

AN ECOLOGICAL SURVEY OF HITHER CREEK TO DETERMINE ITS SUITABILITY AS A SHELLFISH HABITAT

Final Report to the Nantucket Biodiversity Initiative

2019 Research Grant

Submitted February 1, 2020

Chloe Coggins Carey¹

Valerie A. Hall²

¹ Madaket Marine, 20 North Cambridge Street, Nantucket, MA 02554

² Maria Mitchell Association, 4 Vestal Street, Nantucket, MA 02554

ABSTRACT

Hither Creek is a degraded estuary, categorized by the Massachusetts Estuary Project as an impaired ecosystem. In 2008 a shellfish survey was conducted by Epsilon Associates Inc. along the docks of Madaket Marine. They observed high biodiversity of shellfish including hundreds of bay scallop (*Argopecten irradians*) spat attached to macroalgae, contrary to the expectations of an impaired ecosystem. The purpose of our study was to recreate and expand upon the 2008 study. Spat bags were set out every two weeks from mid-May to mid-June near the mouth of the creek, F street dock, and the boatyard. Adult scallops were collected in Madaket Harbor and the gonads were examined histologically to assess spawning condition. Adult and juvenile shellfish were sampled using an Ekman grab and clam rakes along the docks of the boatyard. We found a few scallop spat by the F street dock on July 25, our last day of retrieving. However, water temperatures were too cold to make a correlation between adults spawning in Madaket Harbor and the minimal spat found in Hither Creek. Other shellfish found in the spat bags were soft-shell clams and ribbed mussels. Five adult quahogs were found along the docks of Madaket Marine. We conclude that Hither Creek is not conducive to bay-scallop survival to adulthood, while it could be suitable for ribbed mussels and quahogs. We also question the results and conclusions of the 2008 Epsilon Associates Inc. study.

INTRODUCTION

This study was conducted in order to understand the relationship between the Madaket Harbor scallop population and the Hither Creek ecosystem and to assess Hither Creek as a shellfish habitat. According to the Massachusetts Estuary Project (MEP) Report (Beaton et al. 2015), Hither Creek is categorized as “impaired,” demonstrated by “high chlorophyll *a*, periodic hypoxia, complete loss of eelgrass, dense macroalgae and reduced benthic communities” from high nutrient loading. While the Mass. Division of Marine Fisheries (2011) showed that it is a suitable shellfish area for quahogs and bay scallops (Fig. 1), it appears to no longer be a bay scallop habitat. The Mass. Department of Environmental Protection (1995-2013) eelgrass maps show that eelgrass has not been present in Hither Creek since 1995 (Fig. 2). The benthic substrate of Hither Creek consists of soft silt and mudflats; a habitat possibly suitable for infaunal shellfish such as quahogs (Andrew et al 2001). But because of periodic hypoxia, they are unlikely to survive to adulthood. It is thus no surprise that adult scallops could not be found in 2008, simply because there is no remaining habitat available. We believe that scallop larvae are brought in during spawning season on an incoming tide from Madaket Harbor, but with no protection from predators and poor water quality, the juveniles are not likely to survive.

A study conducted by Epsilon Associates, commissioned in 2008 by Madaket Marine, indicated high biodiversity around the boatyard area of Hither Creek. In addition to high abundance of the green macroalga *Ulva lactuca* and the red macroalga *Agardhiella tenera*, high densities of juvenile bivalves (quahogs and soft-shell clams, and especially bay scallops *Argopecten irradians*) were found (Epsilon Associates 2008). A decade later, however, in December 2018, using the same tools and sampling procedures, we found no evidence of bay scallops of any age (Coggins 2018).

The major goal of this study was to recreate and expand upon the 2008 Epsilon study. We suspect that 2008 was a year when adults in the robust Madaket Harbor population spawned, then tidal currents brought competent larvae up into Hither Creek. These larvae subsequently settled on whatever was available (in this case, the green and red macroalgae), despite the lack of eelgrass. Other studies (Marshall, 1947; Carroll et al. 2010) have found that this is possible. Spat bags were deployed in three locations in Hither Creek at two-week intervals for six weeks to determine if larvae were able to enter the creek and settle in 2019. This was dependent upon

whether or not adults in Madaket Harbor, near the mouth of the creek, were able to spawn in the early part of the summer. Further, we looked to see if juvenile scallops resulting from an early spawn could be found at the head of the creek, near Madaket Marine, as well as other species such as quahogs, clams, and crab species.

METHODS

To meet the goals of this study, we broke the methods down into three major portions:

1. Re-creation of 2008 Epsilon study. See Figure 3 for map of marina sampling stations.

a. Sampling for juvenile bivalves was done at nine stations in Hither Creek at the ends of existing side docks at Madaket Marine (green dots G1 through G9 in Fig. 3). Samples taken with a large Ekman grab sampler were rinsed through a 2 mm sieve. Organisms retained were identified, counted, and released. Average density per station of each species were calculated. Settling substrates (eelgrass, algae, etc.) were noted.

b. Adult shellfish sampling were done at 10 transect stations along the perimeter of the long docks at Madaket Marine (blue dots R1 through R10, in Fig. 3), using a clam basket rake. Shellfish collected were measured and identified before being returned to the water. Total number of adult shellfish and other species per transect were determined.

2. Spat collection. We deployed two spat lines consisting of five spat bags per line, near the mouths and alongside the channels of both Hither Creek and the control creek, every two weeks, from mid- May to mid-June. Each set of spat lines soaked for six weeks before retrieval and subsequent counting and measuring of spat. Average number of spat per date and size-frequency distribution were calculated. Deployment and retrieval of spat lines were coordinated with Tara Riley of the Town of Nantucket Natural Resources Department.

3. Histology of adults. Every two weeks from mid-May through mid-June, at least 50 adult bay scallops were collected in Madaket Harbor by scallop dredge and taken to the histology laboratory at the Maria Mitchell Association. Their gonads were processed for paraffin sectioning and examined under a compound microscope at 100-400x. Gonads were staged on a scale from 0 to 5 (Table 2) to determine the degree of maturation and spawning. We then investigated any possible relationships between adults in the harbor and spat caught in collectors

in Hither Creek and any sampled juveniles found. Water temperatures taken by the Town of Nantucket Natural Resources Department (provided by T. Fournier) were matched with the time and location of the three collections in Madaket Harbor.

RESULTS

1. Re-creation of the Epsilon study.

Throughout sampling along the docks of the marina, only five (5) live adult quahogs (*Mercenaria mercenaria*) were found. Locations are marked on Figure 3. The most commonly found items were broken shells of bay scallops and other shellfish, brought by gulls to open on the hard surface of the docks. The bottom sediments consisted of fine-grained, black, sulfuric particles.

2. Spat collection.

The numerical results of spat collection can be found on Table 1. Note that no spat were seen until late July, in spat bags deployed in mid-June, and that their numbers were small. The map location of spat found at that time is shown on Figure 4. In addition to scallops, the spat of ribbed mussels (*Geukensia demissa*) and soft-shelled clams (*Mya arenaria*) were also found. In all cases, the spat averaged a shell length of 3 mm.

3. Histology of adults.

A summary of the results from 175 adult bay scallops collected over six weeks is shown on Table 3. Average ovarian spawning status is shown to the right of the date of each of the three collections, showing that the majority of scallops were ripe and ready to spawn (average spawning status slightly over 1.0), and only a small percentage of each group had actually begun to do so. The third column indicates the percent of scallops which showed any spawning at all, but in all cases, that spawning was never found in more than 20% of the ovary. The far-right column shows the water temperatures in degrees Celsius taken at the date and location of each collection. These temperatures (11.3, 11.3, and 14.7) are well below the threshold of 20°C needed to initiate spawning in bay scallops

DISCUSSION

No living adult bay scallops were found at the head of Hither Creek due in most part because of the lack of habitat in the creek. Low dissolved oxygen and anaerobic sediments make up the benthic habitat of Hither Creek, which is not suitable for bay scallop populations. A limited number of bay scallop spat was found in the creek, most likely due to the low number of spawning adults in Madaket Harbor. Water temperatures were well below the spawning threshold and no stock recruitment relationship was able to be determined. With the limited number of spat that was discovered, it is nearly impossible to determine the exact location of the spawning adults, since a larval bay scallop will float in the tidal currents for up to two weeks. A previous spat bag study in 2012 by Boyce et al. found that scallop larvae are often carried by tidal currents to areas such as beyond the cut in the East Jetty, an area not conducive to their survival to adulthood.

From the observations and data documented in this 2019 study, we question several aspects of the 2008 Epsilon study. They stated the scallops spawned in May, implying the water temperatures would have had to be significantly warmer than what we found in 2019. Epsilon continued to claim that the abundance of macroalgae in early June was used as a substrate for the spawning bay scallops. However, macroalgae normally doesn't appear until well into the summer season when the temperatures have warmed significantly. From the brief study conducted in June of 2008, Epsilon was able to suggest that several viable shellfish populations exist in the marina. From the summer long study conducted in 2019 it is clear there is no longer a viable shellfish population. With water temperature data missing from 2008, we were unable to determine the integrity of the 2008 study, and whether viable shellfish populations did in fact live in Hither Creek 11 years ago.

ACKNOWLEDGMENTS

This project was made possible with the generosity of the Nantucket Biodiversity and Catherine Slattery and Chris Shannon of Madaket Marine. We also thank the Town of Nantucket Natural Resources Department, the Maria Mitchell Association, Yvonne Vaillancourt of the UMass Field Station, and Carl Sjolund, Boat Captain. Invaluable assistance was lent by members of the MMA Scallop Team, Mackenzie Welch (Research Associate), Tori Dixon, Faizaan Qureshi, Iliyaan Qureshi, Derek Sokol, Sam Dean, Sam Carneal, Sylvi Oh, Mairead Burwell, Katie Purda, Maddie Iller, and Jacqui Jordin

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TABLES AND FIGURES

Time of Spat Bag Deployment	Mid May – end of June	End of May- beginning of July	Mid June – end of July
Ribbed Mussels	0	30	0
Soft-shell Clams	0	0	8
Bay Scallops	0	0	22

Table 1. Average abundance of shellfish spat collected

Spawning Status of Ovary	Sp. Status
Immature or degenerating	0
Full and ripe (ready to spawn)	1
Less than 25% spawned	2
25 – 50% spawned	3
50-75% spawned	4
Fully spawned	5

Table 2 . Scale used to evaluate spawning status of ovaries of the 175 individual bay scallops collected in Madaket Harbor near the mouth of Hither Creek in early summer, 2019. Examination performed at 200-400x under a compound microscope.

Collection #	Date	Sp. Status Avg.	% Spawning	Water Temp °C
1	22 May 2019	1.04	17	11.3
2	2 June 2019	1.05	19	11.3
3	26 June 2019	1.02	14	14.7

Table 3. Summary of average spawning status and percent spawning of bay scallops of 175 bay scallops in the three Madaket Harbor collections of early summer, 2019, compared with water temperatures collected by Town of Nantucket at those dates and locations in early summer, 2019.

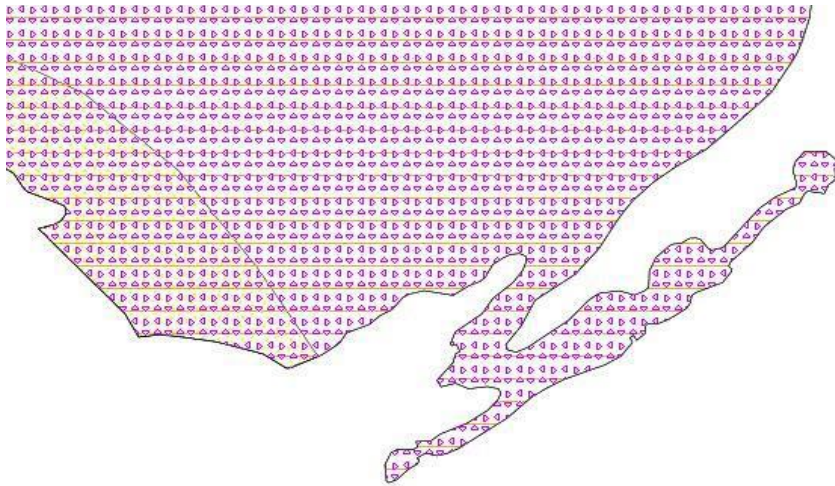


Figure 1. Massachusetts Division of Marine Fisheries map of habitat suitability for quahogs and bay scallops. Hither Creek is outlined in the square above. (maps.massgis.state.ma.us) Purple Triangle: Quahogs; Yellow Line: Bay Scallops

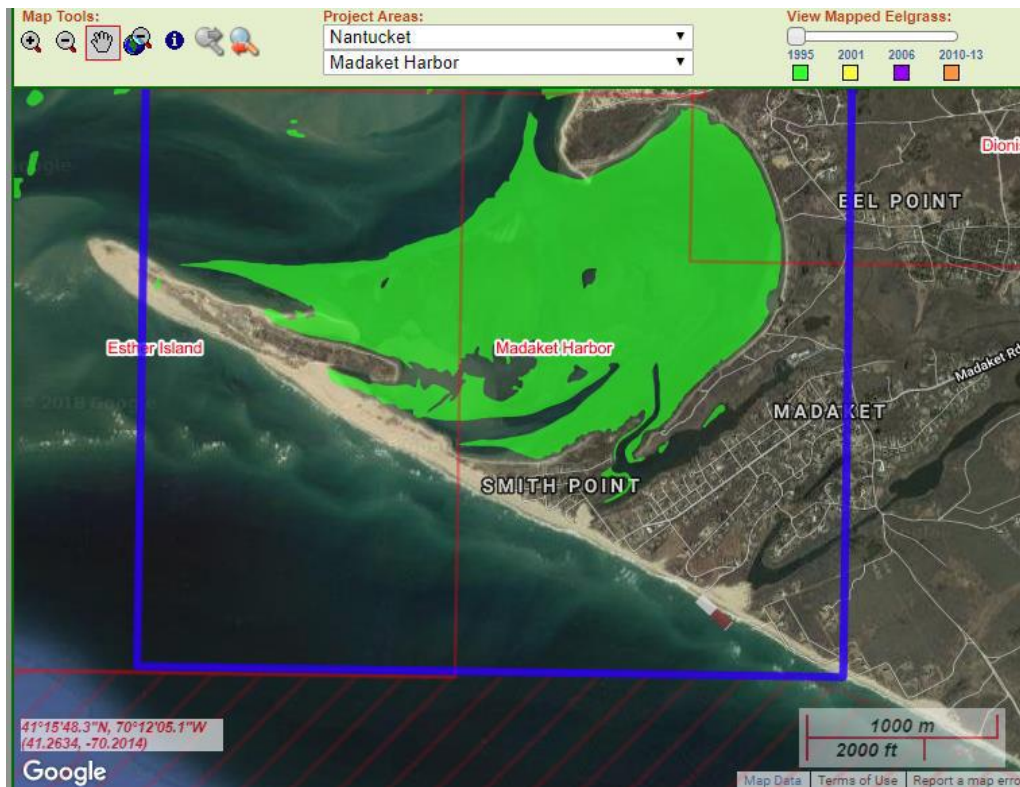


Figure 2. Massachusetts Department of Environmental Protection 1995 eelgrass maps of Madaket Harbor and Hither Creek. (maps.massgis.state.ma.us)



Figure 3. Map of Madaket Marine boat basin, from Epsilon study of 2008. Sampling sites for juveniles in green, for adults in blue. Red arrows mark the locations where adult quahogs were found. (Epsilon Associates, Inc 2008)



Figure 4. Spat bag locations throughout Hither Creek marked in red.