Empirical estimates of maximum catchability and minimum biomass of Georges Bank yellowtail flounder on the NEFSC bottom trawl survey

David Richardson et al.

Intersessional Transboundary Resource Assessment Committee meeting to review yellowtail flounder catchability

26 June 2017

Twin trawl study

Objective: Provide an estimate of the maximum efficiency of the rockhopper gear used on the NEFSC trawl survey for flatfish, skates and goosefish

Chain sweep designed to maximize the catch of fish that are strongly bottom oriented

Chain to Rockhopper sweep catch ratios

Fourspot Flounder

5:1

Smooth Skate
Gulfstream Flounder

4:1

Witch Flounder
Yellowtail Flounder
Windowpane
Little/Winter skate

3:1

Goosefish
Thorny skate

2:1

Barndoor skate
Summer Flounder
American Plaice
Winter Flounder

1:1

Yellowtail on the twin trawl study

Across all of the tows, by weight the rockhopper sweep catch was 27.6% of the chain sweep catch

Table 1 in Working paper

		Day	Night	**All Tows**
Weight	Chain	1516.7	2176.83	**3693.5**
	Rockhopper	307.8	712.44	**1020.2**
	Ratio (95% CI)	4.93 (4.18 -5.74)	3.05 (2.80 -3.32)	**3.62 (3.30 -4.02)**
Number	Chain	4202	6062	10264
	Rockhopper	812	1964	2776
	Ratio (95% CI)	5.17 (4.43 -5.94)	3.08 (2.82 -3.35)	3.70 (3.36 -4.10)
Positive Stations	Chain	59	62	121
	Rockhopper	56	63	119

Analytical Approaches

- Compared a number of approaches to calculating biomass to account for diel effects, and length-specific effects
  - Which approach conceptually makes the most sense and what are the underlying assumptions?
  - Does adding complexity make a difference?
- Used bootstrapping to derive confidence intervals

Standard Approach

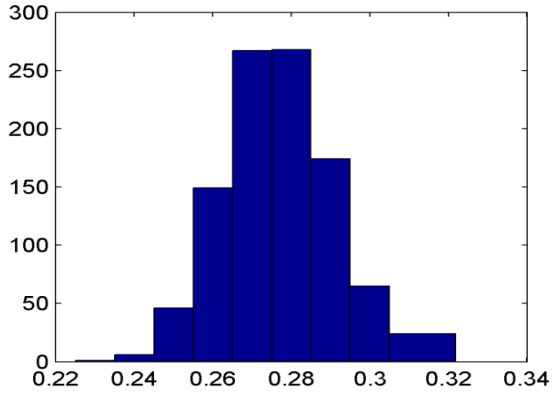
- Ignore diel and length-specific effects
- Chain sweep 100% efficient- Rockhopper sweep efficiency calculated from twin trawl experiment.

$$B_t = \frac{A}{aq} I_t \qquad A=37{,}773\ km^2 \quad a=0.024\ km^2$$

- Uncertainty in biomass presented in working paper based on just uncertainty in q (catchability), and based on uncertainty in q and I_t (index).

q=0.276
(equivalent to the chain sweep being 3.62x more efficient)

Histogram of q estimates



Add length-specific calculations

- APPROACH: Calculate length-specific catchabilities, apply to abundance-at-length data and then convert to biomass with a length-weight relationship
- *RATIONALE:* Appropriate if there are both:
  1. Differences in q by length
  2. Differences between the experiment and survey in length structure
- *IMPACT:* For Georges Bank yellowtail the differences from the standard approach were minor

Diel effects-Approach 1

- *APPROACH:* Assume chain sweep is 100% efficient during both day and night.
- Calculate day and night rockhopper q separately and weight these based on the average proportion of daytime and nighttime tows
- *RATIONALE:* Appropriate if there is a mismatch between the day/night sampling of the experiment and the survey
- *RESULTS:* Slightly lower q in the Spring survey (0.259) and nearly equal q in the fall (0.275)

Diel effects-Approach 2

- *APPROACH:* Assume chain sweep is 100% efficient at night.
- Calculate night rockhopper q based on twin trawl study and daytime rockhopper q based on day:night ratios on survey
- *RATIONALE:* Day:night differences in behavior are prominent in Yellowtail and other flatfish, and nighttime catch rates are consistently higher.

  Allows daytime chain efficiency to be less than 100% or greater than 100% (i.e. daytime herding)

- *RESULTS:* Fall a prominent difference (0.214 vs 0.276). Spring a minor difference (0.270)

Tow-by-Tow analyses

- *APPROACH:* Instead of developing a single catchability value for a survey stratified mean, apply nighttime and daytime catchabilities on a tow-by-tow basis and then calculated the stratified mean
- *RATIONALE:* Sampling of important habitat may not be evenly distributed between day and night in any one year.

  Tow-by-tow analyses will most prominently affect the index trend versus index scaling.

  Largest effect in trend may be seen when there is a prominent day-night difference in rockhopper catchability
- *RESULTS:* Some years scaled up and some down.

Herding

- Many more studies have evaluated herding during the day than at night
- Flatfish herding prominent during the day but tends to break down at night/low light (Ryer 2008)

Daytime herding studies:
Main and Sangster 1981
Bublitz 1996
Somerton and Munro 2001,
Somerton et al. 2006,
Bryan et al. 2014

Day and Nighttime:
Glass and Wardle 1989
Ryer and Barnett 2006
Ryer 2008
Ryer et al 2010

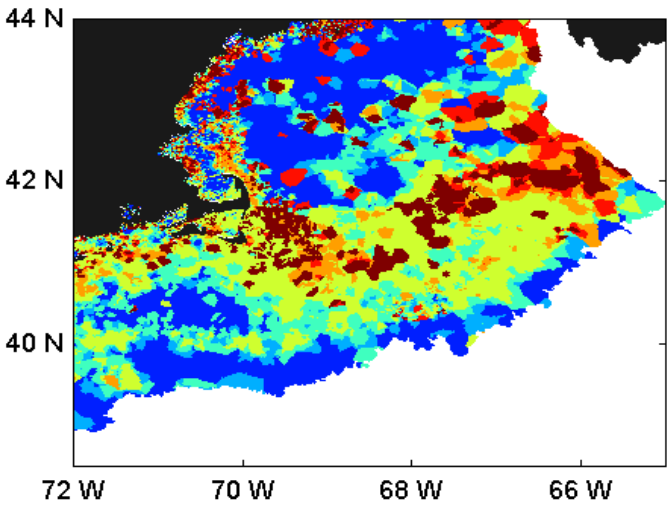
- Fish tend to “rise” & “hop” in the dark versus “run” in the light (Ryer and Barnett 2006)
- Rationale for considering nighttime tows 100% efficient using wing-swept area

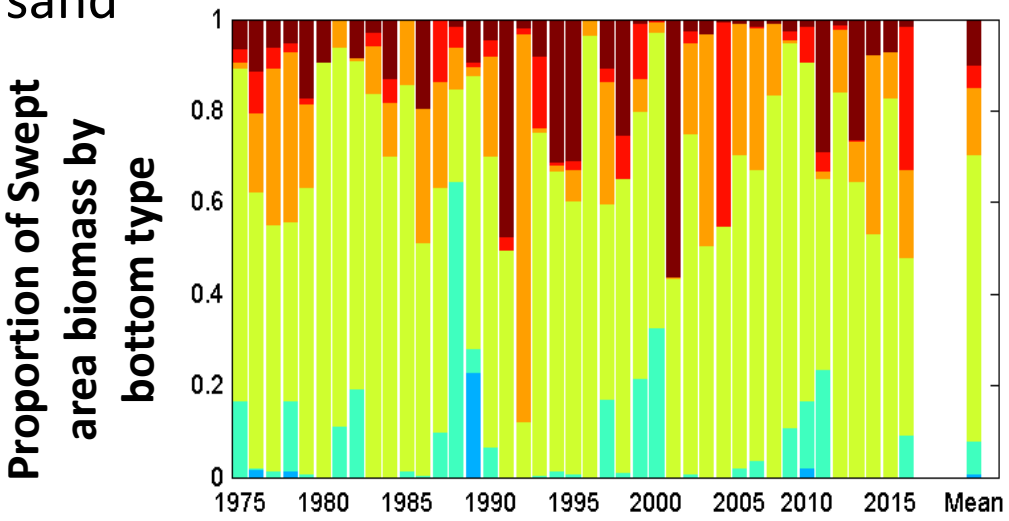
Habitat analysis

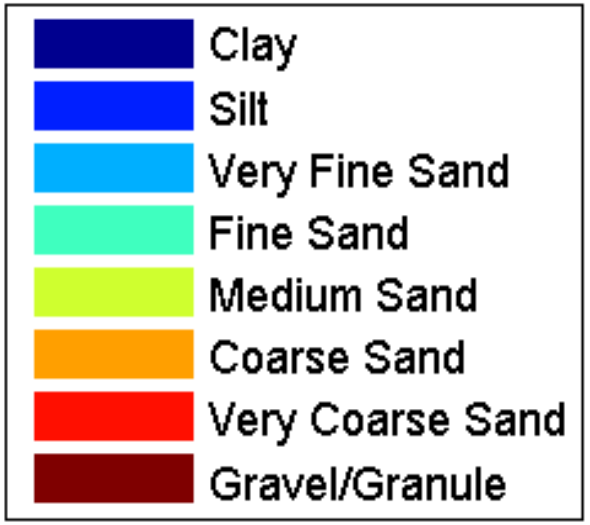
- **Rockhopper sweep ensures many types of bottom type can be towed; chain sweep more constrained**
- **Are the rockhopper catchability estimates applicable to bottom types that were undersampled with the experiment?**
  - **Chain:Rockhopper catch ratio greater in an undersampled habitat than in the experiment –Q an overestimate**
  - **Chain:Rockhopper catch ratio lower in an undersampled habitat than in the experiment, but Rockhopper Q constant –Q is valid**
  - **Chain:Rockhopper catch ratio lower in an undersampled habitat than in the experiment, but Rockhopper Q is not constant –Q is an underestimate and biomass may be biased high**

Habitat sensitivity analysis (1)

- Partitioned swept area biomass by bottom type
- Bottom type source--Northwest Atlantic Marine Ecoregional Assessment---Nature Conservancy
- 86% of the swept area biomass on coarse sand or finer grain bottom types
- 63% of swept area biomass on medium sand

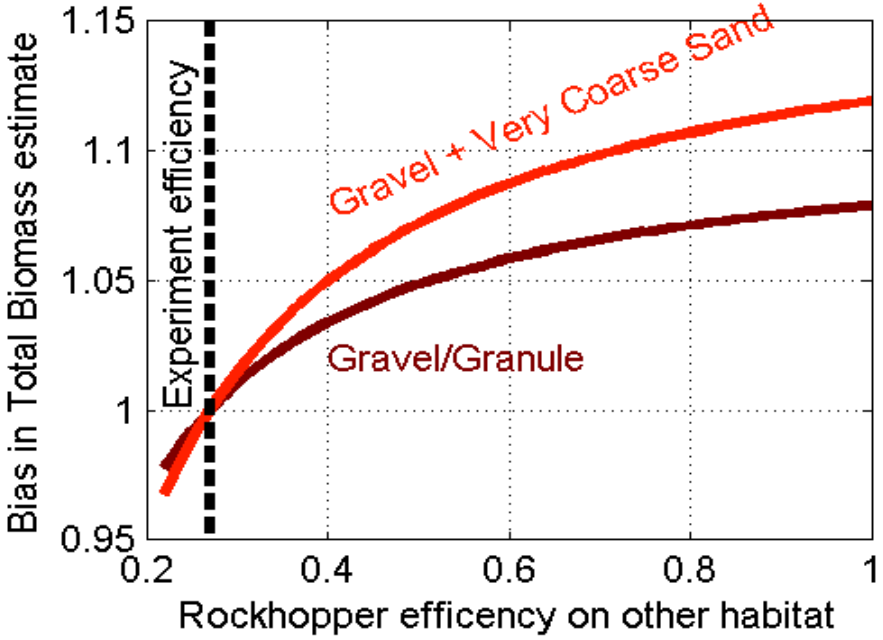






Habitat sensitivity analysis (2)

- What is the bias in the biomass estimate if rockhopper catchability is higher on these larger grain bottom types?
  - ≈7-13% if the rockhopper sweep is 100% efficient on these bottom types



Questions