

# The Effects of the Invasive Ascidian *Didemnum vexillum* on Northern Georges Bank: from Benthic Macrofauna to Demersal Fish Diet



Brian E. Smith<sup>1</sup>, Jeremy S. Collie<sup>2</sup>, and Nicole Lengyel<sup>2</sup>

<sup>1</sup>National Marine Fisheries Service, Northeast Fisheries Science Center, Woods Hole, Massachusetts, USA

<sup>2</sup>University of Rhode Island, Graduate School of Oceanography, Narragansett, Rhode Island, USA

## INTRODUCTION

There has been much concern over the invasive ascidian *Didemnum* sp. in North American waters particularly its effects on marine benthic communities (e.g. Bullard et al. 2007; Valentine et al. 2007; Lengyel et al. 2009). On northern Georges Bank (northwest Atlantic), *Didemnum vexillum* has colonized > 230 km<sup>2</sup> of gravel habitat (Sites 18 and 19 [figure right]; Valentine et al. 2007).

The objectives of this study were to quantify the differences between benthic macrofaunal communities and winter flounder (*Pseudopleuronectes americanus*) feeding habits of northern Georges Bank subjected to contrasting levels of *D. vexillum*. The feeding habits of winter flounder were examined to explore the alteration of predator-prey dynamics in the presence of *D. vexillum* for this region.

## METHODS

### Data Collection

The sampling for this project occurred July through September (2005-2008) within the Habitat Area of Particular Concern (HAPC) region of Closed Area II on Georges Bank (figure left).

Site selection was determined to compare areas with contrasting levels of *D. vexillum* coverage (presence versus absence) while considering variability in the benthic macrofaunal community due to substrate type, depth, and bottom disturbance from commercial fishing. See also Collie et al. (1997; 2005) for detailed site descriptions.

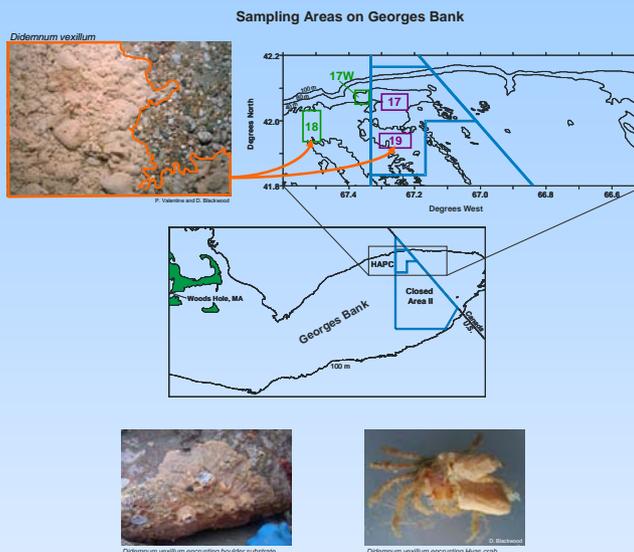
Benthic macrofauna were sampled with a 1-meter wide Naturalists' dredge with a 6.4 mm liner. Organisms were manually sorted from the substrate and later identified, weighed (wet; ±1 mg), and enumerated in the laboratory. Taxa not quantitatively sampled by the dredge (e.g. caprellids, and other amphipods) were removed prior to analysis.

Concurrent with benthic macrofaunal sampling, stomach samples from winter flounder (*Pseudopleuronectes americanus*) were collected with a #36 Yankee (2004-2007) or 4-seam (2008) otter trawl. Stomachs were examined at sea volumetrically or processed in the lab. In each case, wet masses (±0.01 g) were obtained.

### Data Analysis

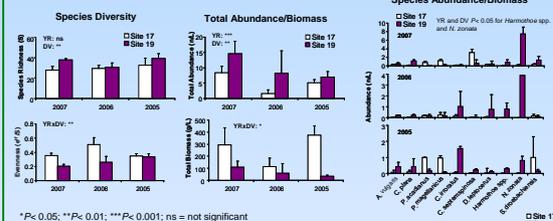
Benthic macrofaunal indices: Total station abundance (n/L) and biomass (g/L); top 10 species abundance and biomass; species richness (S); and evenness (e<sup>H</sup>/S; base 2 logarithm). Two-way ANOVA with year (YR) and *D. vexillum* level (DV) as fixed effects.

Fish diet: Total stomach content index (g; standardized by predator mass (g)); Kruskal-Wallis test. Diet composition (prey as proportion of individual total stomach content); Bray-Curtis similarity index; one-way ANOSIM and SIMPER routine (PRIMER).



## RESULTS: Benthic Macrofauna

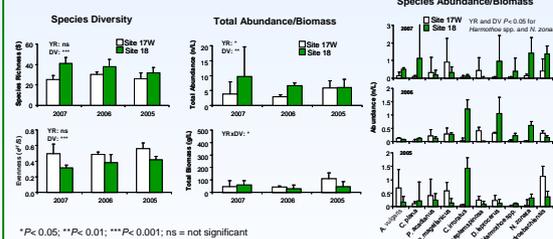
### HAPC Sites 19-17:



\*P<0.05; \*\*P<0.01; \*\*\*P<0.001; ns = not significant

- Species diversity (S), and total abundance and biomass of benthic macrofauna were generally greater at Sites 19 and 18 with *D. vexillum* present. In contrast, evenness (e<sup>H</sup>/S) was more variable with significant Year (YR) and *D. vexillum* level (DV) interactions (Sites 19-17) or higher where *D. vexillum* was absent (Sites 18-17W).

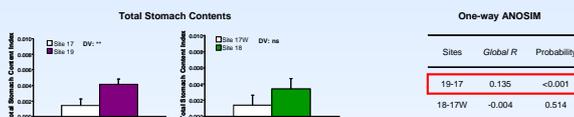
### HAPC Sites 18-17W:



\*P<0.05; \*\*P<0.01; \*\*\*P<0.001; ns = not significant

- Species abundance and biomass for the two polychaetes: *Harmothoe* spp. and *N. zonata*, and the Cancer crab: *C. irroratus* (biomass only) were observed to be higher in the presence of *D. vexillum*, and these results were consistent for both site comparisons (Sites 19-17 and Sites 18-17W)

## RESULTS: Winter Flounder Diet



### SIMPER: Sites 19-17

Taxa	Mean Proportion	Similarity%	Mean	Mean / SD	Percent Contribution
Cancer spp.	0.0223	0.2383	8.97	14.39	15.65
Polychaeta	0.0764	0.1308	4.15	7.75	14.19
Amphozoa	0.1814	0.0009	3.14	1.93	13.85
Well-digested Prey	0.0595	0.0254	1.85	1.74	10.34
Gammaridea	0.0357	0.0286	1.69	0.84	9.36
Sand	0.0064	0.0168	1.63	0.8	5.75
Rock	0.0100	0.0036	0.70	0.56	3.97
<i>Didemnum</i> spp.	0.0000	0.0121	0.16	0.33	3.28

\*P<0.05;

\*\*P<0.01;

\*\*\*P<0.001;

ns = not significant

- In general, a greater amount of food per stomach (total stomach contents) was observed at Sites 19 and 18 where *D. vexillum* was present; however, these differences between sites were only statistically significant for Sites 19-17 found inside Closed Area II
- Marked dissimilarities in winter flounder diet composition were also shown for Sites 19-17 (One-way ANOSIM). Interestingly, the prey items that largely contributed to these differences in feeding habits were taxa that responded positively to the presence of *D. vexillum* as shown in the benthic macrofaunal community (*Cancer* spp. and Polychaeta; SIMPER)

## REFERENCES

Bullard et al. (2007). The colonial ascidian *Didemnum* sp. A: Current distribution, basic biology and potential threat to marine communities of the northeast and west coasts of North America. *J. Exp. Mar. Biol. Ecol.* 342:99-108.

Collie et al. (1997). Effects of bottom fishing on the benthic megafauna of Georges Bank. *Mar. Ecol. Prog. Ser.* 155:159-172.

Collie et al. (2005). Effects of fishing on gravel habitats: assessment and recovery of benthic megafauna on Georges Bank. In: Barnes, PW, Thomas, JP (Eds.), *Benthic Habitats and the Effects of Fishing*. AFS Symp, vol. 41. Bethesda, MD, pp: 325-343.

Lengyel et al. (2009). The invasive colonial ascidian *Didemnum vexillum* on Georges Bank – Ecological effects and genetic identification. *Aquat. Inva.* 4:143-152.

Valentine et al. (2007). The occurrence of the colonial ascidian *Didemnum* sp. on Georges Bank gravel habitat – Ecological observations and potential effects on groundfish and scallop fisheries. *J. Exp. Mar. Biol. Ecol.* 342:179-181.



## CONCLUSIONS

- D. vexillum* has a profound positive effect on two polychaete species (*Harmothoe* spp. and *Nereis zonata*) and to a lesser degree the Cancer crab: *C. irroratus* of northern Georges Bank
- Substantial differences in the feeding habits of winter flounder were observed, linked to prey availability, and documented a second-order effect of *D. vexillum*; however, our findings were more dramatic in areas closed to bottom fishing (inside HAPC of Closed Area II)
- Further work on the second-order effects of *D. vexillum* is currently ongoing and exploring additional economically- and ecologically-important fishes of this region
- For further information please contact Brian Smith (Brian.Smith@noaa.gov)