below the LRP.
- **Upper stock reference:** boundary between the cautious and healthy zones, and represents a threshold below which catch must be progressively reduced in order to avoid reaching the limit reference point.

Some Definitions

- **Spawning stock biomass** (tonnes) is the weight of mature fish.

- **Recruitment** is the number of young fish (age 2) that will contribute to the stock in the future.

- **Total mortality** is all the deaths from the stock including fishing (F) and natural sources (M).

Summary: Modeling framework/Limit Reference Point

- A custom model using multiple sources of data was determined to be the best approach for modeling 3Ps cod and it was decided to assess the stock going forward using this model.

- The new model is the result of collaboration between France and Canada and is considered a substantial improvement upon the previous model.

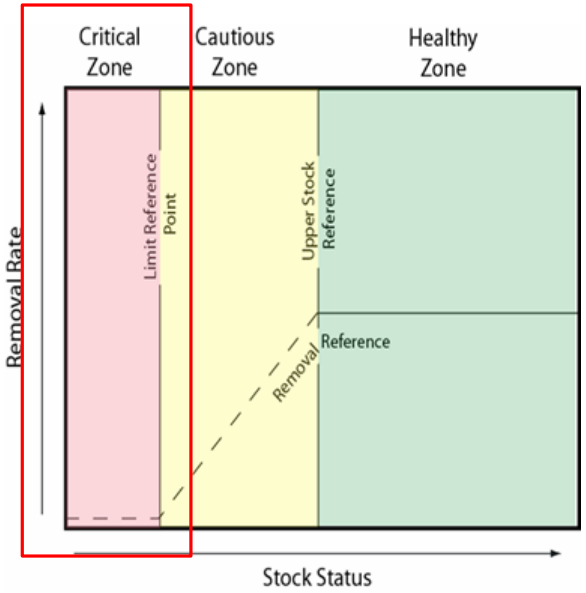
- A new limit reference point was also chosen based on the stock productivity.

Summary: New Model Results

- Natural mortality rates over the last four years have been at the highest levels estimated.
- This year, natural mortality is approximately three times that of fishing mortality.
- While fishing mortality has increased slightly since 2010, it is estimated to be relatively low compared to natural mortality.
- Recruitment has been below the long-term average since the mid-1990s, indicating that fewer young fish have been produced recently.

Summary: Stock Status

- The new model and revised Limit Reference Point indicate that **the 3Ps stock is currently in the critical zone.**



Summary: Future of the Stock

- Under various fishing scenarios, there is a high probability (>99%) that the stock will remain in the critical zone between 2020 and the beginning of 2022.

AN IMPROVED APPROACH: NEW ASSESSMENT MODEL

Framework Meeting (October 2019)

- The CSAS peer review process includes periodic evaluation of existing assessment models with the primary purpose of achieving the best possible model for estimating the dynamics of a stock.

- Previously a meeting was carried out to determine data to be used in the modeling.

- The framework meeting evaluated multiple models for 3Ps cod.

- Development of the new assessment model was a significant, multi-year undertaking requiring highly specialized technical skills and dedicated resources. This included substantial collaboration with France and the Marine Institute.

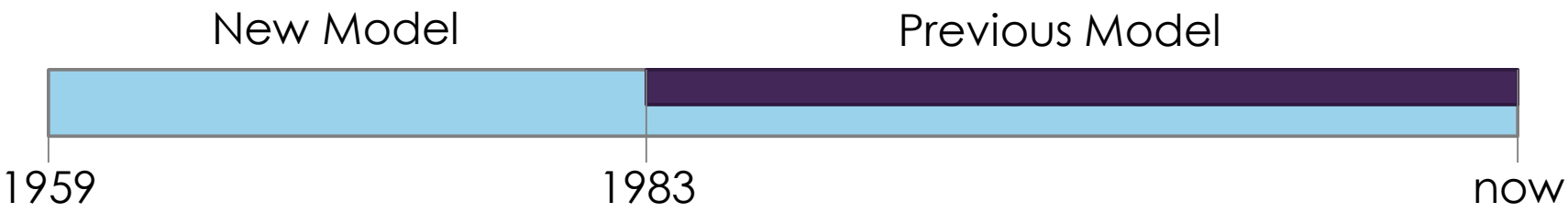
- Independent external experts in fisheries science attended and reviewed the science at this meeting.

Why a New Assessment Model?

- The previous model was unable to estimate both fishing and natural mortality (could not provide catch advice).
- Additionally, this model used only DFO bottom trawl survey data from 1983 onward.
- The new model incorporates more data across a longer time series: this includes commercial landings back to 1959, research surveys by DFO, France, and industry, plus sentinel surveys of the inshore. It can also estimate fishing and natural mortality.
- The new model informs natural mortality by including information on the biological condition of cod.

What's Included in the New Model?

Time series:



Data Inputs:

DFO RV Survey	GEAC Industry Survey	Inshore Sentinel Linetrawl Survey
Commercial Fishery Catch	French ERHAPS Survey	Inshore Sentinel Gill Net Survey

New model

- It was agreed at the Framework meeting to use this new model going forward to assess 3Ps cod.

- This decision was endorsed by the three independent scientific reviewers present at the meeting.

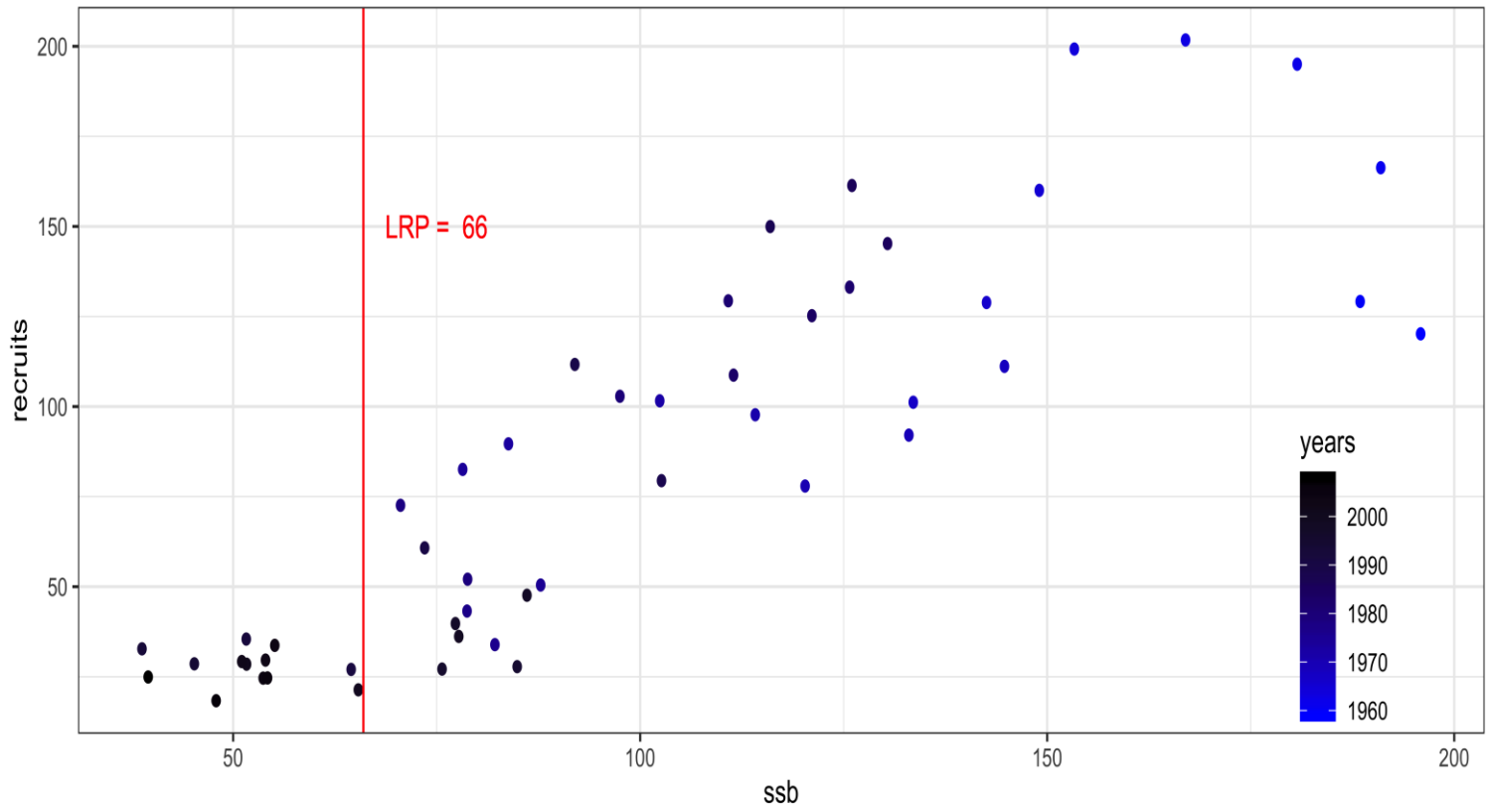
New Limit Reference Point (LRP)

- The former LRP was based on the lowest spawning stock biomass (SSB) from which the stock recovered (1994). It is more appropriate to use an LRP based on stock productivity.

- A new LRP determined at the 3Ps assessment is based on the relationship between SSB and recruitment estimated from the model.

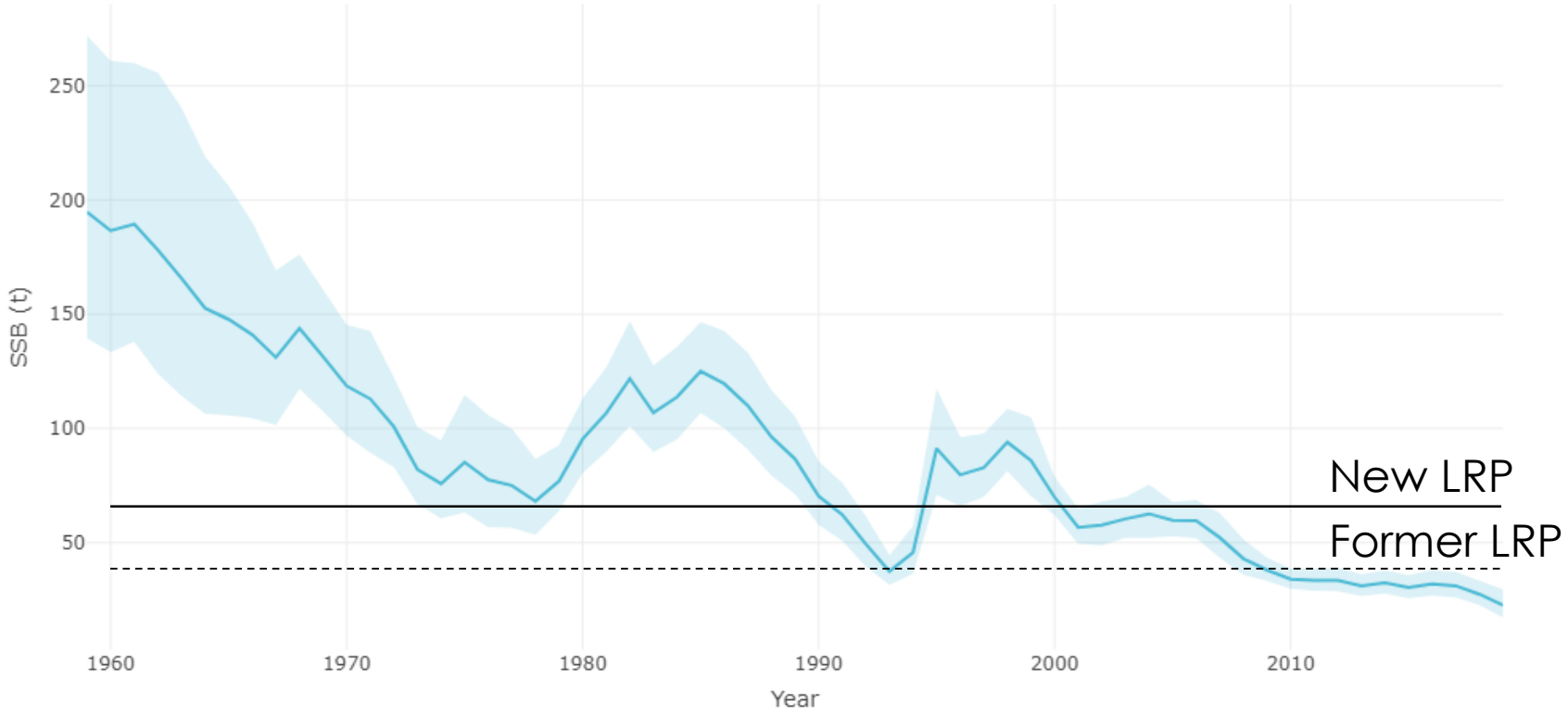
- The LRP is 66,000t of SSB.

New LRP Data


LRP = 66
recruits
ssb
years
2000
1990
1980
1970
1960
200
150
100
50
50
100
150
200

New Model LRP Definition

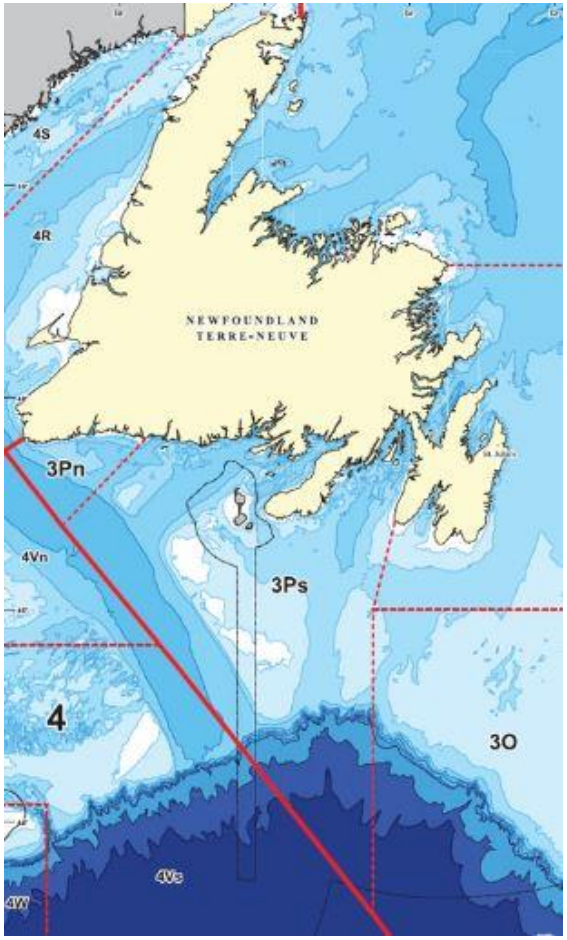
- The Limit Reference Point was redefined based on the connection between adult stock size and expected number of recruits – a more appropriate biological reference.



HOW WE ESTIMATE STOCK SIZE

Using the new model: the science behind our advice

3Ps Cod Areas



- Stock covers NAFO Subdivision 3Ps – extends from Cape St. Mary's to just west of Burgeo Bank, and over St. Pierre Bank, and most of Green Bank.
- Multispecies survey – annual in spring.
- Random sampling by depth across the stock area of 3Ps cod.

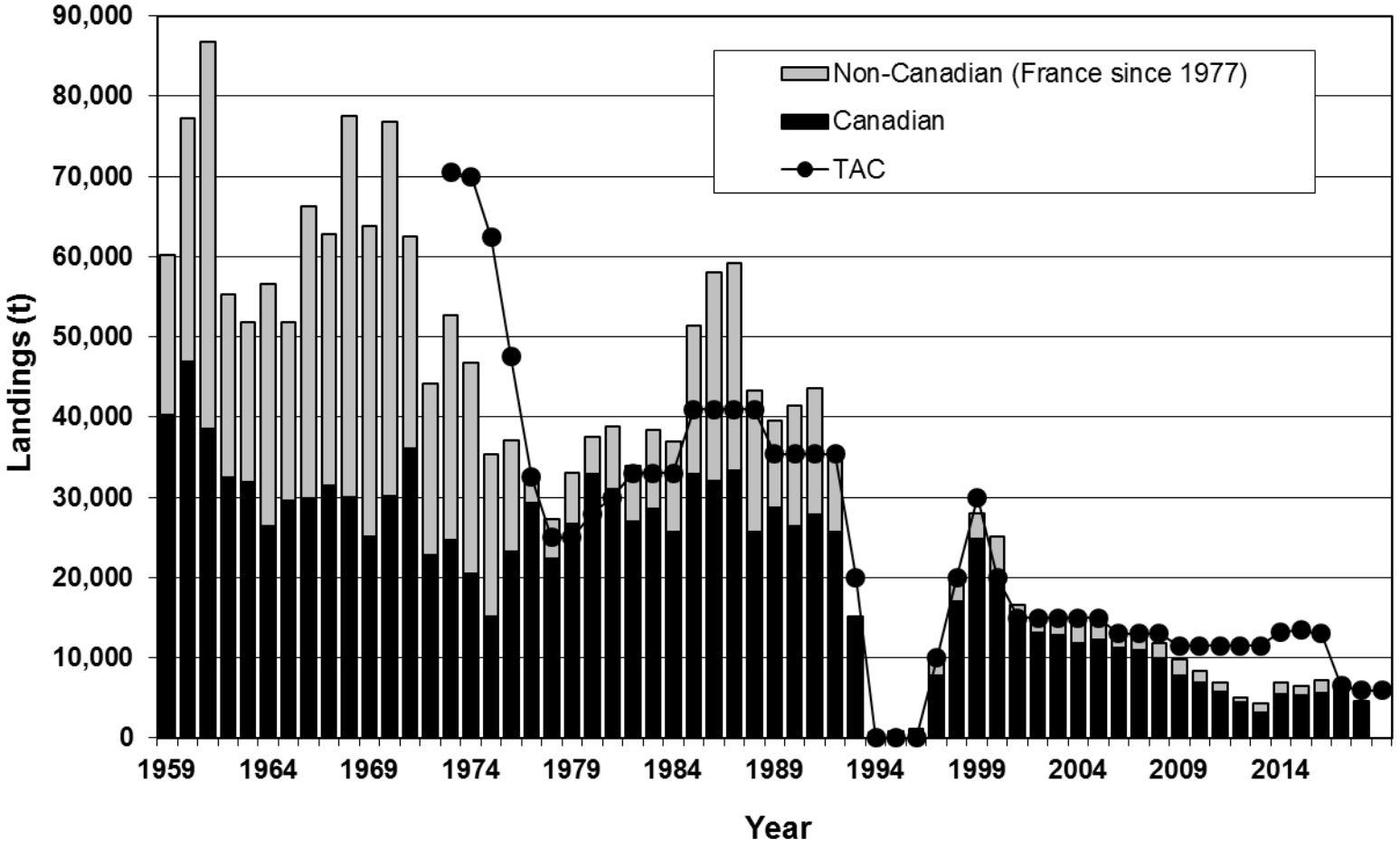
Fishery Data

- Total Allowable Catch (TAC) is shared with France with respect to St. Pierre and Miquelon.

- Total reported landings in 2018-19 were 4,700t compared to 5,000t in 2017-18.

- The TAC for 3Ps cod has not been harvested in full for a decade.

Reported Landings

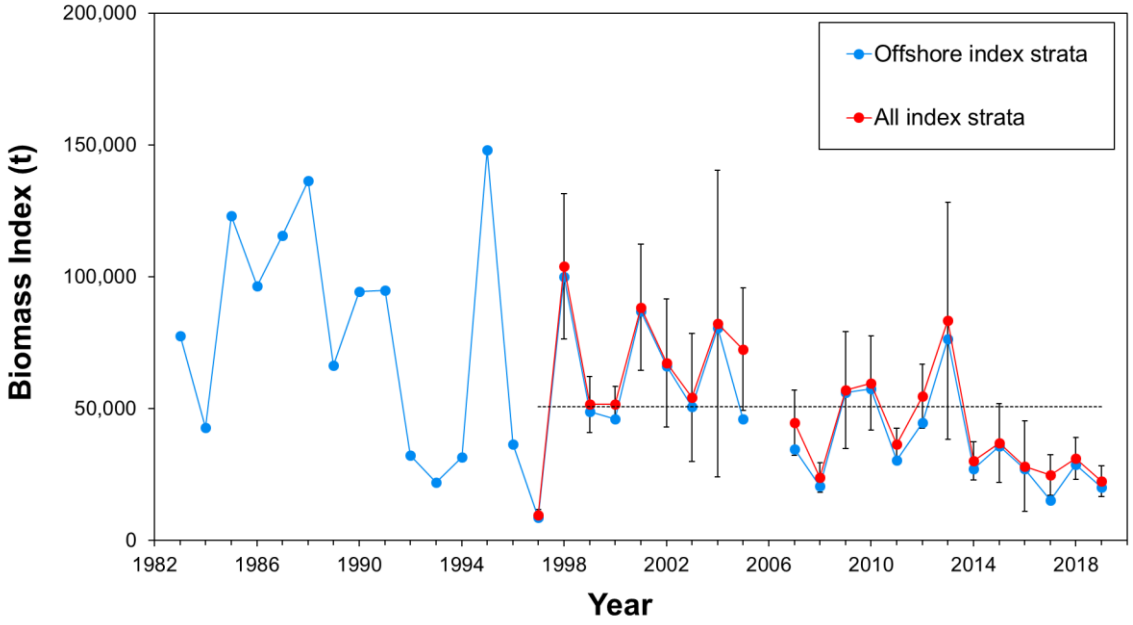


Multispecies Survey

- Number, weight of cod at each tow.

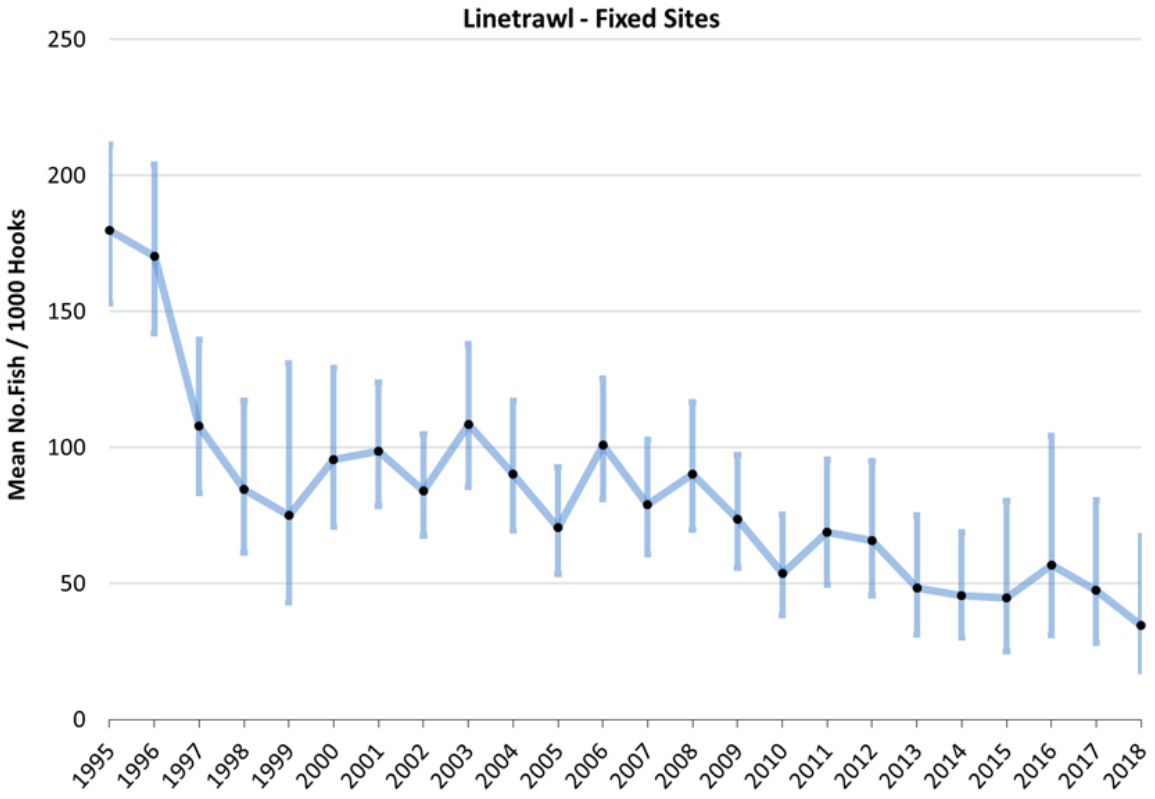
- Also collect otoliths (age), maturity information, diet, etc.

- Forms annual index of abundance and biomass.



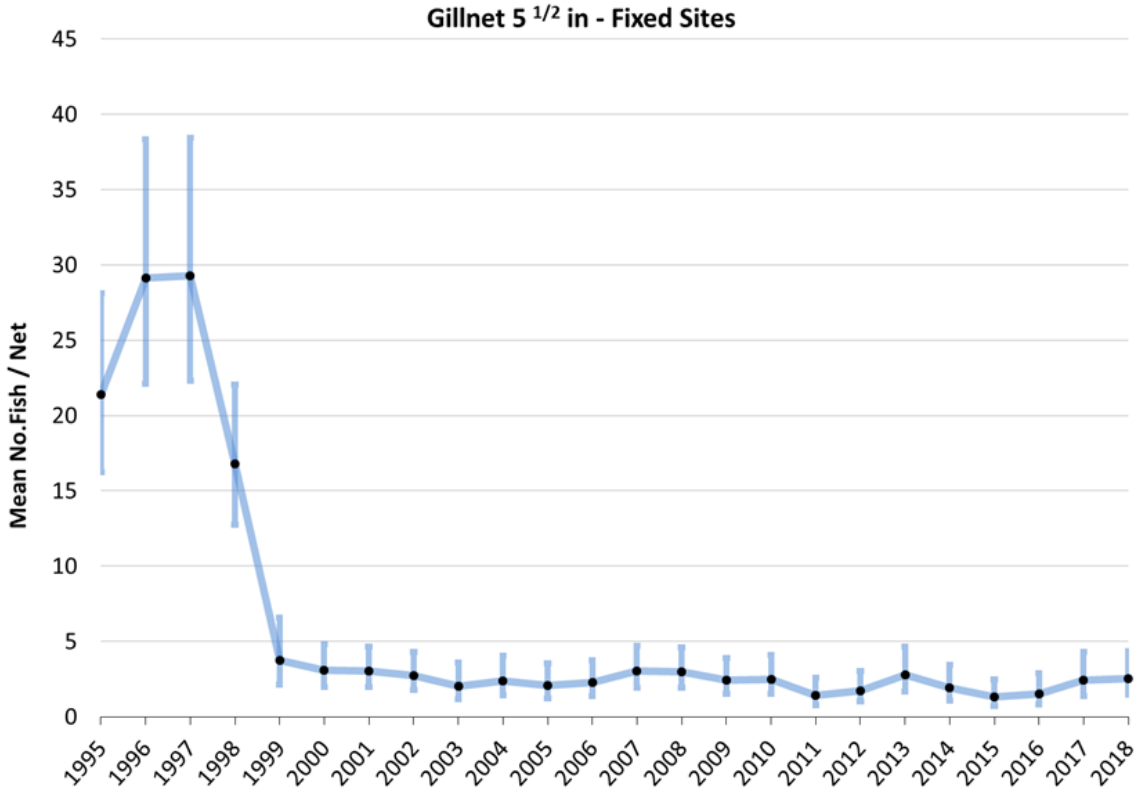
Sentinel Index Data – Linetrawl

- The index has shown decline over time.

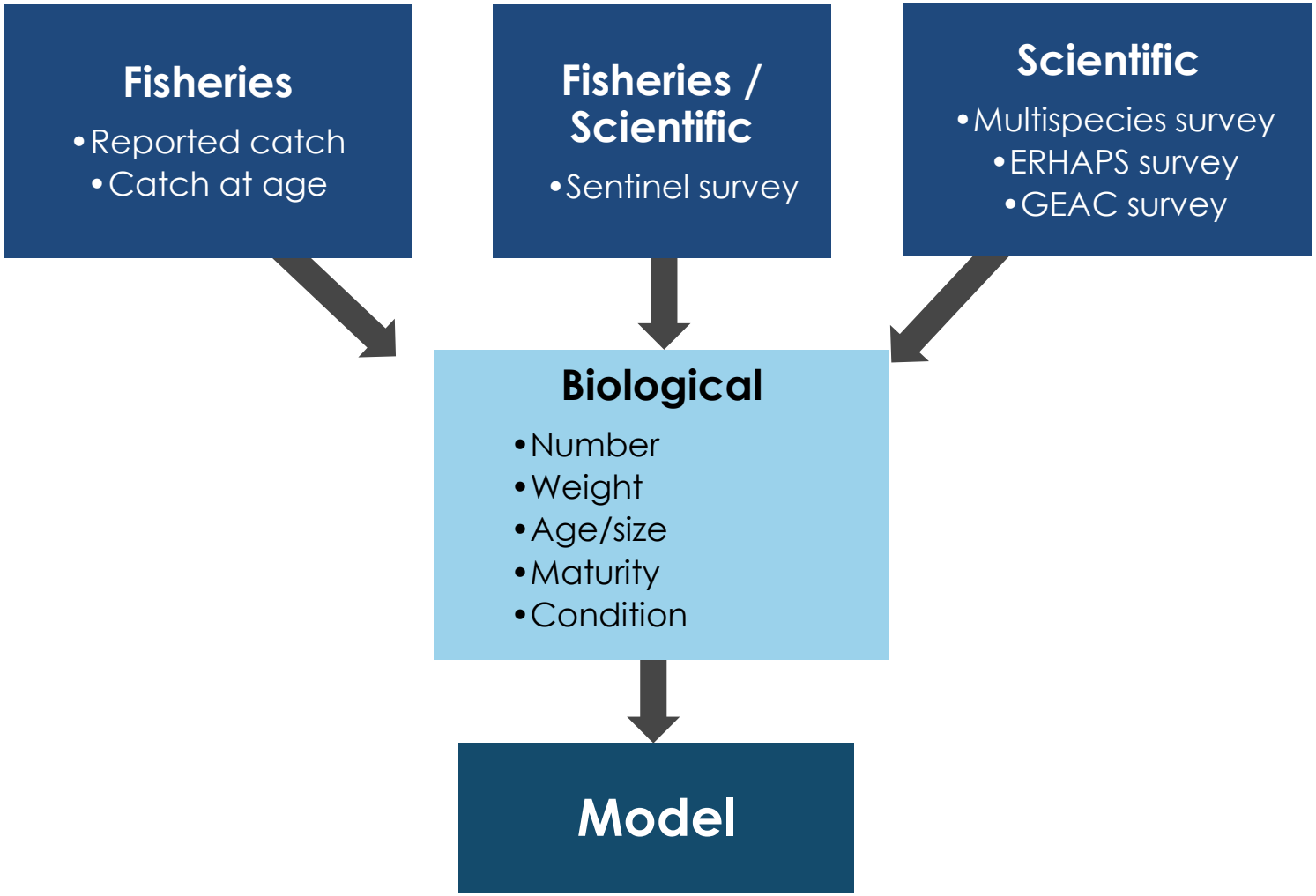


Sentinel Index Data - Gillnet

- The index has been relatively flat at lower levels since 1999.

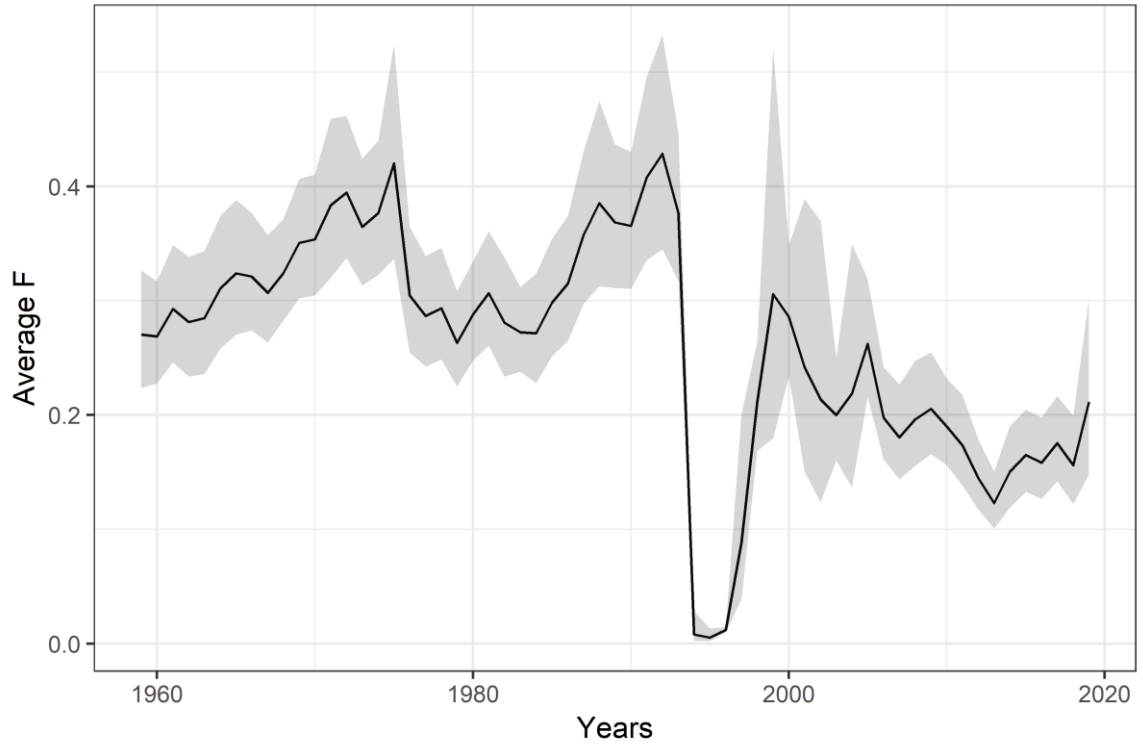


Data ⟶ Model


Fisheries
•Reported catch
•Catch at age
Fisheries / Scientific
•Sentinel survey
Scientific
•Multispecies survey
•ERHAPS survey
•GEAC survey
Biological
•Number
•Weight
•Age/size
•Maturity
•Condition
Model

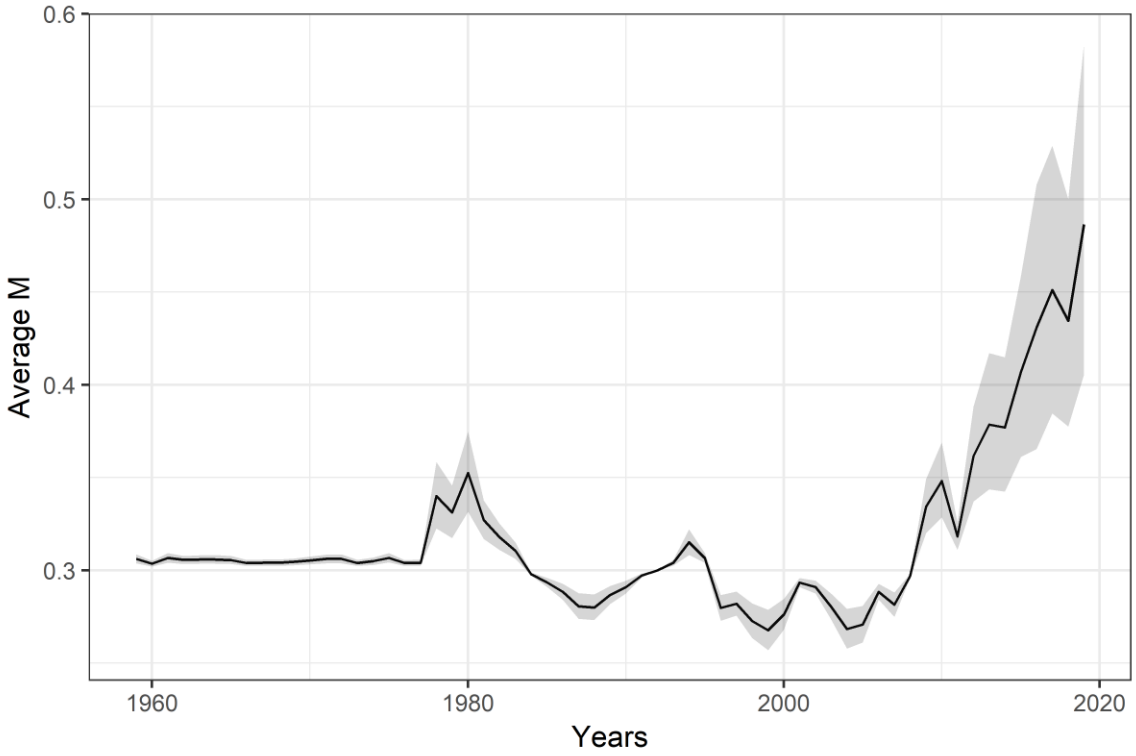
Model results: Fishing mortality

- The estimated fishing mortality rate has been relatively low since 2010 but increased slightly to 2019.



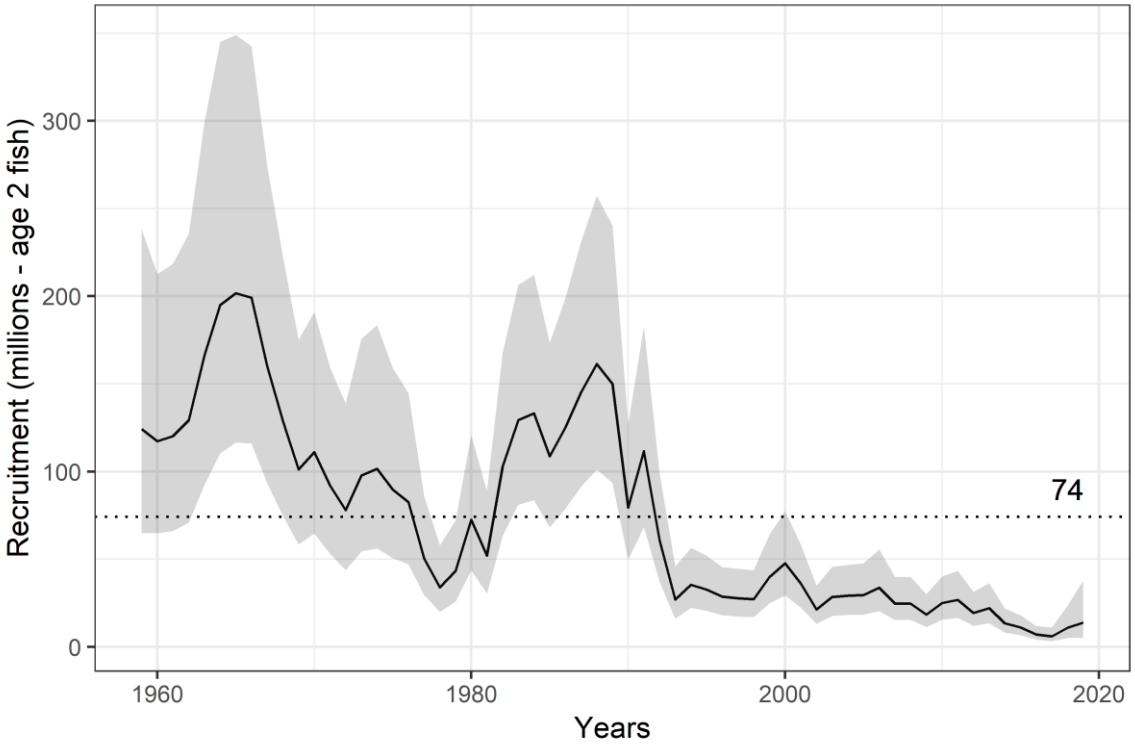
Model results: Natural mortality

- Natural mortality is approximately three times that of fishing mortality this year. Natural mortality rates over the last four years have been at their highest. In 2019, there was an annual reduction of ~ 40% of the stock.



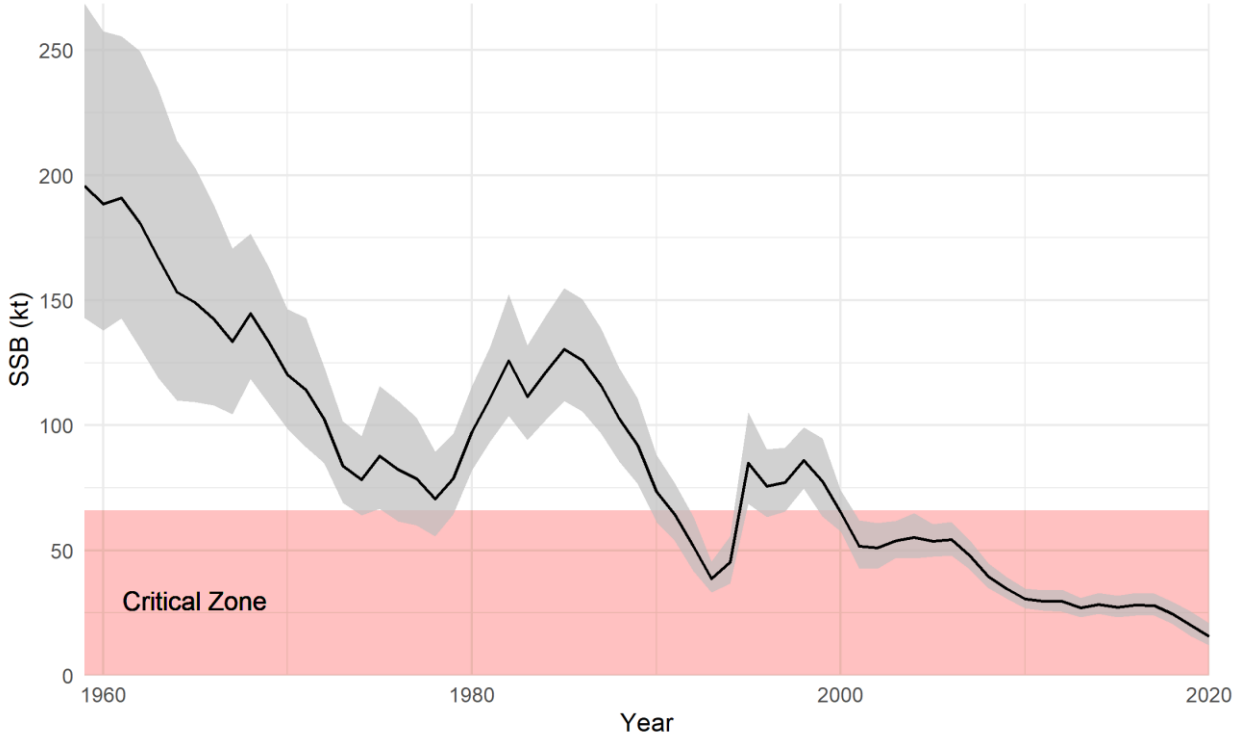
Model Results: Recruitment

- Recruitment is the number of two-year-old fish that will contribute to the stock in the future.
- Estimates have been below the long-term average since the mid-1990s.



Model results: stock status

- The 3Ps cod stock is in the critical zone (at 24% of LRP).

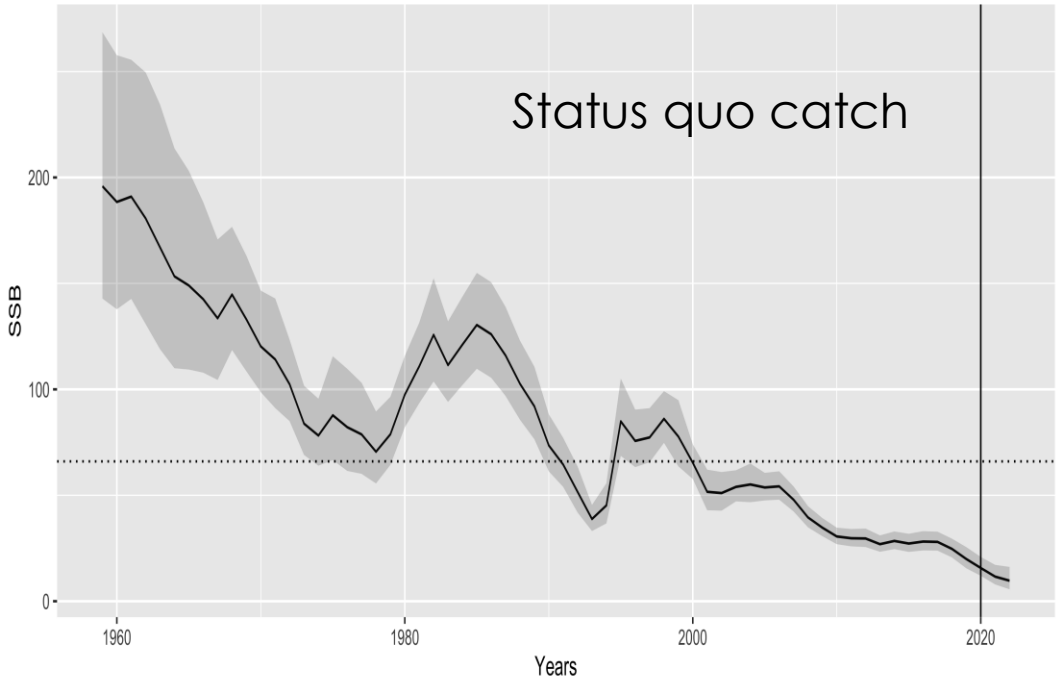


A Changing Ecosystem

- Various factors suggest that the 3Ps ecosystem is undergoing structural changes. Some of the changes we have observed include:
  - Above-average bottom temperatures in the area;
  - Increase in proportion of cod in poor condition;
  - Reduction in the size of the spring phytoplankton bloom;
  - Changes in the zooplankton community; and,
  - An increase in the biomass of warm water fishes (e.g. spiny dogfish and silver hake).

Projections to 2022

- Under various fishing scenarios, there is a high probability that the stock will remain in the critical zone to 2022.
- Projections indicate a low probability of growth under +/-30% of current fishery removals to 2022.
- In a scenario where there are no fishery removals, the probability of growth to 2022 is 16%.



Advice

- The DFO decision-making framework incorporating the precautionary approach requires that removals from all sources must be kept at the lowest possible level until the stock clears the critical zone.

Next Steps

- Stock assessment results will be posted to the CSAS website in the near future. This stock is assessed annually, and previous assessments are also currently available on the CSAS website.

- Fisheries management is consulting with industry in early 2020. The science advice will be presented and discussed at these meetings.

- DFO senior regional officials will consider advice from DFO Science and input from stakeholders in developing a mandate to negotiate future management actions with the Government of France in winter 2020. The management decision will be communicated via a fisheries notice.

Next Steps (cont.)

- Research will continue on the influence of various indices on model performance and outputs, including recruitment.

- Research is ongoing on the distribution, diet and abundance of seals in 3Ps.

Key Takeaways

- The 3Ps cod stock is in the critical zone.
- Natural mortality is a significant factor in current stock status. Data shows that natural mortality rates over the last four years have been at their highest recorded levels.
- The new assessment model is more comprehensive: it incorporates commercial landings back to 1959, as well as a broader range of data, including research surveys by DFO, France, the industry, and the sentinel survey of the inshore.
- The revised LRP is based on stock productivity and is 66 000 t.

Questions?

3Ps cod Bullets

- A new integrated state space model resulting from the 2019 3Ps Cod Framework was used to assess the status of the stock and estimate fishing mortality. This model incorporates catch (1959-2019), time varying natural mortality informed by trends in cod condition, and includes abundance indices from bottom trawl surveys conducted by Canada (1983-2005, 2007-2019), France (1978-1991), industry (GEAC, 1998-2005), and standardized catch rate indices from the Sentinel gillnet and line-trawl surveys (1995-2018).

3Ps cod Bullets

- A new biomass limit reference point (LRP) was determined for the stock based on the relationship between spawning stock biomass (SSB) and recruitment estimated from the model. The LRP is 66,000 t of SSB.
- Spawning Stock Biomass (SSB) at January 1, 2020 is estimated to be 16 kt (12-21). The stock is in the Critical Zone (24% of B_{lim} (18-32)) as defined by the DFO Precautionary Approach (PA) Framework. The probability of being below B_{lim} is >99.9%.

3Ps cod Bullets

- The new model and the revision of the basis for defining the LRP has led to a change in the perception of status of this stock. The stock is now estimated to have been below B_{lim} since the early 2000s.
- The estimated fishing mortality rate (ages 5-8) has ranged between 0.12 and 0.21 since 2010 and in 2019 was 0.21 (0.15-0.30), with an assumed catch of 4453 t.
- Natural mortality was estimated to be 0.49 (0.41-0.58) (ages 5-8) in 2019. Values during the last four years are the highest in the time series.

3Ps cod Bullets

- Recruitment (age 2) estimates have been below the long term average since the mid-1990s.
- Projection of the stock to 2022 was conducted assuming fishery removals to be within +/- 30% of current levels, assuming a catch of 4453 t for 2019, and with no catch. Under these scenarios, there is a probability >99% that the stock will remain below B_{lim} between 2020 and the beginning of 2022.

3Ps cod Bullets

- The probability of stock growth to 2022 is less than 1% across catch scenarios (+/- 30% of current levels), and is 16% when there are no removals.
- Natural mortality plays an important role in projections for this stock. If natural mortality rates are appreciably different from those used, projected outcomes will differ from values reported above.

3Ps cod Bullets

- Bottom temperatures in 3Ps remain above normal, and the spring bloom continues to be reduced in magnitude. Zooplankton biomass in 3Ps was near normal in 2017 and 2018 after four years of low production, with an increased proportion of smaller species. Data were unavailable from 2019. Ongoing warming trends, together with an increased dominance of warm water fishes, indicate that this ecosystem continues to experience structural changes. Reduced growth and condition indicate that cod productivity in 3Ps is reduced.

3Ps cod Bullets

- Consistency with the DFO decision-making framework incorporating the precautionary approach requires that removals from all sources must be kept at the lowest possible level until the stock clears the critical zone.