

**SEEKING *Didemnum* ON GEORGES BANK**

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## Seeking *Didemnum* on Georges Bank

### Preliminary Report of the MITSG Autonomous Underwater Vehicle Cruise To Georges Bank July 8-21, 2008

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Collaborating Participants: Elisabeth Broughton, NOAA:NMFS, Page Valentine, USGS Woods Hole Field Center

**Purpose: To test the efficacy of an acoustic sensor in identifying the distribution of an aggressive sea squirt on Georges Bank that is threatening scallop and groundfish fisheries.**

#### **Introduction:**

The presence of *Didemnum vexillum* (formerly referred to as *Didemnum* sp. A), an introduced and invasive sea squirt in New England was first highlighted with the MIT Sea Grant College Program's funded Rapid Assessment Survey of Marine Invaders in August 2000. By 2003 the sea squirt was observed from Long Island Sound to Damariscotta, Maine (the earliest verified record in 1993) and in Georges Bank. This aggressive sea squirt has invaded hard surfaces in subtidal areas and marinas where it overgrows most species and may be the dominant biomass in the community. Its presence in Georges Bank has the potential to impact the valuable groundfish and scallop fisheries that are already suffering from environmental change and fishing pressure. Documenting the risk *Didemnum* poses as one more threat to the economically important fisheries, was identified as a major regional marine invasion issue by the Northeast Aquatic Nuisance Panel.

Surprisingly, the spatial coverage and abundance of *D. vexillum* in Georges Bank is not known, and what information exists is based on optical images (SEABOSS and HabCam) that have covered only a small portion of the potential sea squirt habitat. The MIT Sea Grant College Program is committed to addressing timely regional projects in support of fisheries management<sup>1</sup>. After extensive consultation with researchers who are surveying the presence of *Didemnum* and its impacts to the community, we proposed to test the efficacy of new technologies to improve surveying for *Didemnum* that achieve two goals:

1. achieving greater spatial coverage per unit time that meets the current standard of optical imaging and
2. initiating studies to document areas suitable for *Didemnum* in support of efforts to predict its spread.

The specific purpose was to evaluate an acoustic sensor, the Sound Metrics DIDSON

<sup>1</sup>Sea Grant and NOAA NMFS agreed to work together collaboratively on issues of interest in May 2004. Since then, a workshop on the use of GIS in support of fisheries management and this initiative were two specific efforts in response to the agreement.

(Dual frequency Identification SONar). The DIDSON was recently employed at MIT for high-resolution inspection of the hulls of Navy ships, and is regularly used by the wider oceanographic community for bottom characterization and fish detection.

### **Autonomous Underwater Vehicles**

The use of an autonomous underwater vehicle (AUV) as a platform for ocean exploration has several advantages over ROVs (Figure 1). AUVs may be deployed from shore or research vessels and are capable of untethered dives and precision surveys in shallow and deep water. Several factors make the AUV operations cost-effective and low risk resulting in high quality data products. Accurate navigation and functioning within close proximity to the sea floor (between 1-10 m) permit collection of high resolution data from a variety of sensors and produce detailed maps based on geo-referenced survey patterns. Often data collected by AUVs may be used to highlight areas for later investigation where further investigation is desired.

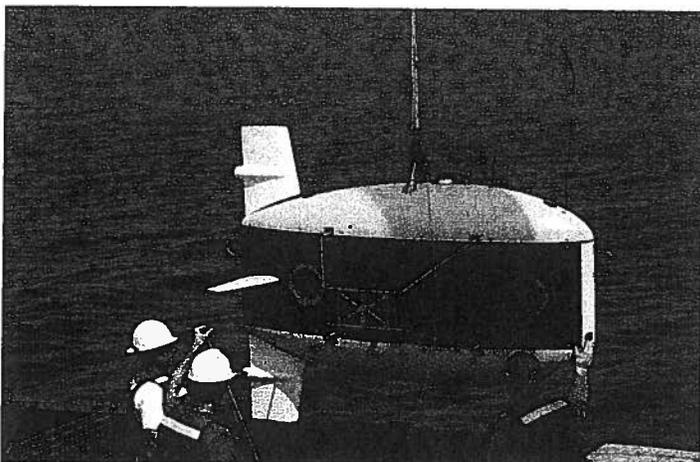


Figure 1. Preparing to launch the MIT Sea Grant College Program autonomous underwater vehicle from the NOAA R/V Bigelow.

Compared to ROVs, AUVs have limited real time control but can map larger areas of the sea floor. Because they are untethered and do not require dynamic positioning, AUVs require minimal surface support, i.e. small research vessels can supervise more than one AUV at a time thereby increasing spatial coverage at less cost.

MIT Sea Grant College Program's most recent AUV is Odyssey IV, a mid-sized (2 m x 1 m x 1.5 m, <1000 lb), streamlined, deep-water capable (6000 m) platform with over 120 L/25 kg (available volume/weight in water) allocated to science payloads. The AUV is stable in towed flight and can perform fast, drop-weight assisted dives. Reaching target depth triggers a weight release mechanism and transition to controlled flight. A hover-capable design, Odyssey IV is controllable from zero speed up to 1.5 m sec<sup>-1</sup> in sustained survey runs. Powerful vectored thrusters are used for hovering in place, or precise four-degree-of-freedom maneuvers (control of surge, sway, heave, and yaw). Navigation suitable for exploratory missions is via Doppler velocimeter-aided dead reckoning, which eliminates the need for reference beacons on the sea floor and increases operational flexibility. The Odyssey IV energy storage and power management system can support

payloads requiring up to 1.5 kW (peak power). Live supervisory command and control, and small amounts of science data upload, are available via acoustic modem. The ROV-like dynamic control, power density, and payload capacity of this AUV make it suitable for a variety of ocean exploration tasks.

The challenge is to identify one or more sensors that can detect the presence of the soft-bodied sea squirt *in situ* using off-the-shelf technologies and a variety of platforms (e.g., AUVs, ROVs, and shipboard). For the AUV platform, a color digital camera and an acoustic sensor were proposed initially as technologies for surveying the seafloor. As an alternative to optical sensors, the DIDSON appeared to be the best option for acoustically sensing the centimeter thick *Didemnum* from the gravel substrate on which it is growing in Georges Bank. Compared to an optical imaging sensor, the DIDSON has the potential to cover 10 times the area of the sea floor in the same time ( $0.5 \text{ km}^2 \text{ d}^{-1}$ ) compared to a camera ( $0.05 \text{ km}^2 \text{ d}^{-1}$ ). The digital camera provides ground truthing for testing alternative sensors. The initial survey covered areas where *Didemnum* has been found and verified as having abundant growth (P. Valentine, USGS, pers. comm. 2007) and expanded to nearby regions that were not previously surveyed.

The research project was initiated this summer with the MITSG autonomous underwater vehicle (AUV), Odyssey IV that carried a DIDSON and an optical camera system. The AUV was deployed in Georges Bank from NOAA's R/V Bigelow during a cruise from July 8-21, 2008. Based on information from previous cruises, the northwest corner of Georges Bank in Closed Area II was surveyed using both acoustic and optical sensors. In addition, the response of the AUV was evaluated in an area of the sea floor where currents reached  $\sim 2.5$  kn. Data from successful tracks were analyzed for presence and absence of *Didemnum* and macrofauna that can be identified from photographs.

Our preliminary findings were successful in detecting *Didemnum* with our optical camera and detecting macrofauna on the seafloor. As a platform for continuing to survey *Didemnum* on the sea floor, the AUV demonstrated several advantages over remotely operated vehicles. It can maintain constant altitude, record geo-referenced data, and log its location for each optical image recorded, and provide additional environmental data (e.g. temperature, salinity, and pH).

There was less success with the DIDSON. The acoustic sensor did not provide sufficient detail to distinguish *Didemnum* from the surrounding gravel habitat. We will be researching other potential sensors for which the Odyssey IV is a suitable platform.

### **Preliminary Data**

There were ten highly successful runs and the data from these images are being collected and will be analyzed to identify species and relative abundances. The preliminary data we collected are consistent with information from other optical data collected in the same region within a few months of our survey. Specifically, we found that *Didemnum* was not as abundant in coverage as previously reported ranging from a 1% to 12-15% in images where it was observed (Figure 2). Examining seven tracks, the number of frames

that had *Didemnum* present ranged from 26% to 100% (Figure 3). For this analysis, only colonies of several centimeters that were clearly *Didemnum* were counted, thus these data probably under-represent the total area where colonies were present. The smaller colony size was observed in an earlier cruise in April, 2008 (S. Gallagher, WHOI, pers. comm., 2008) and a subsequent cruise in August, 2008 (P. Valentine, USGS, pers. comm., 2008) confirmed that colonies were smaller in the summer of 2008 compared to earlier surveys.



Figure 2. An optical image of the sea floor in Closed Area II, Georges Bank showing several colonies of *Didemnum vexillum* growing on gravel substrate.

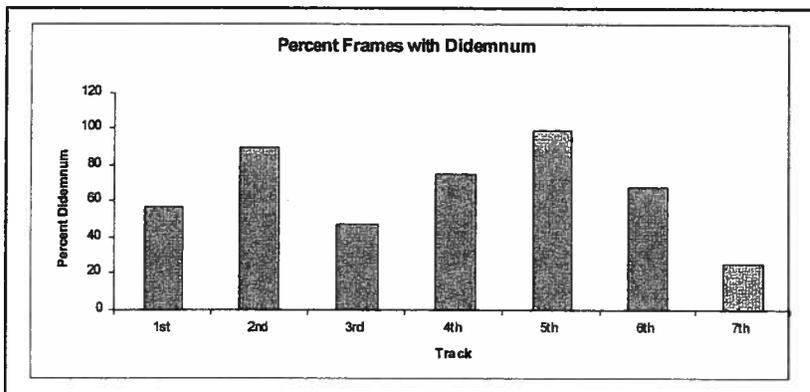


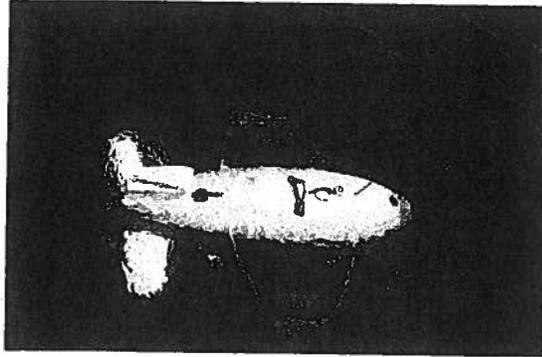
Figure 2. Graph showing the percentage of frames per track that had one or more colonies of *Didemnum vexillum* present. Only clearly identifiable colonies of several centimeters were counted.

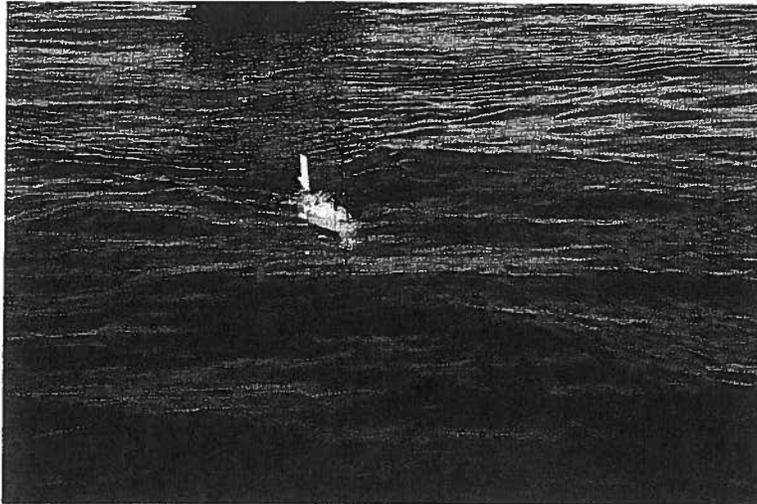
Additional analyses will examine distribution and abundance of clearly identifiable fauna and explore the relationship of environmental data and habitat type with *Didemnum* and important and abundant species in the Closed Area of Georges Bank.

### Next Steps

The impact of *Didemnum vexillum* on the productive groundfish and scallop fisheries in Georges Bank remains a concern and should be the focus of future studies. Although it was not abundant during the 2008 surveys, its presence in the limited areas where we searched, suggests it remains a threat to the species of concern.

Future work needs to be more comprehensive in two areas, mapping of the seafloor to identify potential habitat (hard substrate, gravel areas) and more extensive sampling to identify the spatial coverage of *Didemnum*. Change in colony size is hypothesized to be related to temperature and this needs to be further explored during all seasons. This calls for platforms that collect environmental data at depth and sensors that can provide accurate identification of *Didemnum* colonies in faster rates than optical sensors can provide. These two efforts will be the focus of the future AUV development.





### Georges Bank Sea Scallops Trends in Landings and Fishing Mortality

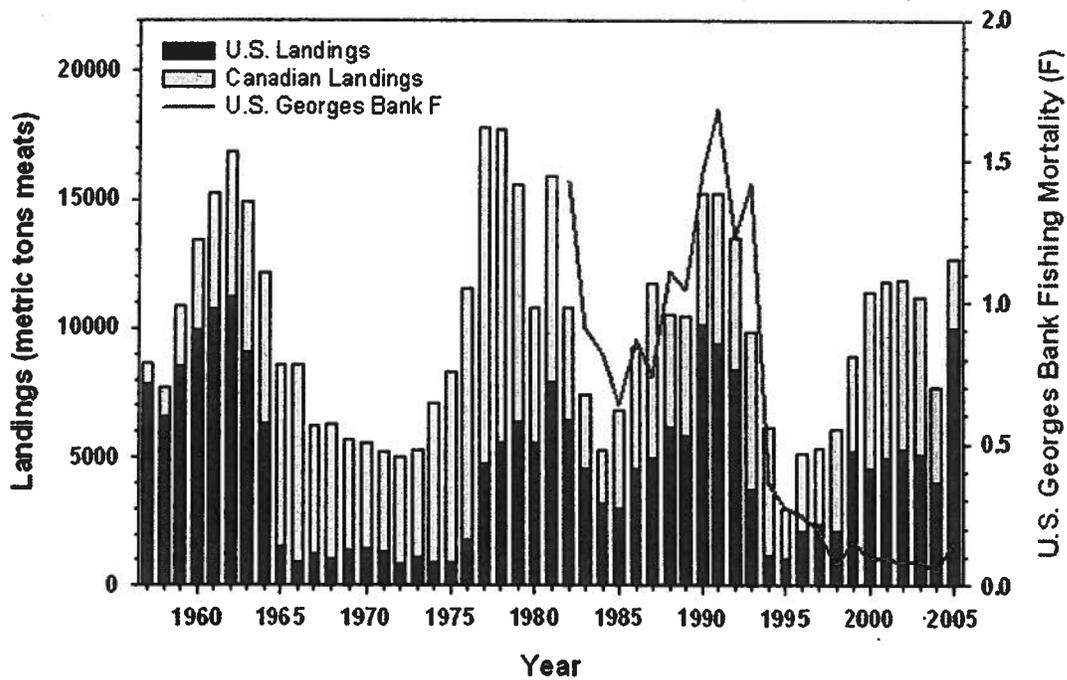


Figure 36.5. Trends in catch and fishing mortality for Georges Bank sea scallops.

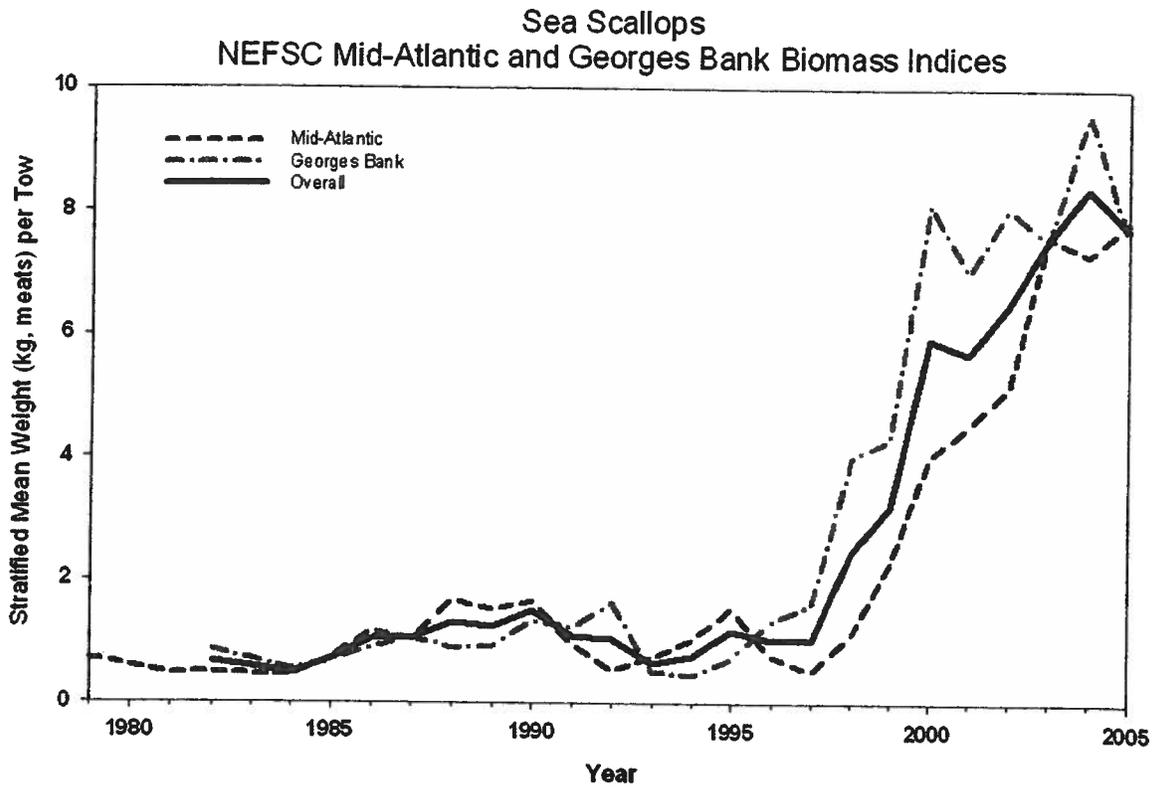


Figure 36.6. Biomass indices (stratified mean weight per tow) for sea scallops in the Mid-Atlantic and Georges Bank regions, and in the two regions combined, from NEFSC sea scallop research vessel surveys.

## Mid-Atlantic Sea Scallops Trends in Landings and Fishing Mortality

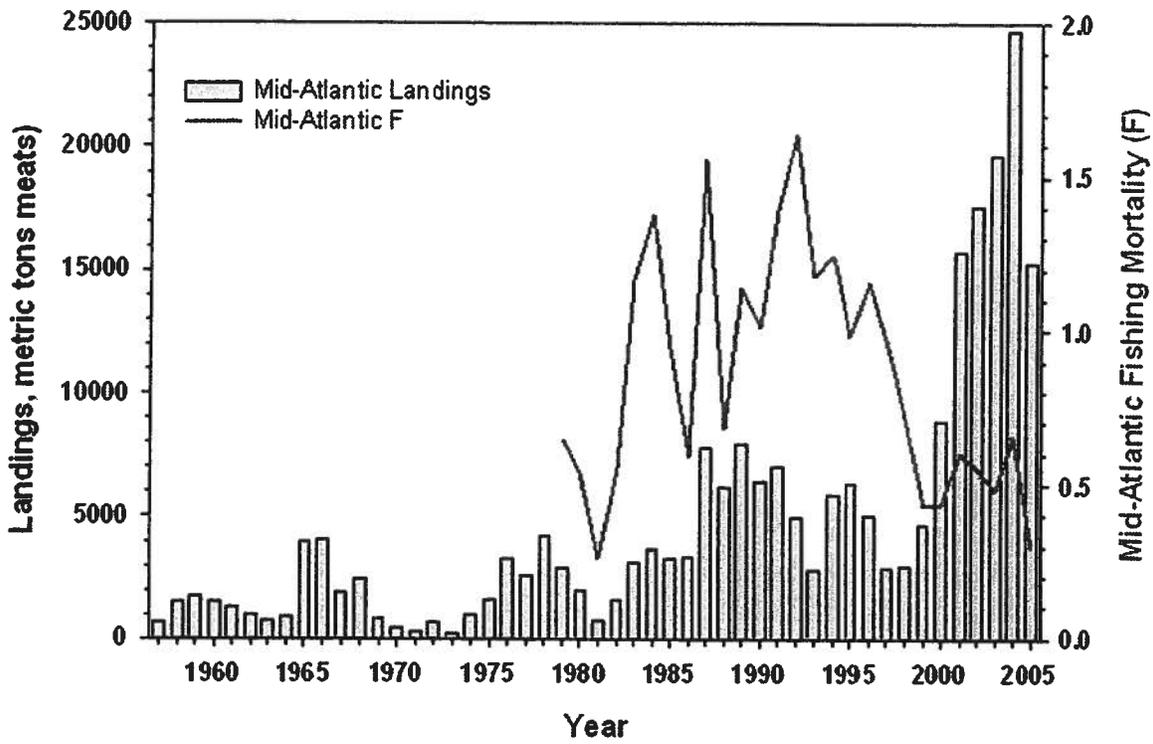


Figure 36.9. Trends in landings and fishing mortality for Mid-Atlantic sea scallops.

# U.S. Georges Bank Sea Scallops

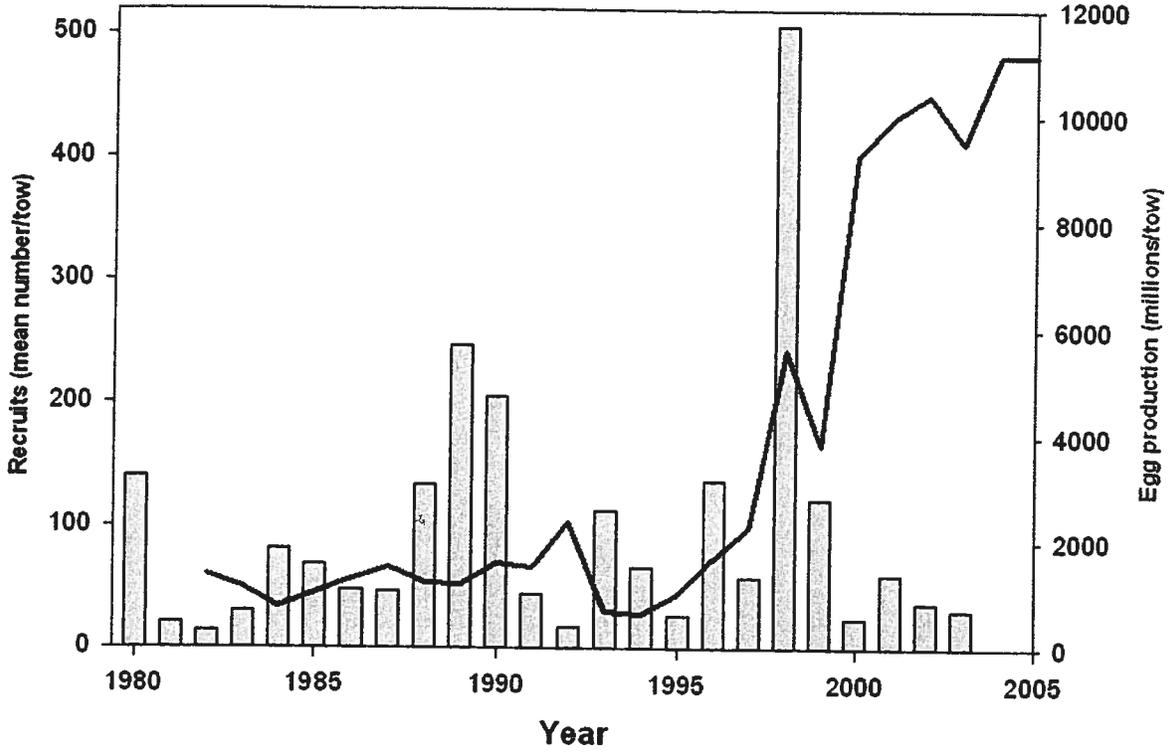


Figure 36.8. Recruitment (bars, at year spawned) and egg production for U.S. Georges Bank sea scallops (Canadian Georges Bank is included in the egg production estimate).

