Where did all the sponges go? Community shifts on a deep water rocky reef in Long Island Sound

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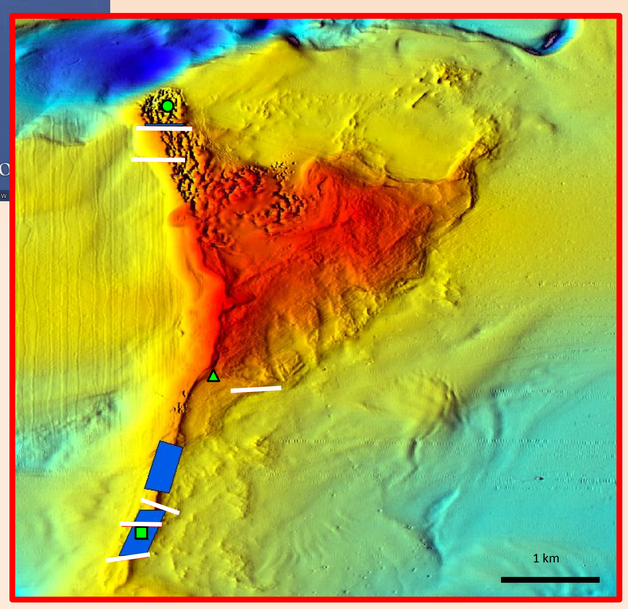
Abstract:

Stratford Shoal is a topographic high dividing the west and central basins of Long Island Sound. The southern side of the shoal has a linear north-south tending boulder reef feature along the crest. Repeated observations of the reef using remote and diver-held cameras from 1991 to 2010 found an apparently stable epibenthic community dominated by branching sponge (*Haliclona oculata*), northern star coral (*Astrangia poculata*), blue mussel (*Mytilus edulis*), and erect bryozoa. In 2012, when the boulder reef area was imaged as a part of a benthic habitat mapping project, *A. poculata* was still abundant, but no *H. oculata* was found. Additionally, while *M. edulis* was the dominant filter-feeding mollusk in 1991 and 2007, the slipper snail *Crepidula fornicata* was dominant in 2010 and 2012. A number of mechanisms (e.g., species interactions, disease, recruitment failure, thermal stress, sediment loading, freshwater input) may have contributed, individually or synergistically, to the community shifts. However, because of the ad hoc and aperiodic nature of the observations, drivers of the shift are indeterminate. As a result, whether the observed changes reflect a short term disturbance or a long term community state remains unclear as do the effects of changes in functional roles of dominant species.

Stratford Shoal

- Topographic high separating west and central basins of Long Island Sound (LIS)
- Boulder reef feature along crest of southern side of shoal (Inset)
- Benthic images taken 5 times in past 22 years



Sampling at Stratford Shoal

Date	Map Symbol	Imaging method
June 27, 1991	Green Triangle	MiniRover MK II (ROV)
May 31, 2007	Green Square	ISIS (Camera sled) & Diver-held cameras
April XX, 2010	Green Circle	Hela (ROV)
October 10-17, 2012	White Lines	SEABoss (Grab - camera)
December 12-13, 2012	Blue Polygons	ISIS (Camera sled)

1991- 2010:

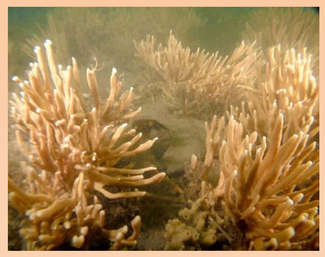
- Epibenthic community dominated by:
  - Branching sponge (*Haliclona oculata*)
  - Northern star coral (*Astrangia poculata*)
  - Blue mussels (*Mytilus edulis*)
  - Erect bryozoa

2012:

- Epibenthic community dominated by:
  - *Astrangia poculata*
  - Slipper snail (*Crepidula fornicata*)
  - Encrusting sponges (e.g. *Cliona celata*)
- No *Haliclona oculata* found

Acknowledgements

This work was funded by the Long Island Sound Mapping Initiative. Thank you to the captains and crews of the RV UConn (1991), the OSV Bold (2007), the RV Lowell Weicker (2007), the NOAA Ship Victor Loosanoff (2010, 2012), and the RV Connecticut (2012).



What happened to the *Haliclona oculata* population?

Potential Mechanisms	Likely driver in this case?	Justification
Regression of adults for overwintering	No	• *H. oculata* active year-round in eastern LIS (Fell 1974) • Regression is rare in marine sponges (Fell 1978)
Recruitment failure + senescence of adults	?/No	• Recruitment dynamics of deep water populations unknown • Time series shows a range of sizes in sponges
Predation	?/secondary driver?	• Sponge predation is usually sublethal (Wulff 2006) • Lack of evidence of pulse of predators between 2010 and 2012
Competition	?/No/ secondary driver?	• Small area of attachment suggests *H. oculata* is a strong spatial competitor • No obvious replacement within the community in 2012, though *Crepidula fornicata* could have undercut adult sponges
Thermal Stress	?/Yes	• LIS warming over last 40 years (Howell and Auster 2012) • Summer 2011 and Winter 2012 were particularly warm • Mass mortality of *H. oculata* in Netherlands attributed to unusually warm summer (Koopmans and Wijffels 2008) • *A. poculata* can withstand temperatures up to 27 °C (Jaques et al 1983)
Disease	?	• Increased temperature linked to increased virulence in sponge disease (Webster 2007) • Mass mortality of *H. oculata* in Wales attributed to disease (Webster 2007)
Reduced salinity due to Hurricane Irene	?	• *H. oculata* growth rates lower at lower salinities (Koopmans and Wijffels 2008)
Increased sedimentation due to Hurricane Irene	?	• Sponges, including *H. oculata*, often found in areas of relatively high sedimentation (Gin 1997, Bell 2007) • Tubular sponges can actively deflect sediment (Bell 2004)
Increased currents due to Hurricane Irene	?/Yes	• Relatively small attachment point increases probability of detachment • Recovery via gemmules may not be developed enough for detection by remote imagery

Importance of *Haliclona oculata*:

- Can be important reproductive habitat for fishes (Houziaux et al. 2007)
- Source of pharmologically active extracts for a variety of human diseases (Gupta et al 2012)

Importance of Stratford Shoal reef:

- Deep (>10 m) water hard substrate reefs are spatially rare in Long Island Sound (REF)
- Structurally complex habitats such as boulder reefs can be important habitat for ecologically and economically important species (Lindholm et al. 2002)

Conclusions:

- Between 2010 and 2012, an apparently stable sponge community on Stratford Shoal disappeared
  - Multiple mechanisms, particularly increased temperatures and hurricane-related currents, may have contributed to sponge loss
  - Dead sponges rapidly disintegrate making determining causes of sponge die-offs in the field difficult (Wulff 2006)
  - Systematic monitoring and local process studies are needed to understand fine time scale dynamics in this community
- Understanding deep water reef community dynamics and the functional role of species within those communities is needed to:
  - Assess the role of natural variation vs. anthropogenic drivers
  - Link management actions to conservation goals and sustainable use

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