



#3a

2016 TRAC Status Report Eastern Georges Bank Cod

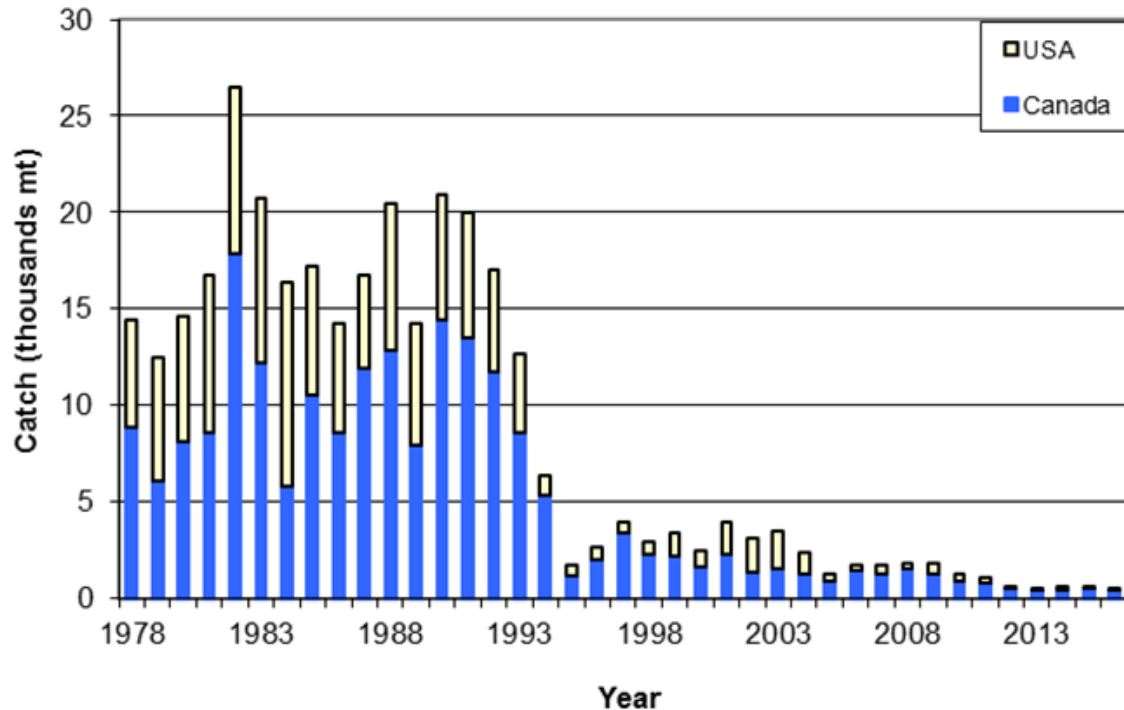
NEFMC Meeting

Sep. 27, 2017

Presented by: Liz Brooks
NEFSC

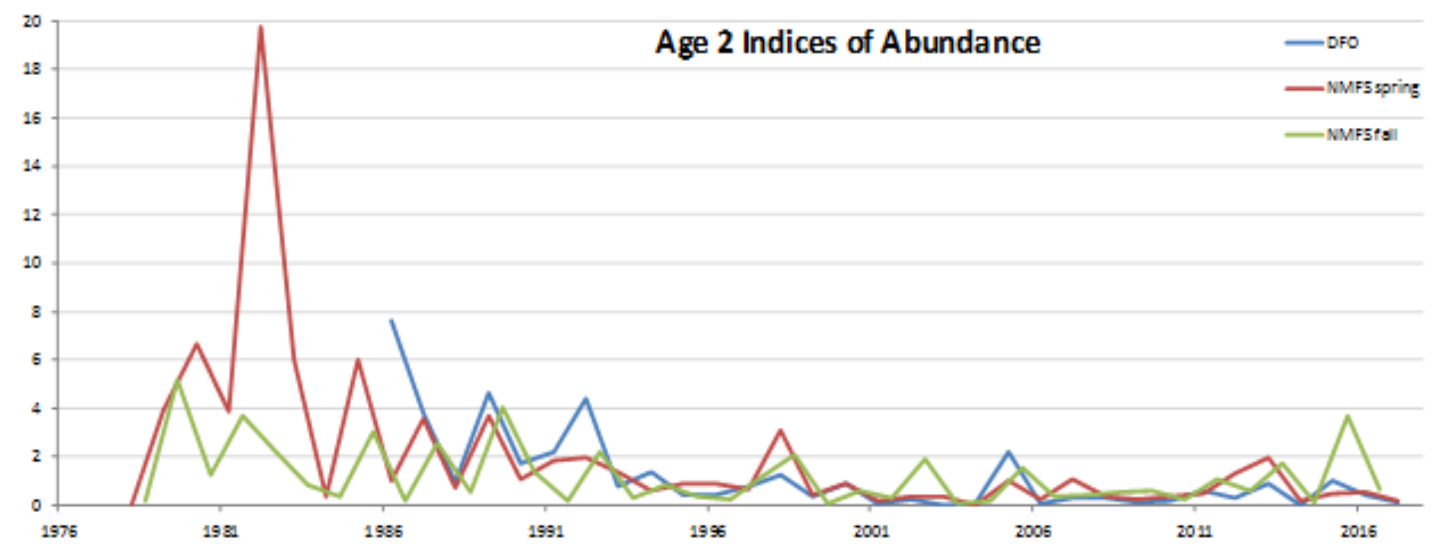
Prepared by: Yanjun Wang
Fisheries and Oceans Canada

Canadian and USA Catches



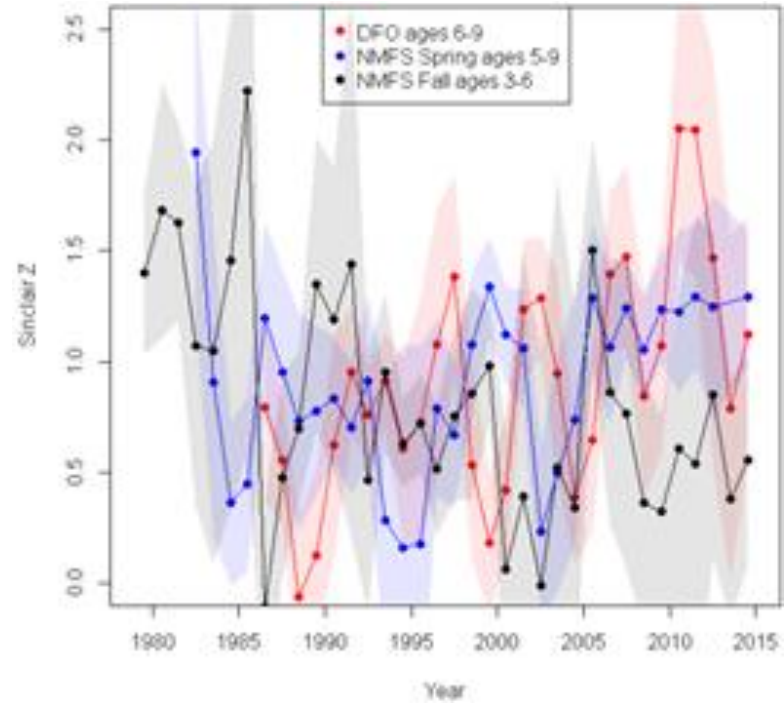
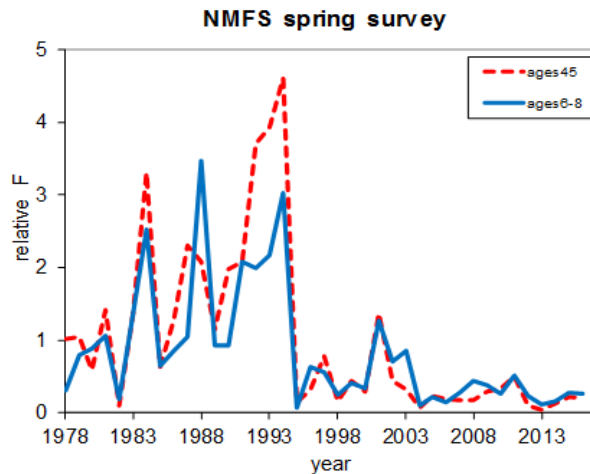
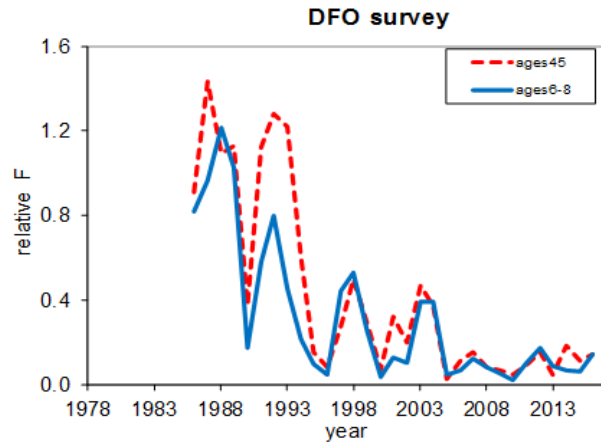
- 2016 combined Canada/USA catches were **537** mt(Quota **625** mt), including **17** mt of discards.
- 2016 Canadian catch **440** mt (Quota **488** mt)
- 2016 USA catch **97** mt (USA using different quota year, **138** mt)

Recruitment from survey



- Recruitment has been poor for the last 25 years.

Relative F and Z

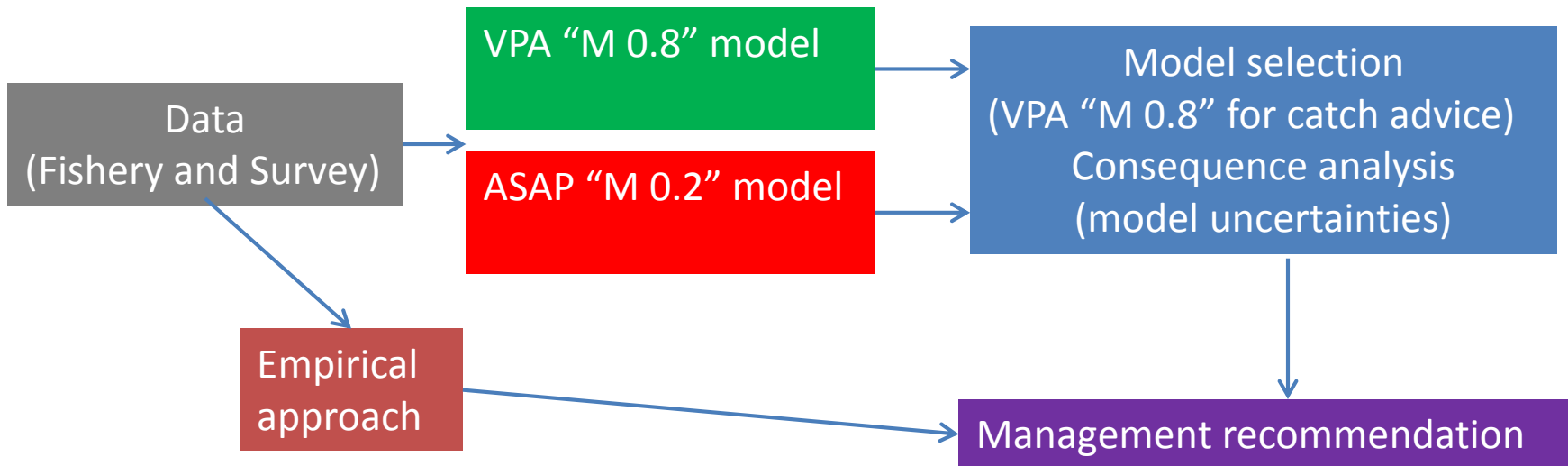


- Relative fishing mortality has declined since 1995, although total mortality(Z) from all sources has remained high.

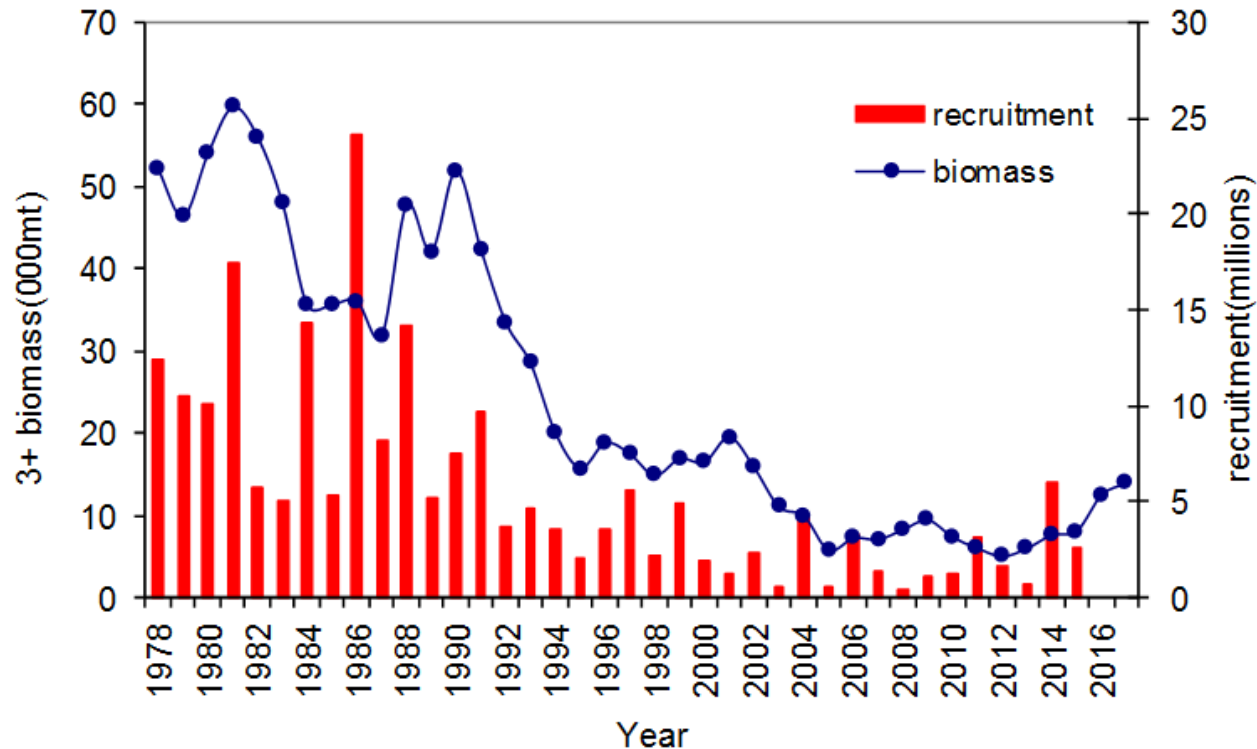
2017 EGB cod stock assessment approach

Hypothesis for
population dynamics

Results

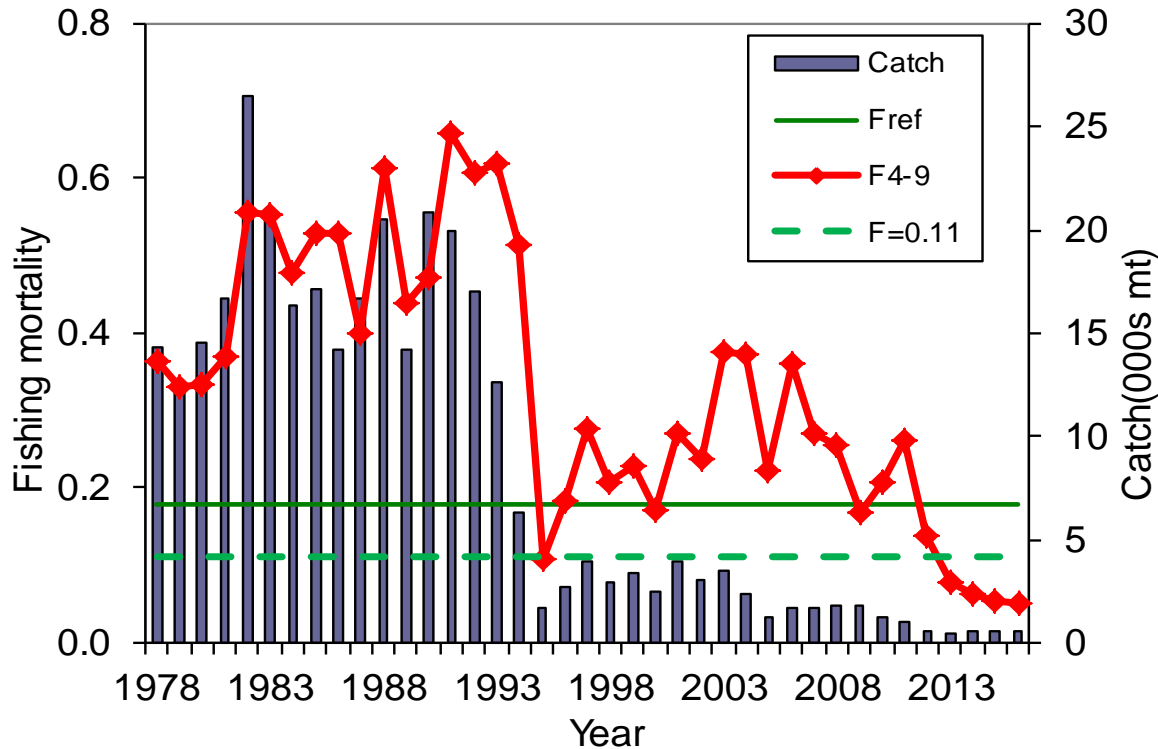


VPA “M 0.8” model



- The estimated adult population biomass at the beginning of 2017 was 13,944 mt.
- Recruitment at age 1 has been low in recent years, but the 2013 year class estimated at 6 million fish shows the highest estimated recruitment since 1990.

VPA “M 0.8” model



- The fishing mortality reference is $F=0.11$ based on a flat top selectivity.
- Fishing mortality (ages 4-9) in 2016 was estimated to be 0.05.
- In 2016, only age 4 was fully recruited with dome-shape selectivity. Consequently, the average F_{4-9} cannot be directly compared to the model reference $F=0.11$, so it is difficult to conclude whether we are achieving low risk of exceeding $F=0.11$.

Harvest Strategy

- TMGC(2002) has adopted a strategy to maintain a low to neutral risk of exceeding the fishing mortality reference.
- When stock conditions are poor, fishing mortality rates should be further reduced to promote rebuilding.

Outlook from VPA “M 0.8” model

Risk of fishery catch exceeding F reference point 0.11 in 2018 and 2019

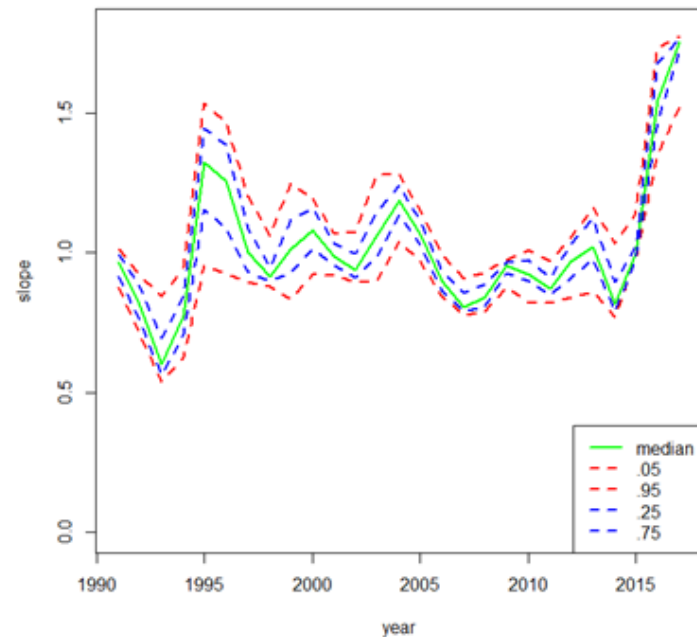
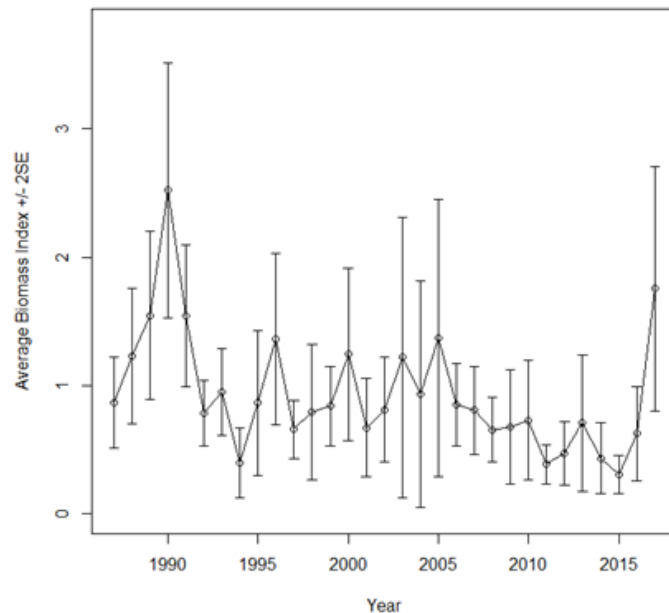
| Probability | 0.25 | 0.5 | 0.75 |
|----------------------------|-----------------|-----------------|----------|
| 2018 | 1,072 mt | 1,270 mt | 1,488 mt |
| 2019 (if $F_{2018}=0.11$) | 892 mt | 1,032 mt | 1,192 mt |

Risk that ages 3+ biomass will not increase from 2018 to 2019 and from 2019 to 2020

| Probability | 0.25 | 0.5 | 0.75 |
|------------------------------------|-----------------|----------|----------|
| 2018 to 2019 | 1,288 mt | 1,558 mt | 1,854 mt |
| 2019 to 2020 (if $F_{2018}=0.11$) | 0 mt | 0 mt | 0 mt |

Empirical approach

- This method was developed at 2016 TRAC, which is adjusting recent quotas by recent population biomass trends derived from fitting the average of the three surveys (DFO spring, NMFS spring, NMFS fall) to a *loess* smoother.



- It relies on recent quotas (2014-2016) and assumes that these quotas reflect sustainable catch levels.

2018 quota advice from empirical approach

| Year | 5% | 25% | 50% | 75% | 95% |
|-------------|-----------|------------|------------|------------|------------|
| 2018 | 1,002 | 1,133 | 1,156 | 1,164 | 1,168 |

- The percentiles reflect the probability that the true average 3-year trend is within a given bound

TRAC Catch advice

- Despite model uncertainties, all assessment results, and all biological and fishery indicators, suggest that low catches are needed to promote rebuilding.
- In order to provide a range of catch advice, the TRAC considered all three model results.

TRAC Catch advice

| | Measure | Catch Advice | % Difference from 2017 Quota (730 mt) |
|------------------|-----------------------------|--------------|---------------------------------------|
| VPA | Neutral Risk | 1,270 mt | 74% |
| | Low Risk (25%) | 1,072 mt | 47% |
| | F=0.062 | 711 | -2.6% |
| ASAP | Median | 412 mt | -44% |
| Empirical | 50 th Percentile | 1,156 mt | 58% |

- Due to the presence of the stronger 2013 year class and the increase in biomass for all three surveys in the most recent year, the TRAC reached consensus that there was no reason to recommend reducing catch advice below the 2017 quota; therefore, it was agreed that **730** mt was an appropriate lower bound for the 2018 catch advice.
- The TRAC recommends an upper bound of **900** mt (23% increase from 2017). This reflects a reduction from VPA projected catch at Fref, which is consistent with TMGC harvest strategy and recognizing that the potential projected catch to be optimistically high given past experience with VPA projections. It was also noted that a variety of methods to average catch advice produce a number around **900**.

Other TOR

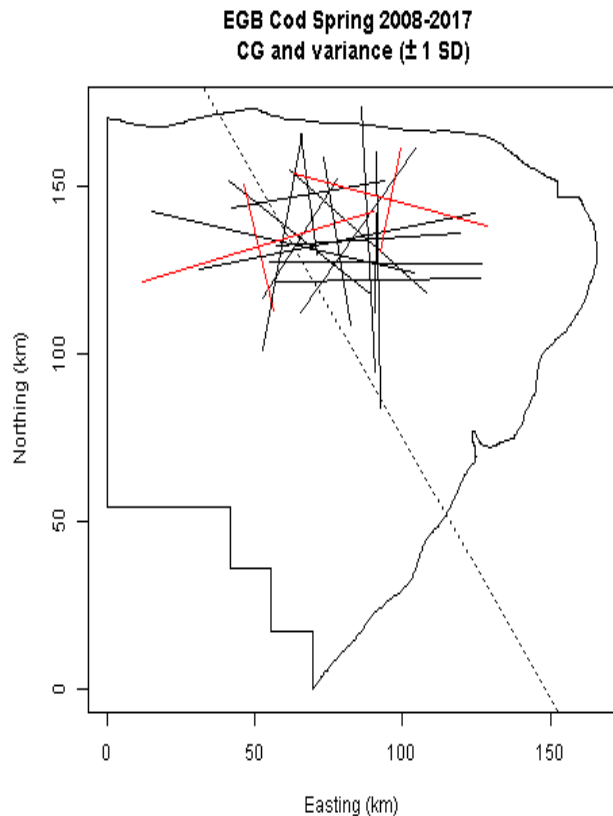
- For information, describe potential modeling approaches that could be considered in future assessment of Georges Bank stocks.

Statistical catch-at-age models with time-varying natural mortality, selectivity and survey catchability

- Estimating time-varying selectivity or catchability did not improve model performance.
- All models showed large increases in M for ages 6+, Retrospective patterns were acceptable.
- Top-ranked models estimated M for ages 6+ increased from around 0.25 yr⁻¹ in 1978 to ~1.5 yr⁻¹ in recent years.

Other TOR

- Evaluate potential implications of the delayed 2016 RV spring survey on the 2017 allocation shares assessment



- The mean location in 2016 was within ± 1 standard deviation of other mean locations over the past decade
- In terms of spatial distribution there should be no impact of the delayed 2016 survey on the assessment.

Thanks!



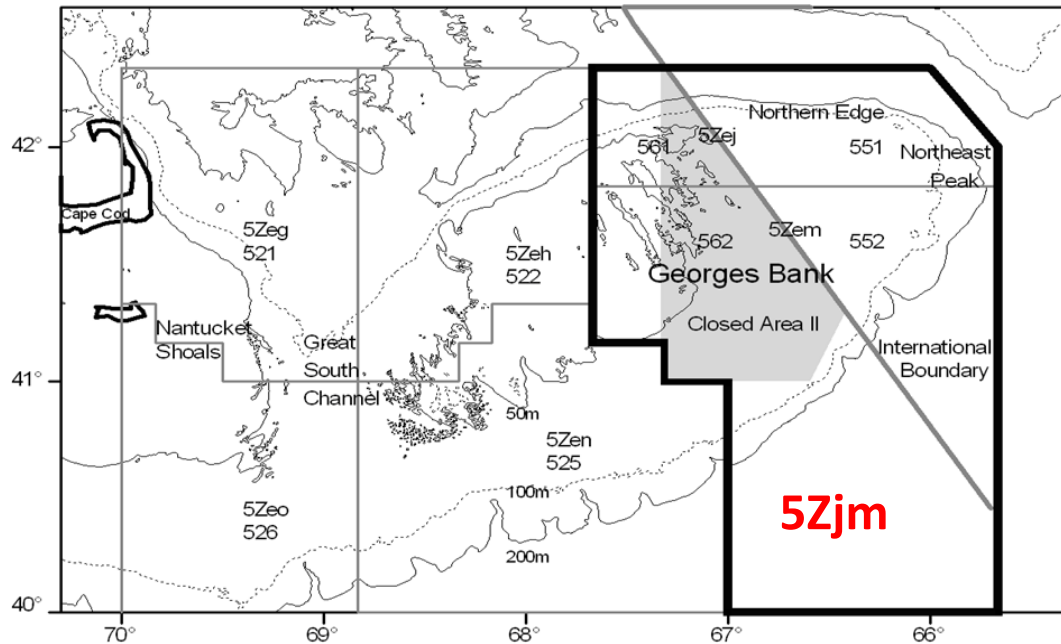
2017 TRAC Status Reports

Eastern Georges Bank haddock

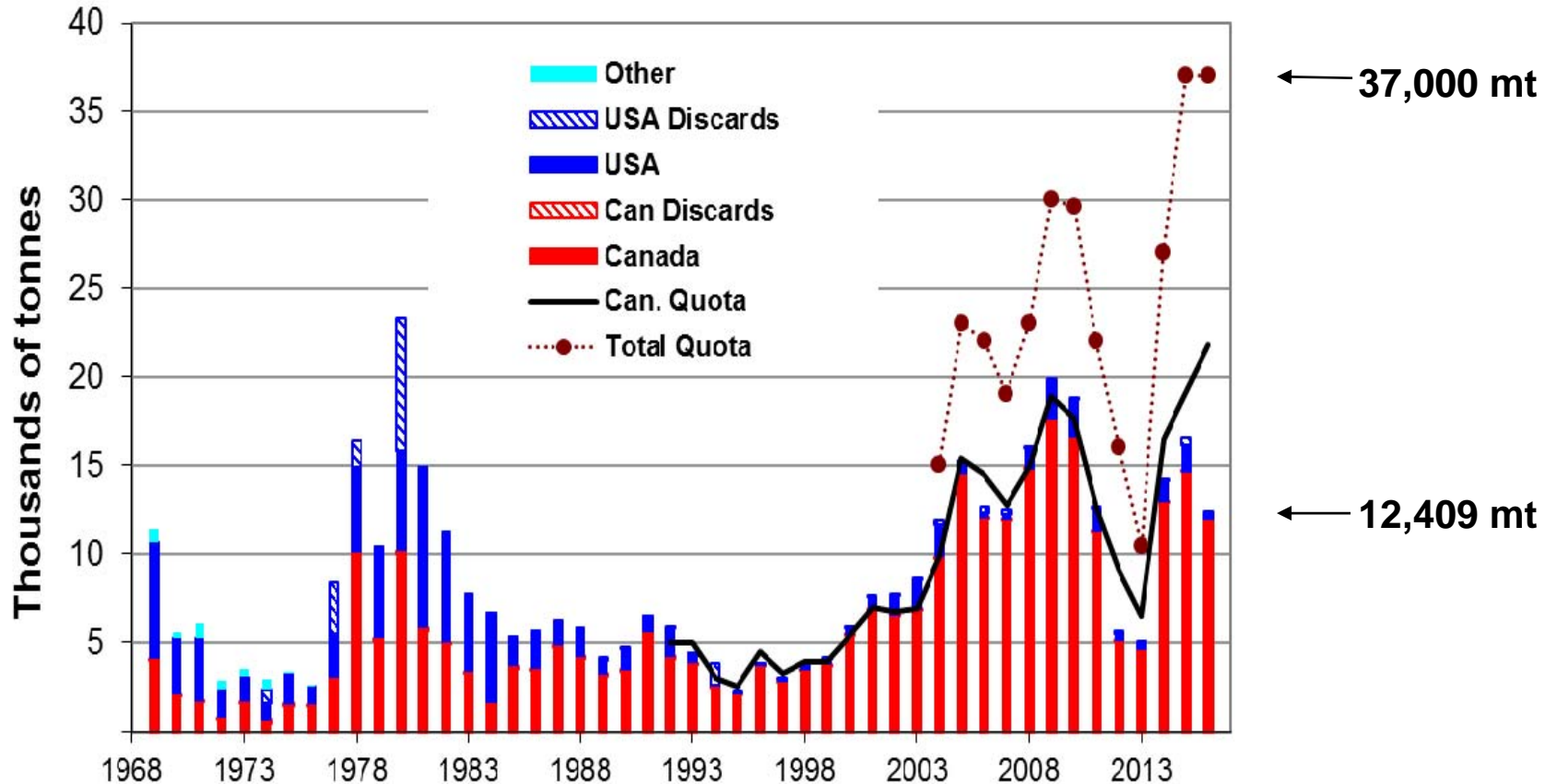
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Eastern Georges Bank Haddock

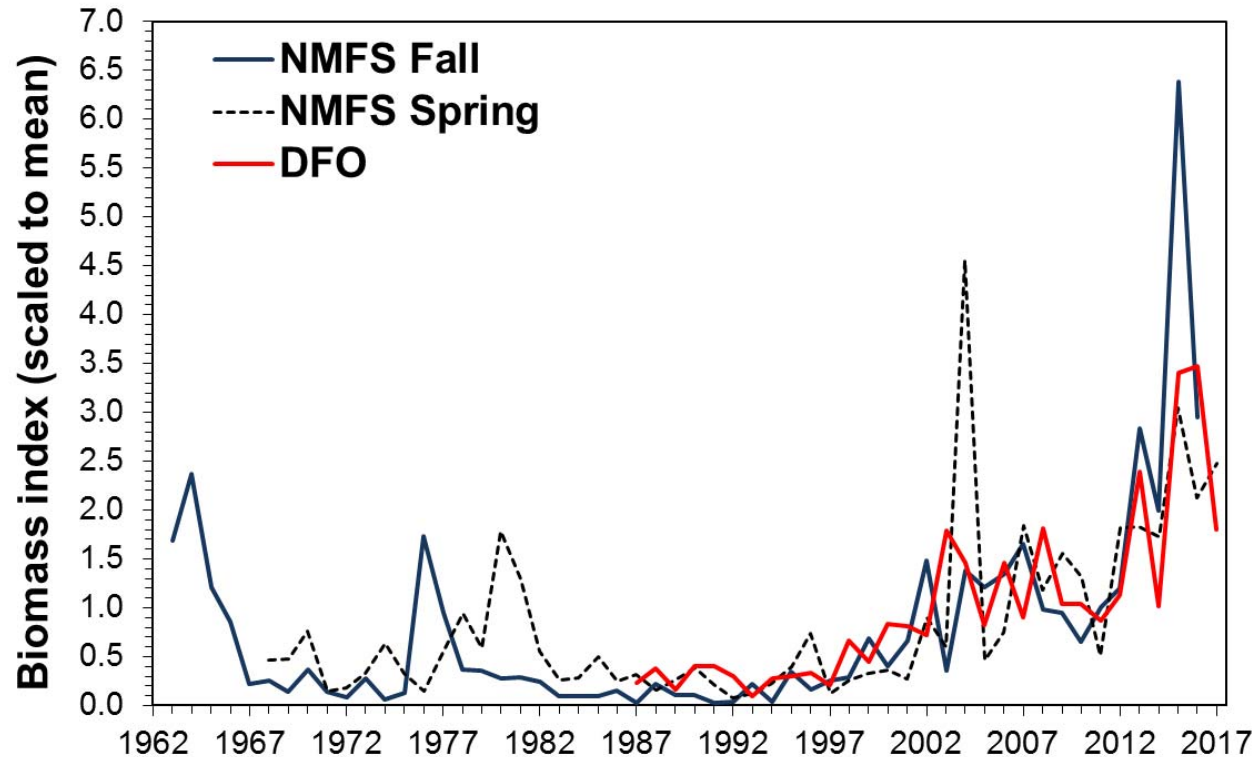


USA and Canadian Catch



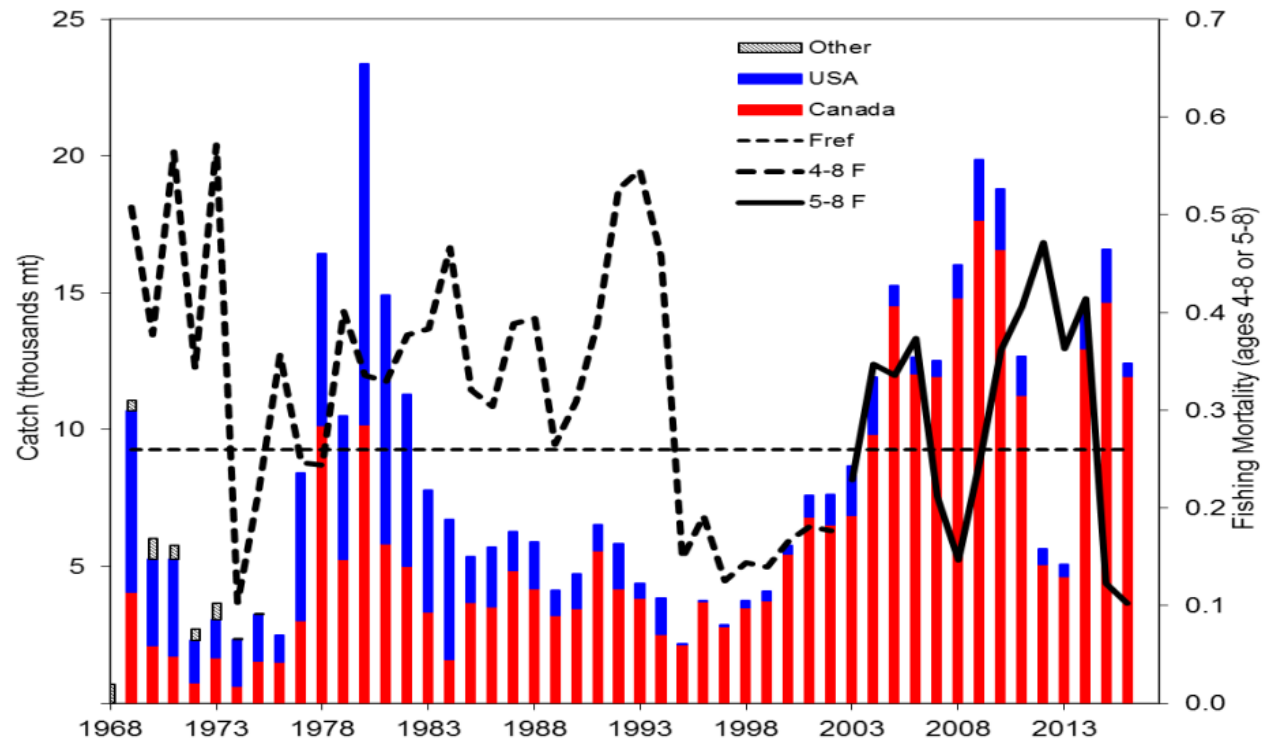
- ◆ Canadian + USA 2016 total catch **12,409** mt (Quota **37,000** mt), 34% of total quota.
- ◆ Canadian 2016 catch **11,943** mt (Quota **21,830** mt), 55% of quota
- ◆ USA catch **466** mt (USA using different quota year, **15,170** mt), 3% of quota

Survey Trends



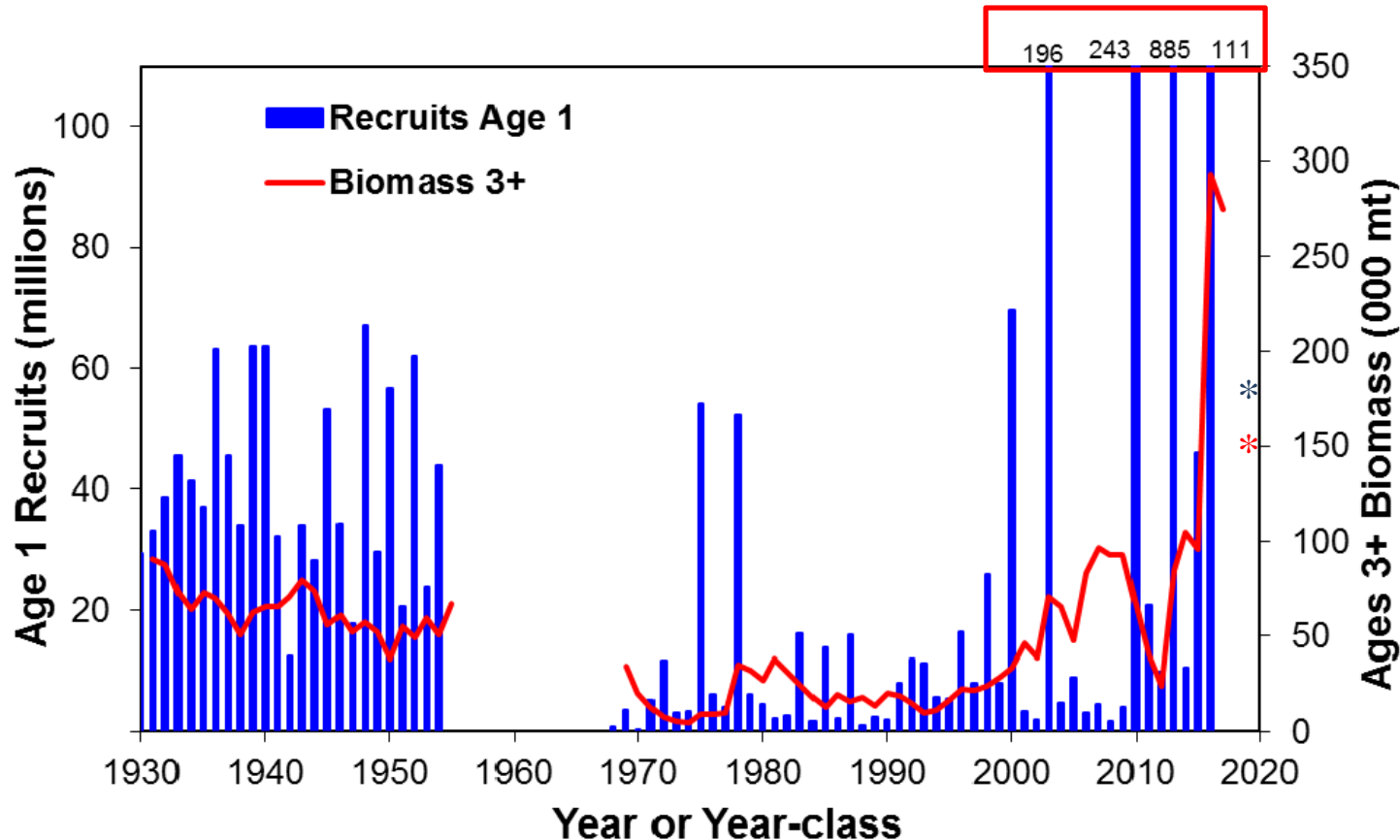
- Series scaled to mean track each other well
- Substantial **decrease** in biomass index for the most recent DFO (48%) and NMFS fall (53%) surveys. Small **increase** for NMFS spring (16%)
- Surveys still near time-series highest

Catch and Fishing Mortality



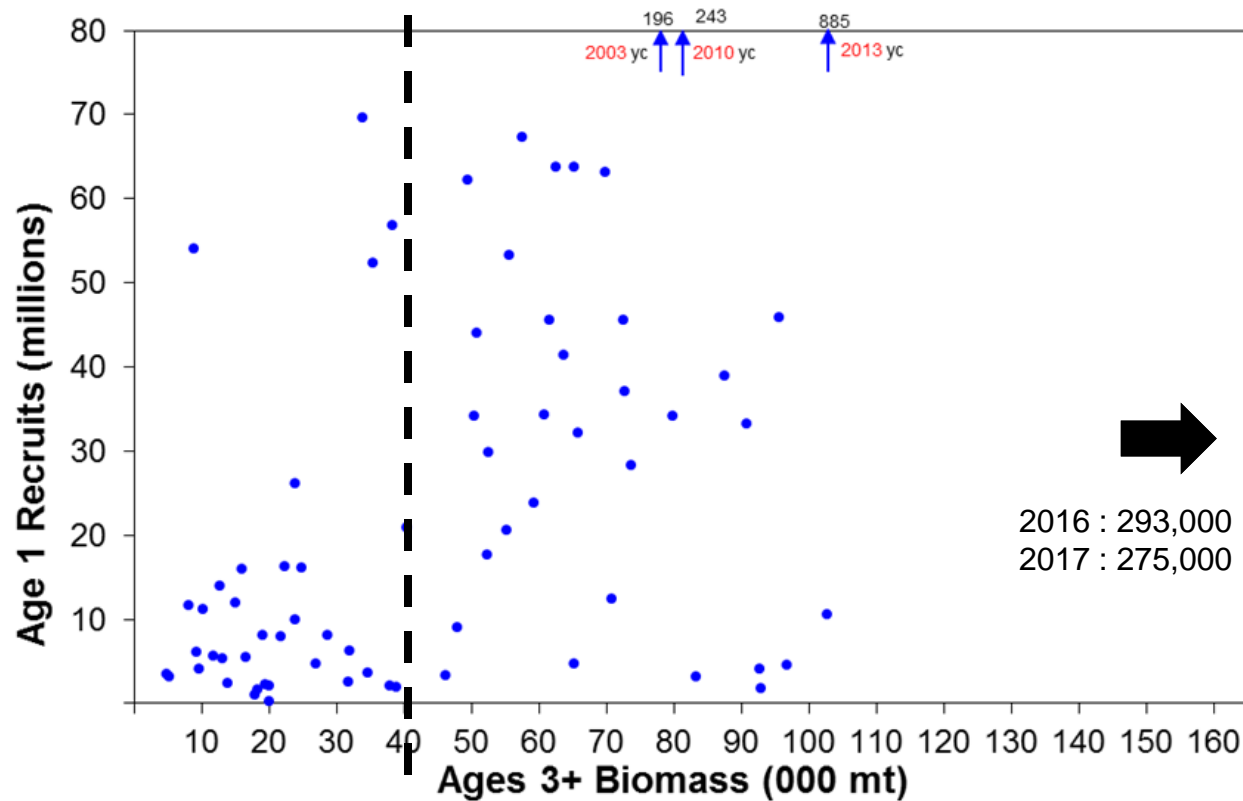
- The Fishing mortality reference point is 0.26.
- Fishing mortality was above Fref in 2004-2006 and 2010-2014. F_{5-8} in 2016 was estimated to be 0.102.
- Fref is based on flat-topped selectivity, but in recent years the fishery exhibits domed selectivity, so cannot directly compare F_{5-8} with Fref.

Recruitment and Ages 3+ Biomass



- Since 1995, adult population biomass (ages 3+) has fluctuated between 16,700 mt and 125,700 mt. The estimated adult population biomass at the beginning of 2017 was about 274,500 mt.
- Except for the strong 2000 and 2011 year classes and the exceptionally strong 2003, 2010 and 2013 year classes, recruitment has fluctuated between 1.8 and 26.1 million since 1990.

Stock and Recruitment Relationship



- The current biomass is well above 40,000 mt. When biomass is above this threshold, there is a better chance for higher recruitment

Special Consideration

| Peel | Age 1 Recruits | Age 3-8 Biomass | Age 5-8 F |
|--|-------------------|--------------------|---------------|
| 1 | 0.65 | 0.18 | -0.075 |
| 2 | 0.24 | 0.21 | -0.415 |
| 3 | 0.78 | 0.48 | -0.543 |
| 4 | 0.51 | 0.86 | -0.632 |
| 5 | 3.34 | 1.33 | -0.640 |
| 6 | 0.83 | 1.38 | -0.537 |
| 7 | 0.26 | 0.96 | -0.425 |
| Mohn's Rho | 0.95 | 0.77 | -0.467 |
| % Adjustment | 0.514 | 0.564 | 1.876 |
| calculated as $1/(1 + \text{rho value})$ | | | |

| Parameter | Estimate | rho Adjusted |
|----------------------|----------|-----------------|
| 2016 5-8 F | 0.10 | 0.19 |
| 2016 R (millions) | 111.58 | 57.36 |
| 2017 3+ B (mt) | 274,482 | 154,877 |

- A retrospective bias was first noted in the 2014 assessment, and has gotten worse in this assessment.
- The retrospective bias results in decreases in adult biomass and increases in F compared to the results of previous assessments.

Harvest Strategy

- TMGC(2002) has adopted a strategy to maintain a low to neutral risk of exceeding the fishing mortality reference.
- When stock conditions are poor, fishing mortality rates should be further reduced to promote rebuilding.

Risk of fishery catch exceeding

$$F_{\text{ref}} = 0.26$$

| Probability of exceeding F_{ref} | 25% | 50% | 75% |
|---|-----------|-----------|------------|
| 2018 catch | 71,000 mt | 86,000 mt | 102,000 mt |
| 2018 catch (rho adjusted) | 35,000 mt | 44,000 mt | 53,000 mt |
| 2019 catch | 44,500 mt | 53,000 mt | 63,000 mt |
| 2019 catch (rho adjusted) | 23,000 mt | 27,500 mt | 33,000 mt |

Risk that ages 3+ biomass will not increase

- A catch of **17,000 mt** [**11,000 mt**] in 2018 results in a neutral risk (50%) that the 2018 biomass will not increase by 10%. Both the low and neutral 2018 catch associated with not exceeding F_{ref} will produce a decline in biomass. Adult biomass is projected to be **242,883 mt** [**126,137 mt**], at the beginning of 2019 at the F_{ref} catch level.
- Even if no catch is taken in **2019**, biomass is projected to decline because of the 2013 year class decrease in numbers and assumed weight at age. Adult biomass is projected to be **195,716 mt** [**102,058 mt**] at the beginning of 2020 at the F_{ref} catch level.

[rho adjusted]

TRAC Advice

- All TRAC participants
 - catch should be lower than the standard projections
 - due to the poor model performance
 - uncertainty about growth patterns and abundance for the 2013 year class
- TRAC external reviewers
 - apply the rho adjustment and follow the sensitivity catch advice
- TRAC scientists
 - No consensus on the appropriate magnitude for reducing catch advice

Summary

- Positive features:
 - three exceptionally strong and two strong year classes in the last 13 years.
 - population age structure displays a broad representation of age groups
 - spatial distribution patterns were similar to the average patterns over the previous ten years.
- Negative features:
 - there has been a general decline in size and weights at age since the late 1990s
 - decline in size at age appears to be exacerbated for the 2013 year class
 - Fish condition has generally been below the time series average since 2004 for all three surveys and was the lowest in the time series for both the DFO and NMFS spring surveys in 2017.
- Performance of the VPA for EGB Haddock was poor and seems to be getting worse with time.
- If the 2017 quota is caught, the 2017 F will be above F_{ref} due to the revision of the size of the 2013 year class in the 2017 assessment.

Other TOR

- Compare contemporary estimates of F40% and F0.1 to current Fref
- Consider how updating this assessment with 2015-2016 data (i.e. what would have been used for the VPA assessment for 2016 TRAC) informs the 2016 Haddock Interim Report; suggest revisions to the Interim Report if necessary
- Evaluate potential implications of the delayed 2016 RV spring survey on the 2017 allocation shares assessment

Other TOR

- Compare contemporary estimates of F40% and F0.1 to current Fref

| Time period | F _{0.1} | F _{40%} |
|---|------------------|------------------|
| 5 year average (2011-2015) | 0.63 | 0.55 |
| <i>(Sensitivity 1) 5 year average, PR(age 9+)=0.7</i> | 0.44 | 0.51 |
| <i>(Sensitivity 2) 5 year average, PR(ages 7 to 9+)=1.0</i> | 0.34 | 0.47 |
| 14 year average (2002-2015) | 0.45 | 0.38 |
| <i>(Sensitivity 1) 14 year average, PR(age 9+)=0.7</i> | 0.36 | 0.36 |
| <i>(Sensitivity 2) 14 year average, PR(age 9+)=1.0</i> | 0.31 | 0.35 |

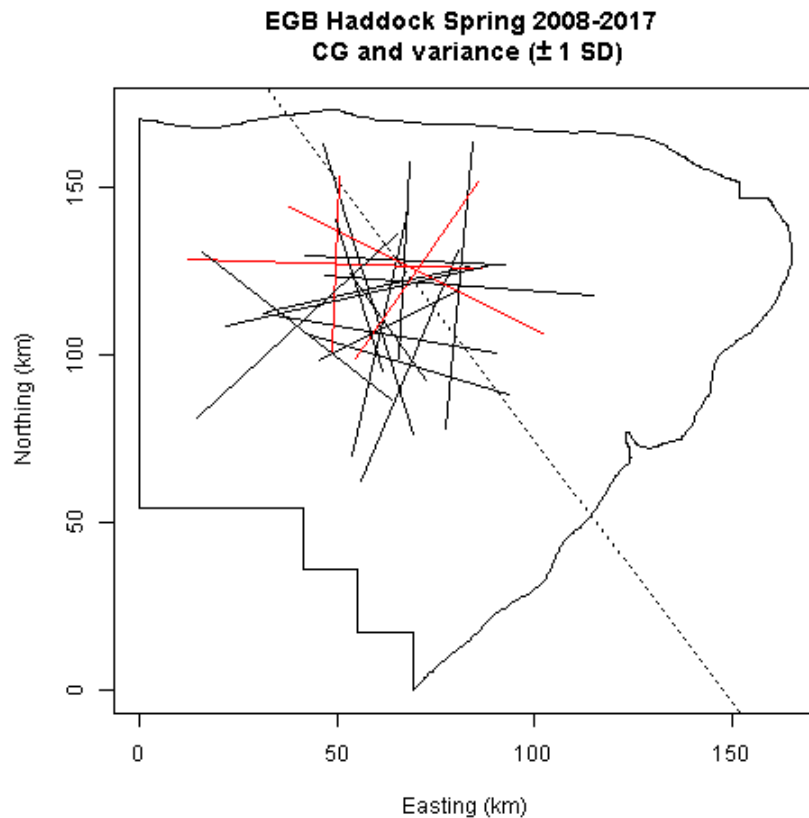
- Two time periods used to estimate Fref (5 year or 14 year)
- Two sensitivities to explore impact of selectivity on older ages
- F_{0.1} and F_{40%} were > current F_{ref} (0.26)
- Sensitivities demonstrate strong influence of selectivity at oldest ages

Other TOR

- Consider how updating this assessment with 2015-2016 data (i.e. what would have been used for the VPA assessment for 2016 TRAC) informs the 2016 Haddock Interim Report; suggest revisions to the Interim Report if necessary
 - The calculated range for 2017 TAC is lower for projected catch at neutral risk, but the agreed quota still falls within the new range
 - The driver of these differences in projected catch were from the overestimate of WAA for large year classes (both beginning of year and fishery weights at age) and the retrospective pattern
 - The average survey index was a good indicator of 3+ biomass

Other TOR

- Evaluate potential implications of the delayed 2016 RV spring survey on the 2017 allocation shares assessment



- The mean location in 2016 was within ± 1 standard deviation of other mean locations over the past decade
- In terms of spatial distribution there should be no impact of the delayed 2016 survey on the assessment.

Thank you for your attention.
Questions?



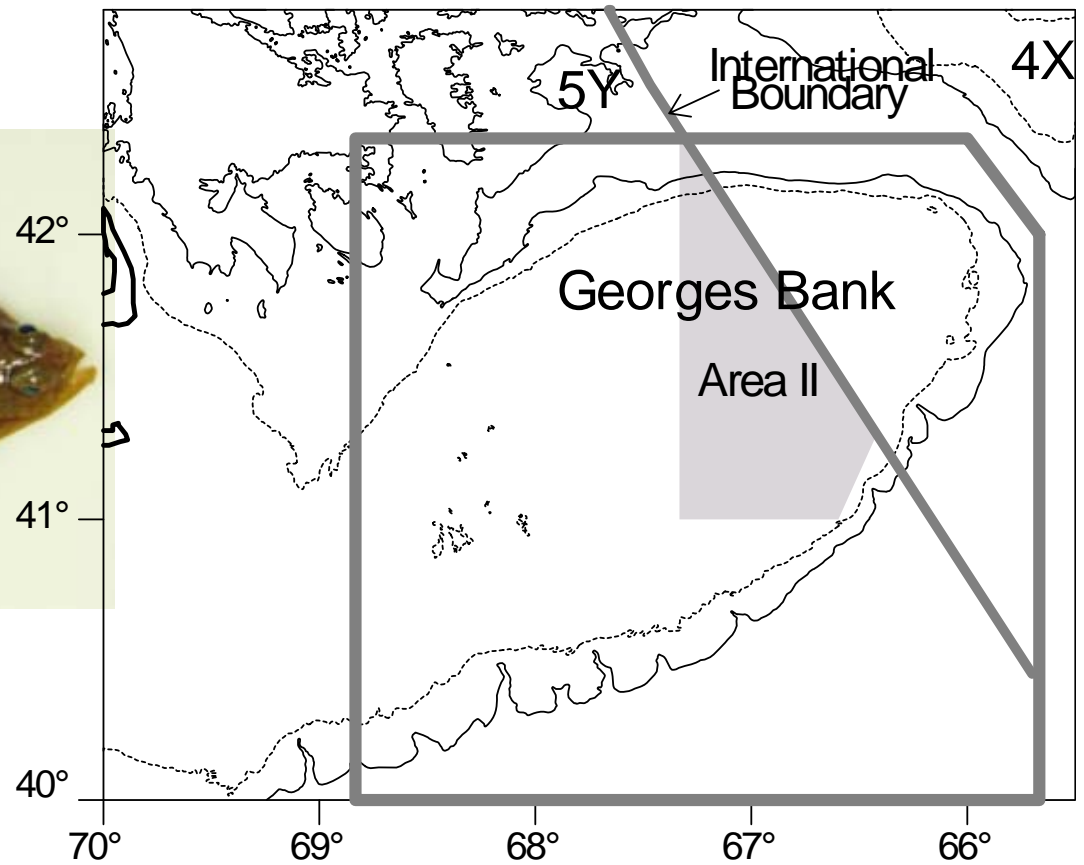
2017 TRAC Status Reports

Georges Bank yellowtail flounder

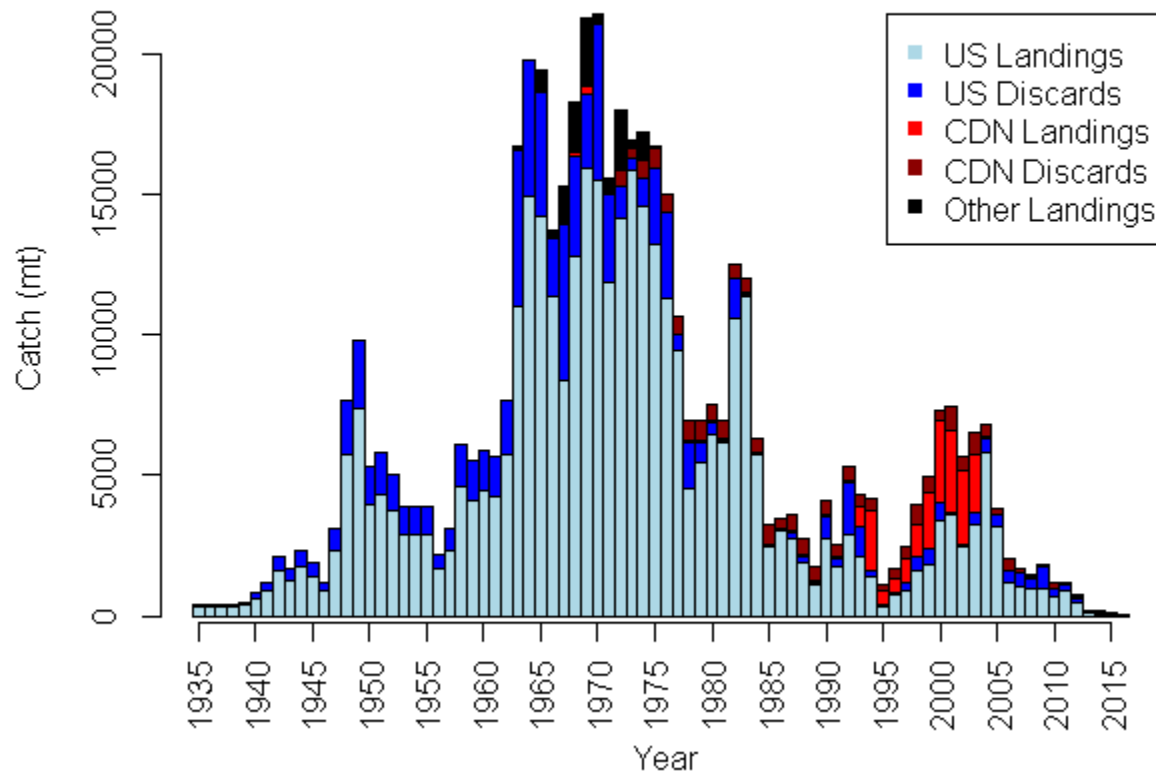
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Georges Bank Yellowtail Flounder

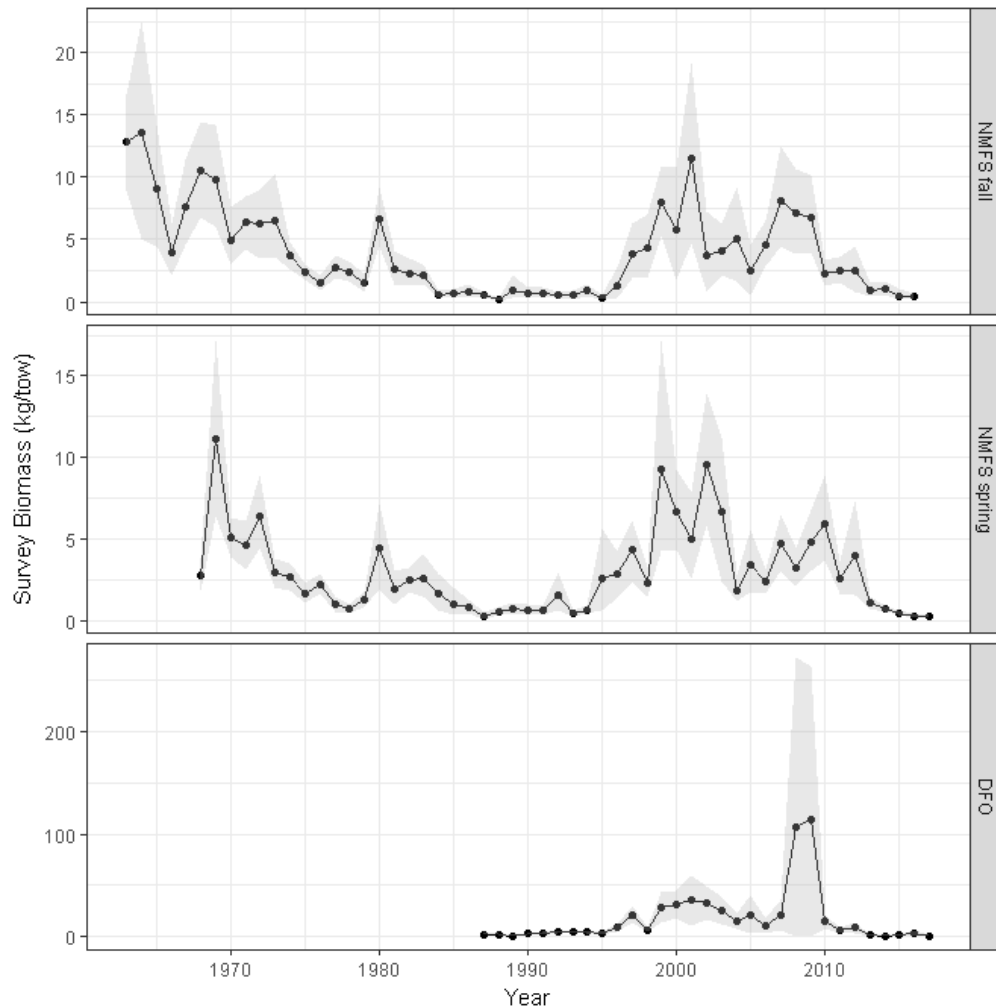


GB Yellowtail Flounder Catch



- ◆ Canadian + USA 2016 total catch **44** mt (Quota **354** mt), lowest catch ever (1935-2016)
- ◆ Canadian 2016 catch **10** mt (Quota **85** mt)
- ◆ USA catch **33** mt (USA using different quota year, **269** mt)
- ◆ 2016 Catch was 39% discards, 61% landings

Survey Trends

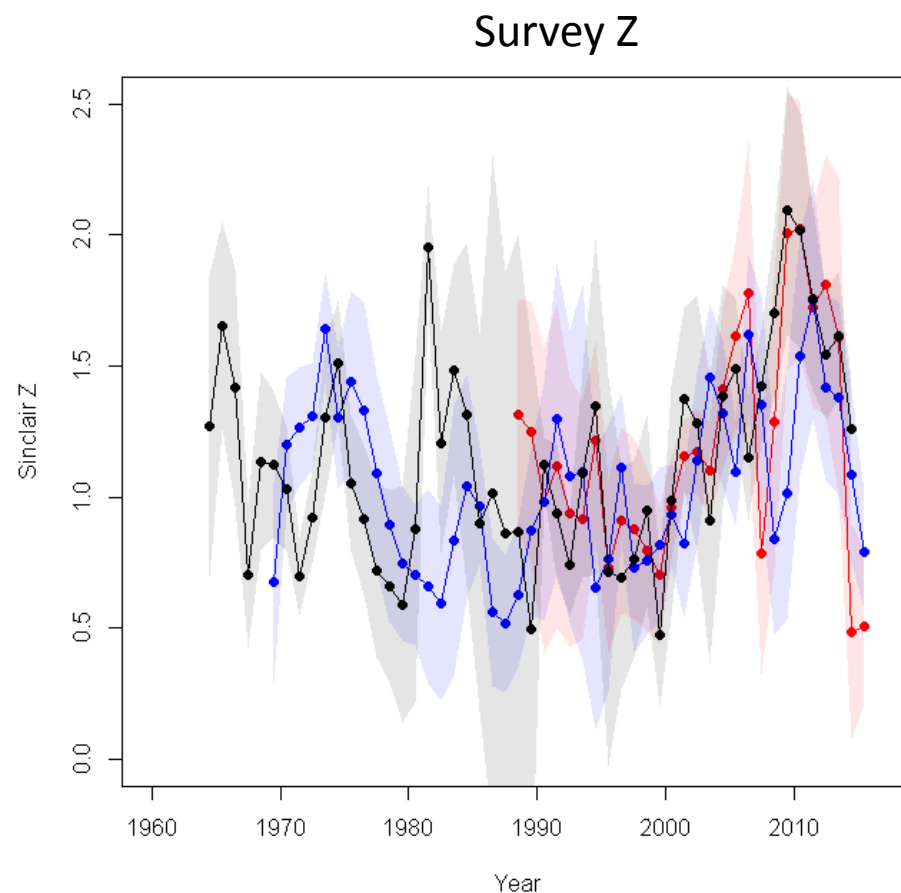
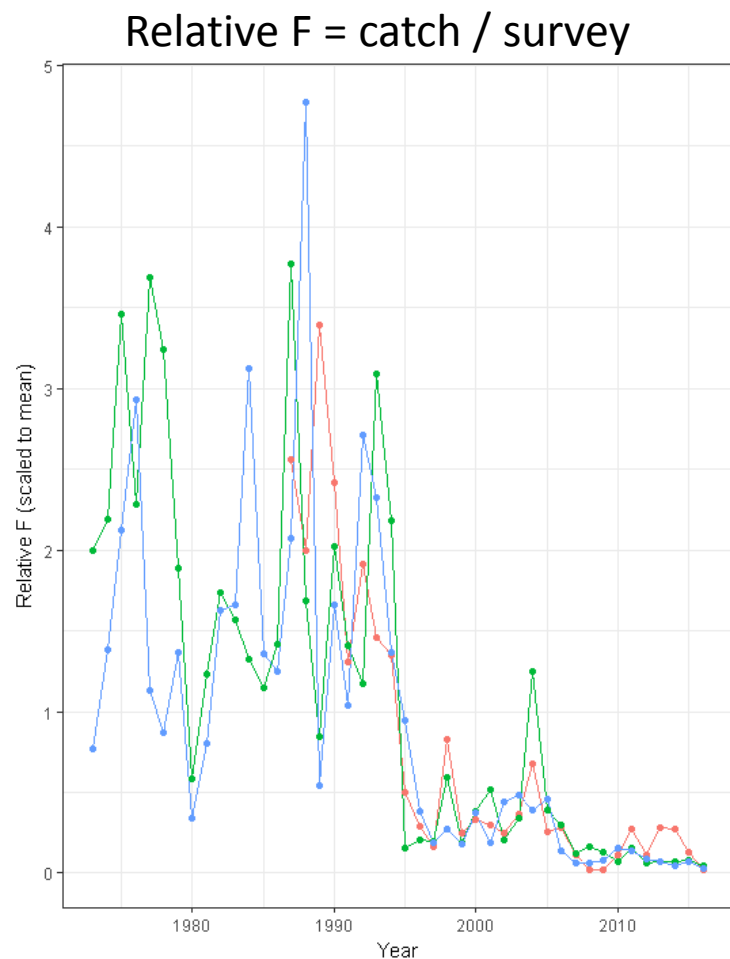


- Fall 2016 3rd lowest in 54 years
- Spring 2017 lowest in 50 years
- DFO 2017 lowest in 31 years

• The three survey biomasses indicate the capacity of the stock is significantly diminished.

• Stock biomass is low and productivity is poor.

Relative F and Z



- Relative fishing mortality has declined since 1995, although total mortality(Z) from all sources has remained high.
- Fishing does not appear to be a major driver of stock status currently

2017 Intersessional on Survey q

- 26 June 2017 conference call to discuss 3 WP
- 2 WP estimated survey q from twin-trawl experiment
- 1 WP examined herding from bridle experiment
- Consensus
 - Use survey q = 0.31
 - Use wing width for area of tow (no herding)
 - Apply these decisions to all three surveys
- Overall effect is approx 3 fold increase in average biomass and thus catch advice for a given exploitation rate

$$B = I * (A / a) / q$$

Empirical Model Approach

- Empirical approach
 - Expand 3 bottom trawl surveys to B
 - Assume $q=0.37 \rightarrow q=0.31^*$
 - Use door spread for swept area \rightarrow use wing spread*
 - Average 2017 DFO, 2017 NEFSC spring, 2016 NEFSC fall
 - Apply exploitation rate
 - range: 2% - 16% \rightarrow new range?

*TRAC Intercessional consensus (26 June 2017).

Empirical Results

| Year | Biomass (mt) | | | | mu = | 0.02 | 0.06 |
|------|--------------|--------|---------------|---------|------|-------------------|-------|
| | DFO | Spring | Fall (year-1) | Average | | Catch Advice (mt) | |
| 2010 | 29,452 | 68,752 | 83,490 | 60,565 | | 1,211 | 3,634 |
| 2011 | 12,344 | 29,621 | 27,821 | 23,262 | | 465 | 1,396 |
| 2012 | 18,113 | 46,209 | 30,354 | 31,559 | | 631 | 1,894 |
| 2013 | 2,249 | 12,766 | 31,199 | 15,404 | | 308 | 924 |
| 2014 | 1,654 | 8,564 | 10,828 | 7,015 | | 140 | 421 |
| 2015 | 2,650 | 5,861 | 12,682 | 7,064 | | 141 | 424 |
| 2016 | 5,569 | 3,610 | 5,811 | 4,997 | | 100 | 300 |
| 2017 | 1,104 | 2,819 | 5,432 | 3,118 | | 62 | 187 |

Recent Biomass Trend
 31% decline 2015-2016
 36% decline 2016-2017

- Using the new $q=0.31$ estimate and wing spread results in biomass estimates being approximately 3 times larger than biomass estimates based on $q=0.37$ and door spread
- Biomass trends are identical because all years are scaled by the same constant value

Empirical Results

full range of exploitation rates

| Exploitation Rate | Catch Advice (mt) |
|-------------------|-------------------|
| 2% | 62 |
| 4% | 125 |
| 6% | 187 |
| 8% | 249 |
| 10% | 312 |
| 12% | 374 |
| 14% | 437 |
| 16% | 499 |

TRAC Advice

- TRAC external reviewers and scientists
 - Recommend low exploitation (2%-6%) to allow for possibility of rebuilding: 62-187 mt
 - Survey declines, truncated age structure, low recruitment, high total mortality do not support increasing quota above 300 mt
- Broader TRAC perspective
 - Full range of exploitation rates (2%-16%) still informative
 - Concerned that low quota would limit catch of other species
 - Agree there are no data that support increasing quota above 300 mt

Special Considerations

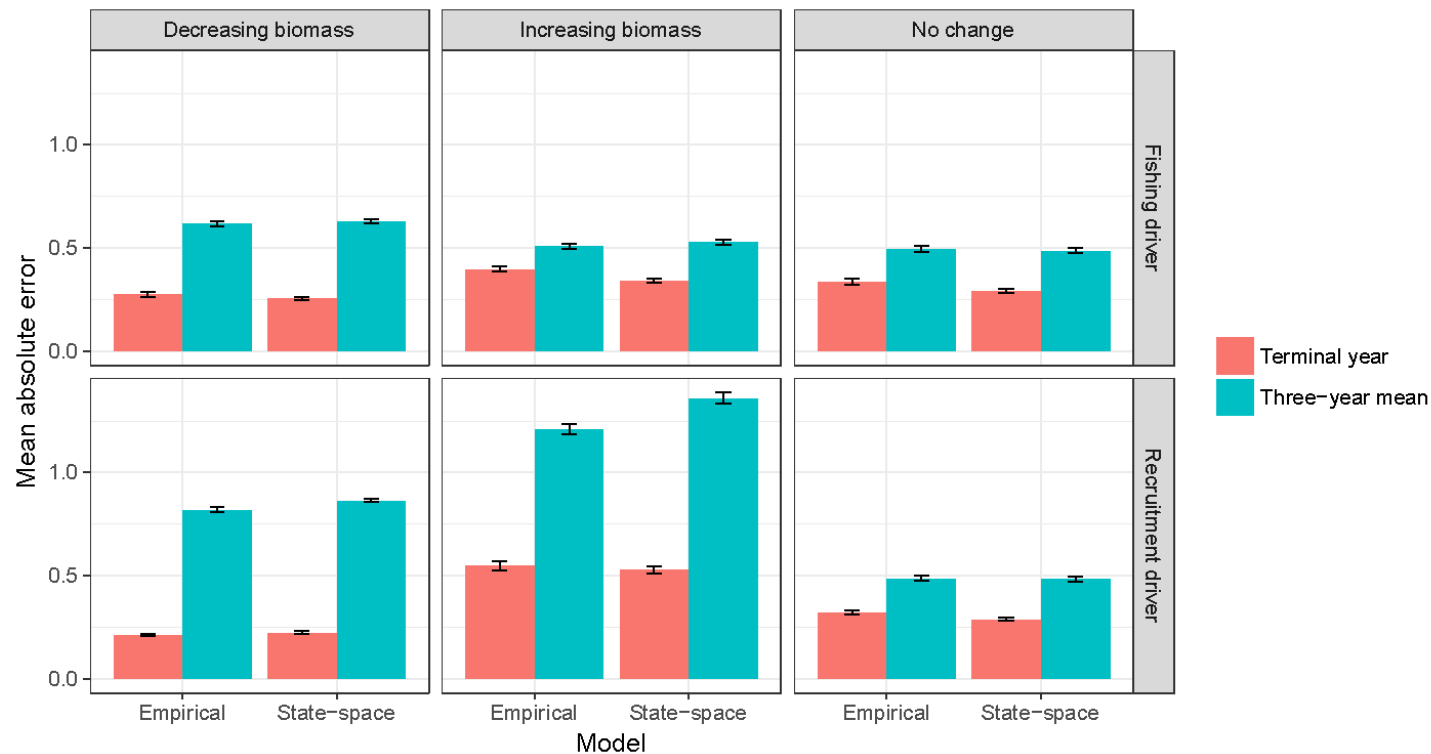
- Strong decline of the stock since 2010, despite quotas and catches being well below the exploitation range (16%), is why the range for exploitation rate was reconsidered this year.
- Catches less than recent quotas can be attributed in part to management regulations in both countries
 - yellowtail is not allocated to the directed fishery in Canada
 - gear restrictions in both countries
 - bycatch avoidance programs in the USA
 - Total Allowable Catch (TAC) management of a multispecies fishery in the USA
- The US scallop fishery uses rotational management between the Mid-Atlantic and Georges Bank. In years when the scallop fishery is on Georges Bank, higher US catches of yellowtail flounder are expected.

Other TOR

- Conduct a sensitivity analysis to evaluate basing catch advice on using multiple years of biomass estimates (e.g., a three year moving average).
- For information, describe potential modeling approaches that could be considered in future assessment of Georges Bank stocks
- Evaluate potential implications of the delayed 2016 RV spring survey on the 2017 allocation shares assessment
- Evaluate and quantify, if possible, scientific uncertainty of the assessment output (catch projection), discussing current practices of characterization and alternative methods of evaluation

Other TOR

- Conduct a sensitivity analysis to evaluate basing catch advice on using multiple years of biomass estimates (e.g., a three year moving average).



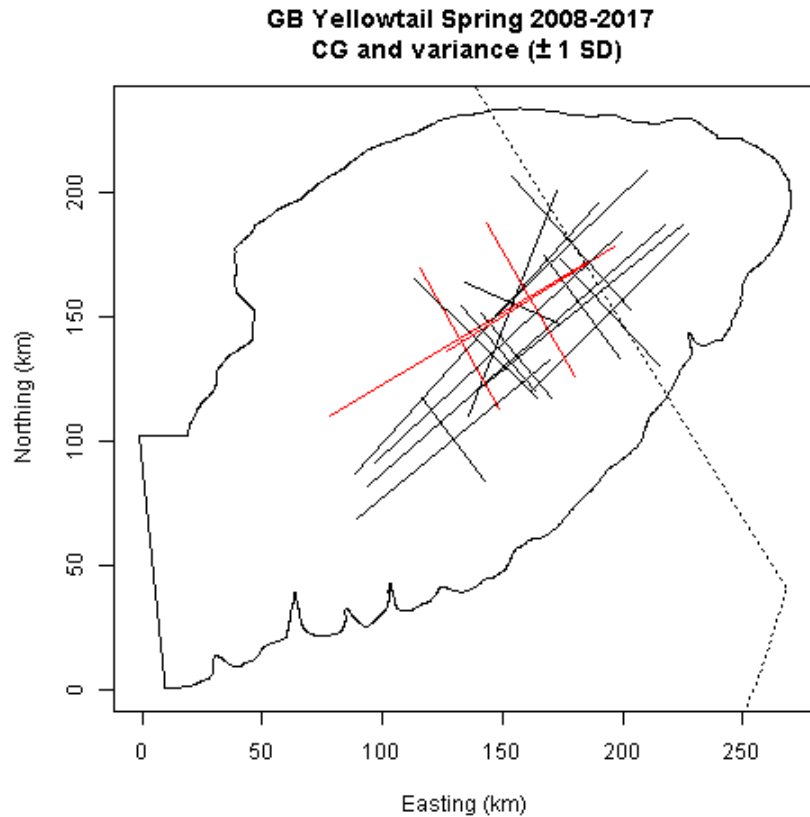
→ Simulation study demonstrated better performance using terminal year rather than 3-year moving average

Other TOR

- Evaluate and quantify, if possible, scientific uncertainty of the assessment output (catch projection), discussing current practices of characterization and alternative methods of evaluation
 - Survey catch/tow (annual variability)
 - Survey area (untowable area)
 - Tow area (consider some herding)
 - Survey catchability (uncertainty in new q estimate)
- Simulation study conducted to vary these 4 factors, evaluate impact on catch advice
- The survey catch per tow was the dominant source of uncertainty
- The decrease in the average survey biomass was much greater than the uncertainty bounds found during this exercise, meaning the decline in the surveys is significant

Other TOR

- Evaluate potential implications of the delayed 2016 RV spring survey on the 2017 allocation shares assessment



- The mean location in 2016 was within ± 1 standard deviation of other mean locations over the past decade
- In terms of spatial distribution there should be no impact of the delayed 2016 survey on the assessment.

Other TOR

- For information, describe potential modeling approaches that could be considered in future assessment of Georges Bank stocks
 - 2 State Space Models explored, estimating unreported catch or changes in natural mortality
- Both state models can substantially reduce retrospective bias
- One approach predicts catch well below observed catch in the early years and well above the observed catch in recent years (up to 4 times higher)
- One approach estimates M for ages 3-6 has increased from ~ 0.25 to ~ 1.0
- Both approaches indicate poor condition of the stock with few adults, low expectation of incoming cohorts, and high total mortality

Thank you for your attention.
Questions?