Science, Service, Stewardship

Chronic Bottom Fishing, the Invasive Ascidian *Didemnum vexillum*, and Demersal Fish Feeding: The "Pros" and "Cons" of Habitat Alteration on Northern Georges Bank

Brian E. Smith[1], Jeremy S. Collie[2], and Nicole L. Lengyel[2]

[1]NOAA, NMFS, Woods Hole, MA

[2]University of Rhode Island, Graduate School of Oceanography, Narragansett, RI

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Major Objectives

- Examine the effects of bottom fishing disturbance and *Didemnum vexillum* on two benthic communities of northern Georges Bank:
    1. Epibenthic Macroinvertebrates
    2. Demersal Fish Diets
        - Alteration of predator-prey dynamics

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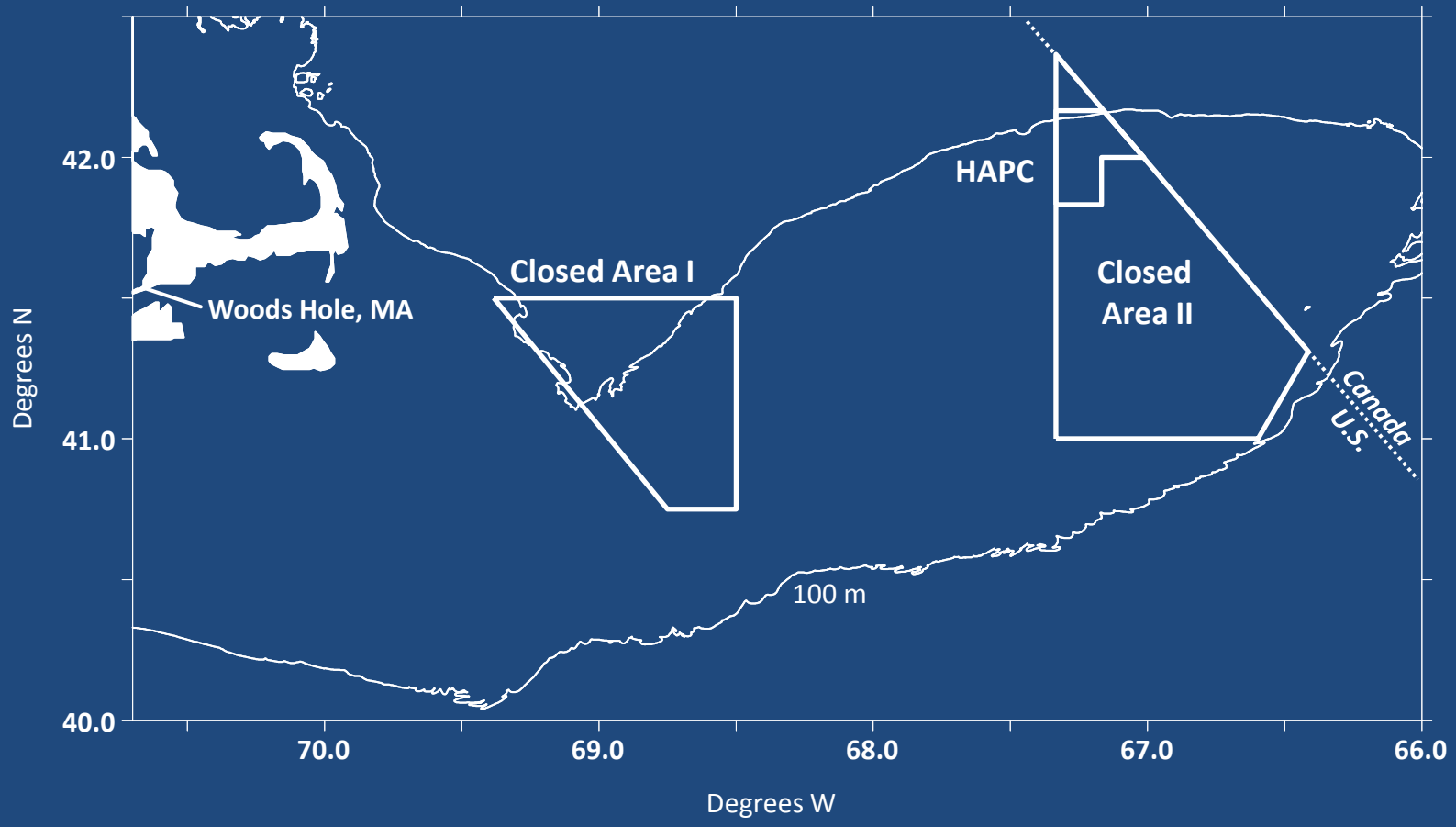
Rationale

- Global concern for chronic bottom fishing disturbance and the invasive *D. vexillum*, particularly in North American waters
- Evidence of impact on Georges Bank benthic invertebrate communities, but indirect effects on commercially- and ecologically-important resources (i.e. demersal fishes) largely unexamined

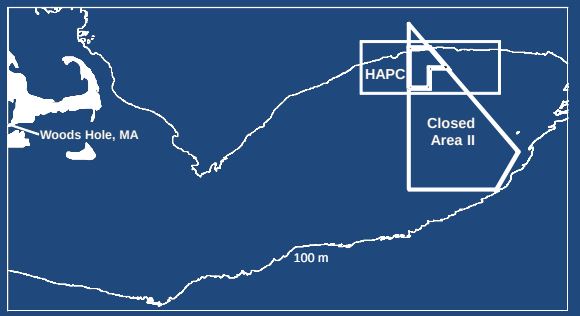
Methods

Sampling Regions of Georges Bank



- Closed areas implemented in 1994
- *D. vexillum* first documented on Georges Bank in 2002

Methods

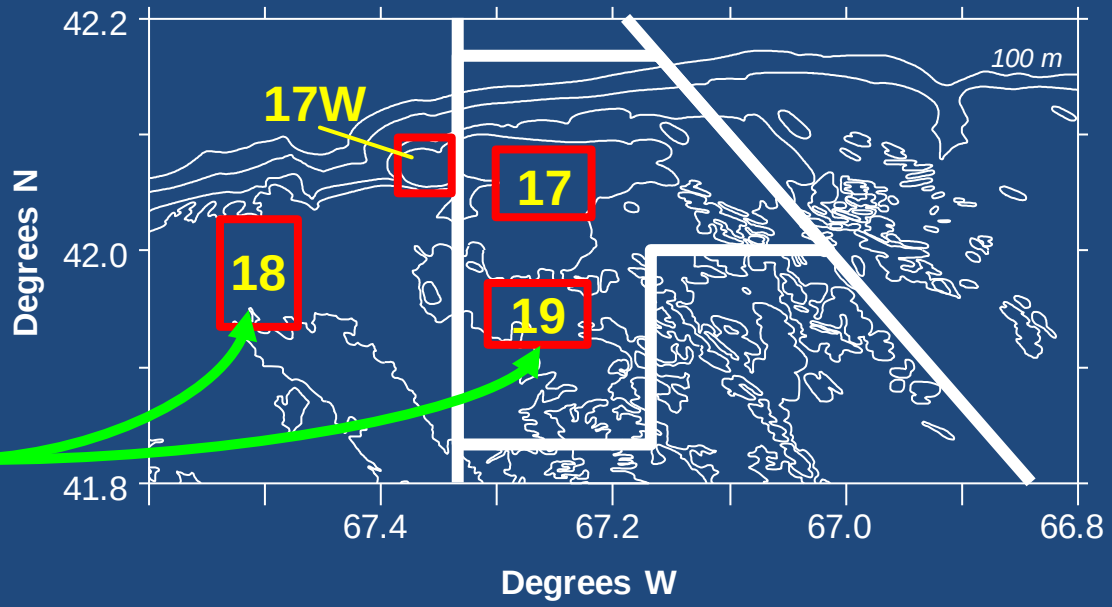


Sampling Sites

- HAPC (4), depth: 45-55 m, gravel/cobble substrate
- Similar substrate type and depth
- Bottom fishing disturbance (Sites 17W-17, 18-19)
- *D. vexillum* presence/absence (Sites 17W-18, 17-19)
- Combined coverage > 230 km^2 at Sites 18 and 19
- Collie et al. 1997, Hermsen et al. 2003, Collie et al. 2005

Didemnum vexillum

P. Valentine and D. Blackwood



Methods

Station Sampling:

- Benthic macrofauna: 1-m Naturalist dredge (2004-08; 2-3 per site)

- Demersal fish: NEFSC Yankee 36 Trawl (2004-07; 1-4 per site), and 4-Seam Trawl (2008; 2-3 per site)

- Fish Stomachs: Examined at sea (volumetrically) and preserved for lab processing (2004-08)

  - Haddock (*M. aeglefinus*)
  - Winter Flounder (*P. americanus*)
  - Winter Skate (*L. ocellata*)
  - Little Skate (*L. erinacea*)
  - Longhorn Sculpin (*M. octodecemspinosus*)

FRV Bigelow

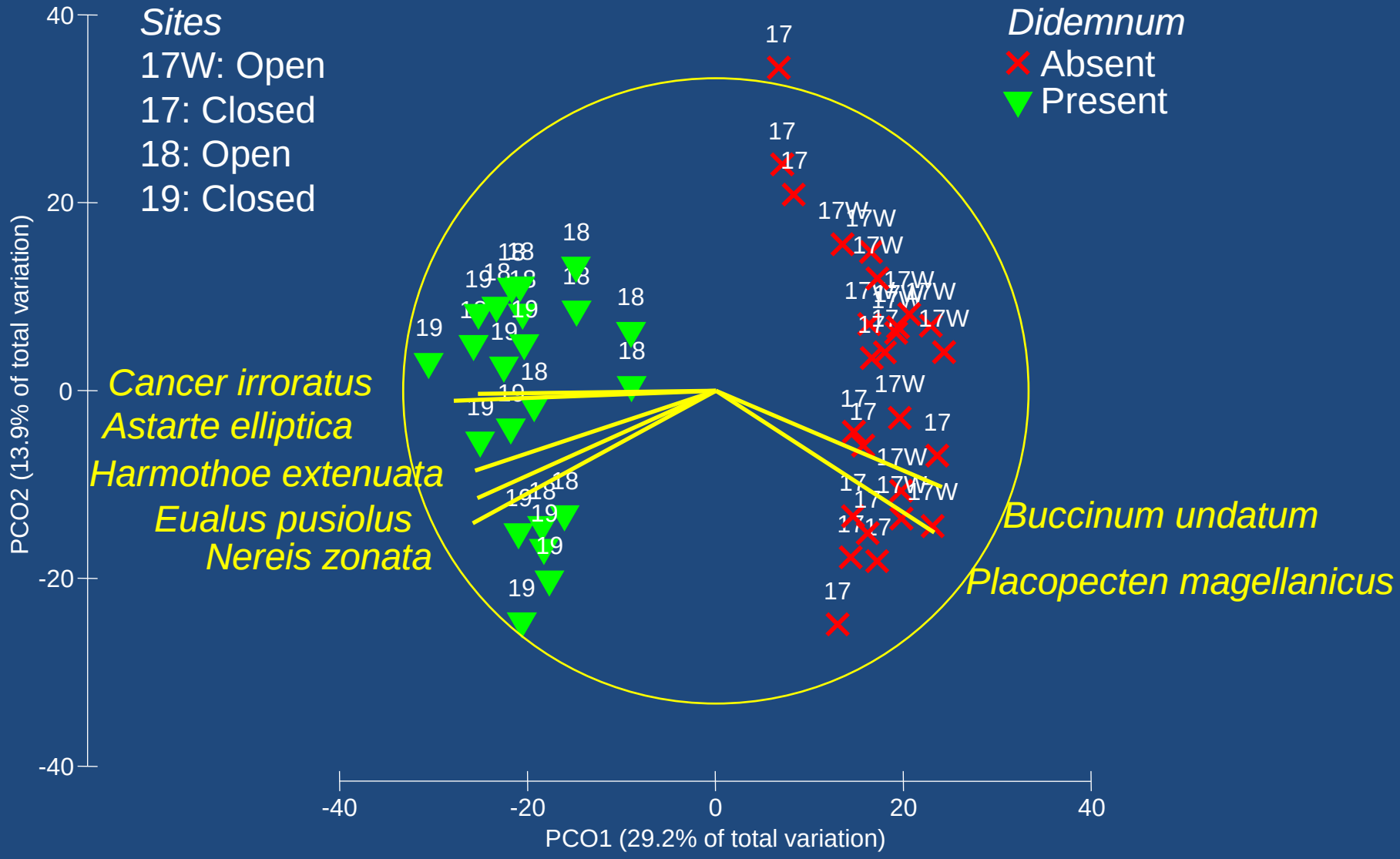
Methods

Data Analysis: Year, Fishing Disturbance level, and *D. vexillum* level as fixed effects

- Benthos: Standardized abundance (n/L) and biomass (g/L), two-way ANOVA
  - Site combinations, species correlations, PCO
  - Top 10 species abundance and biomass

- Fish Diet: Stomach contents standardized as proportion of predator mass or total stomach content
  - Total stomach content index, Kruskal-Wallis
  - Diet similarities, 10-12 major prey taxa for predators, Bray-Curtis similarity index, ANOSIM, SIMPER
  - Rank correlations: Fish diet – benthos; reshuffle benthos between sites

Results: Benthos



Results: Benthos

- Indices: Top 10 Species Abundance (n L^{-1}) and Biomass (g L^{-1})
  - Statistical differences across fishing disturbance levels
  - Fishing effect NS for many species between Sites 18 and 19 with *D. vexillum*
  - Effect of *D. vexillum* on abundance and/or biomass significant for *Harmothoe* spp., *Nereis zonata*, and *Cancer irroratus*; greater amounts where *D. vexillum* present
  - *D. vexillum* effect consistent for both site combinations

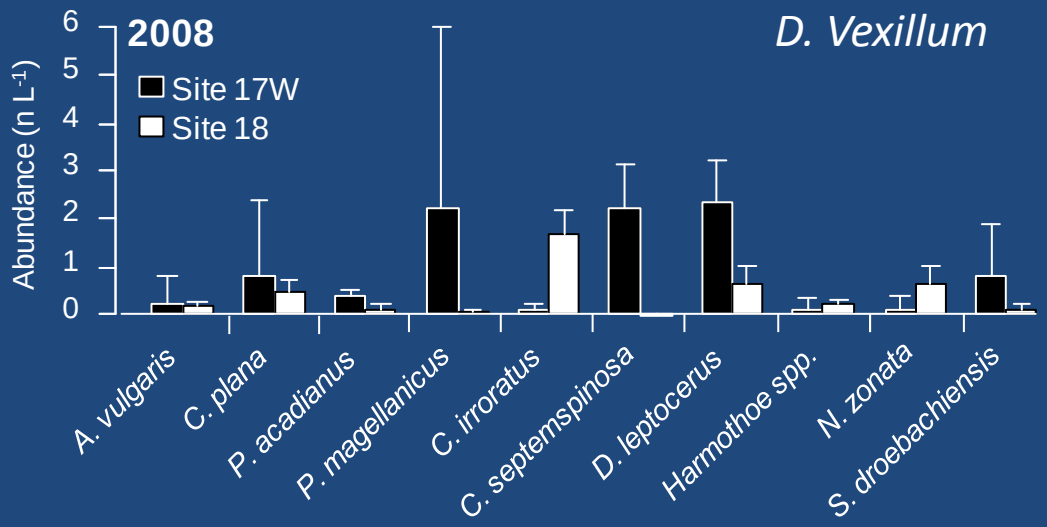
Abundance, 17W-18

Species	Year(F)	Site(F)	Int.(F)
Harmothoe spp.	8.28*	27.79**	2.99
N. zonata	5.53*	87.21***	1.20

Biomass, 17W-18

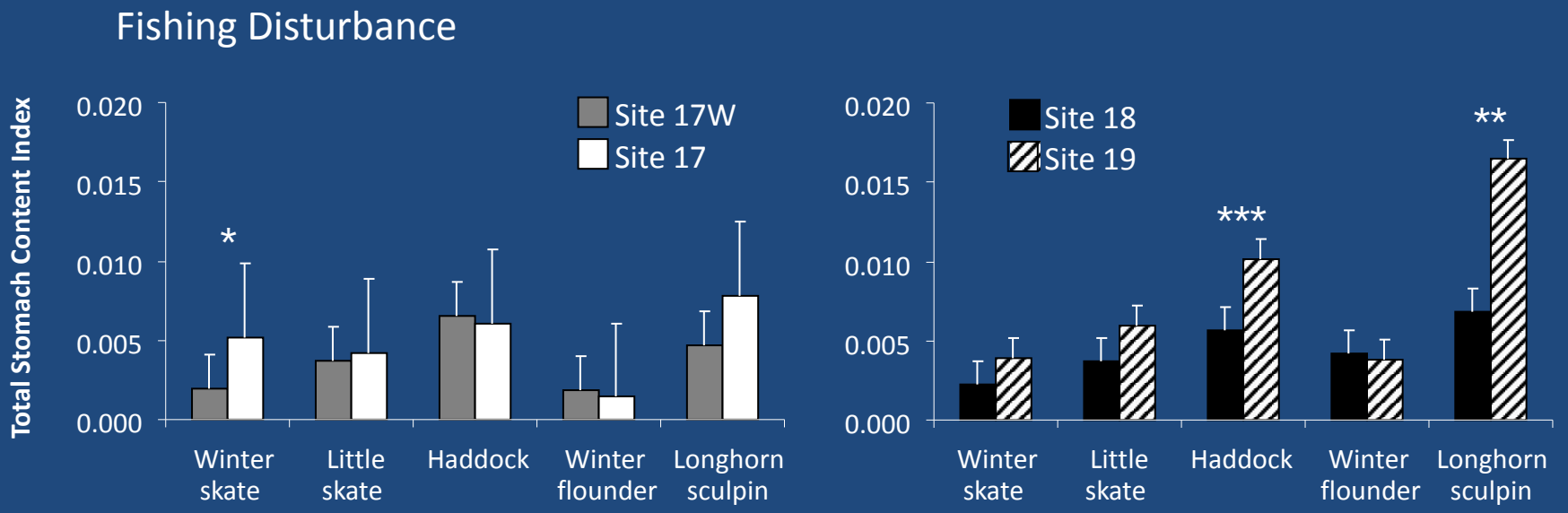
Species	Year(F)	Site(F)	Int.(F)
C. irroratus	2.52	76.73***	0.94
Harmothoe spp.	1.32	16.92**	0.57
N. zonata	8.04***	133.93***	2.15

*p <0.05; **p <0.01; ***p <0.001



Results: Fish Diet

- Diet Index: Total Stomach Contents (g)
  - Few differences across fishing disturbance levels
  - Consistently greater total amounts of food eaten in non-fished areas
  - Few differences across *D. vexillum* levels
  - Generally more food eaten in areas with *D. vexillum*



Results: Fish Diet

Winter Flounder Diet Sampling

- Diet Composition
  - Minor differences across fishing disturbance levels
    - Winter flounder: Sites 18-19
  - In contrast, multiple species with statistical differences in diet composition across *D. vexillum* levels
    - Sites 17W-18: winter skate, little skate, and longhorn sculpin
    - Sites 17-19: little skate, haddock, winter flounder, and longhorn sculpin
  - *D. vexillum* appears to have a stronger influence on prey availability

Results: Fish Diet

- Diet Similarity Percentages
  - Winter flounder diets at Sites 18 and 19, differences due to taxa: Anthozoa (+18), *Cancer* crabs (+19), and Polychaeta (+19)
  - Fragile taxa (e.g. Polychaeta) shown to be reduced by fishing disturbance, but presence of *D. vexillum* possibly limiting fishing effect
  - Considering *D. vexillum* effect, diet differences for all species primarily due to taxa: Polychaeta and *Cancer* spp. (+18 and +19)

D. vexillum: Winter Flounder, Sites 17-19

	Mean Proportion		Dissimilarity		Percent	
Taxa	Site 17	Site 19	Mean	Mean SD^{-1}	Contribution	Cumulative
Cancer spp. crabs	0.0223	0.2383	15.65	1.02	19.08	19.08
Polychaeta	0.0764	0.1308	14.19	0.97	17.31	36.39
Anthozoa	0.1814	0.0009	13.85	0.81	16.89	53.28
Well-digested Prey	0.0565	0.0254	10.34	0.74	12.61	65.89
Gammaridea	0.0357	0.0286	9.36	0.65	11.42	77.30
Sand	0.0064	0.0168	5.75	0.52	7.02	84.32
Rock	0.0100	0.0036	3.97	0.62	4.84	89.16
Didemnum spp.	0.0000	0.0121	3.28	0.35	4.00	93.16

Results: Fish Diet

Hyas spp. with D. vexillum

- Rank Correlations: Fish Diet – Benthos
  - Fish diets generally reflected what was available within the benthic environment
  - These results were most consistent within non-fished and *D. vexillum* present sites
  - Strongest correlations observed for species with larger proportions of benthic invertebrates in their diets (e.g. haddock and winter flounder)
  - Results highlight the strong association between demersal fish diets and benthic invertebrates despite differences in sampling efficiency between devices

Conclusions

- Documented bottom fishing disturbance and *D. vexillum* effects on Georges Bank benthos and prey availability
- Chronic bottom fishing reduced some benthic taxa (fragile), but *D. vexillum* confirmed to be favorable for select taxa (e.g. two polychaete species)
- Fish diet compositions mirrored benthos
- These results represent relatively short-term effects of *D. vexillum*; long-term effects on Georges Bank remain unknown

Dredge Sample

Acknowledgements

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Questions?