1-21-2009

Video-Based Mapping of Oyster Bottom in the Upper Piscataqua River, Sturgeon Creek, and Spruce Creek

Raymond E. Grizzle
University of New Hampshire - Main Campus, ray.grizzle@unh.edu

Krystin M. Ward
University of New Hampshire - Main Campus, Krystin.Ward@unh.edu

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A Final Report to

The Piscataqua Region Estuaries Partnership

Submitted by

Raymond Grizzle and Krystin Ward
University of New Hampshire
Jackson Estuarine Laboratory and Department of Biological Sciences
85 Adams Point Road
Durham, NH 03824

Date of Report

January 21, 2009

This report was funded by a grant from the Piscataqua Region Estuaries Partnership, as authorized by the U.S. Environmental Protection Agency pursuant to Section 320 of the Clean Water Act.

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Abstract

Towed, underwater videography was used to map and characterize the extent of oyster bottom in the upper Piscataqua River, Sturgeon Creek, and Spruce Creek. Georeferenced video imagery was obtained on five different days in summer and fall 2008. Significant shell bottom (with live oysters in most areas) was found only in the upper Piscataqua River in two areas: (1) the general location of the previously mapped (2003) upper Piscataqua River reef, and (2) in the Piscataqua River at the mouth of Sturgeon Creek. The Sturgeon Creek reef was classified into low and high density shell which covered a total area of 15.6 acres (~63,000 m^2). Recommendations included additional survey work in the lower Salmon Falls and Cocheco Rivers, and Spruce Creek.

Executive Summary

This project was designed to provide new information on the distribution of eastern oysters (*Crassostrea virginica*) in three general areas: upper Piscataqua River, Sturgeon Creek, and Spruce Creek. Most of these areas had not been surveyed since the 1970s.

A towed, underwater videography system with onboard GPS unit was deployed for a total of five days in June, August, October, and November 2008. Georeferenced video imagery was recorded along a total of 12.3 km of shiptracks. The imagery was classified into “non-reef” (<10% shell cover), “low density” reef (10-50% shell cover and live oysters), and “high density” reef (>50% shell cover and live oysters).

The major finding of the surveys was a live oyster reef which covered a bottom area of 15.6 Acres (~63,000 m^2) at the mouth of Sturgeon Creek. Based on the size of live oysters visible in the video imagery, this reef appeared to be the result of the excessively high 2006 spat set that occurred in many areas. In comparison to other oyster reefs in the Piscataqua region, the Sturgeon Creek reef ranks third in total bottom areal coverage.

Based on findings from the present project, additional video surveys are recommended for three areas: the entire upper Piscataqua River/lower Salmon Falls River, the Cocheco River, and Spruce Creek. These surveys would result in a more complete inventory of the areal extent of oyster resources in the Piscataqua region.

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Introduction

Management of eastern oyster (*Crassostrea virginica*) populations in New Hampshire involves annual extractive sampling by divers using quadrats to determine the density and size distributions of live oysters on the major reefs. Information on spatial dimensions of each reef is also needed to estimate the total numbers of oysters per reef and in the region as a whole (Trowbridge 2002, 2005). Because reef size and shape typically remain stable over relatively long time periods, mapping is only conducted sporadically. Most of the major New Hampshire reefs that are sampled annually had been mapped in 1997 (Langan 1997), 2001 (Smith 2002), 2003 (Grizzle and Brodeur 2004), and 2004-2005 (Grizzle et al. 2008b).

This project was designed to provide spatial information on "oyster bottom" in three areas mostly falling within Maine waters. The survey area included a major reef that was mapped in 2003 in the upper Piscataqua River, but most of the areas had not been surveyed for oyster bottom coverage since the 1970s.

Project Goals, Objectives, and Deliverables

The major objective of the project was to map the boundaries of and characterize oyster bottom in the upper Piscataqua River, Sturgeon Creek, and Spruce Creek (Fig. 1). There were two guaranteed deliverables: (1) overview map showing shiptracks of all recorded underwater video; and (2) a GIS shapefile for each of the mapped reefs in Spruce Creek, Sturgeon Creek, and the upper Piscataqua River. There were two potential deliverables: (1) a new GIS shapefile for the reef that was previously surveyed for NHEP (Grizzle and Brodeur 2004) in the upper Piscataqua River; and (2) a map showing location and approximate extent of shell bottom in areas not able to be fully mapped for the current project.

Methods

Towed, underwater videography following the methods described in Grizzle and Brodeur (2004; also see Grizzle et al. 2005, 2008a for additional details) was used to survey the Maine side of the upper Piscataqua River, Sturgeon Creek, and Spruce Creek to locate and map the boundaries of significant shell bottom. Field surveys were conducted in 2008 on June 17, August 25 and 29, and October 27 in the upper Piscataqua River area, on August 29 in Sturgeon Creek, and on November 5 in Spruce Creek (Fig. 1). For all surveys, a SeaViewer model 550 color video camera was deployed in towed mode on a sled with video imagery continuously recorded onto a digital video recorder along each transect (Fig. 2). A Garmin 76CSx GPS unit was used with WAAS mode activated, with horizontal position data recorded near-continuously along each shiptrack.

The imagery was viewed in real-time to locate areas with significant amounts of shell. When shell was encountered, the extent of the shell bottom in that area was delineated by navigating multiple parallel transects. All imagery was later reviewed in the laboratory and classified into one of three categories: “non-reef” (<10% shell cover), “low density” reef (10-50% shell cover and live oysters), and “high density” reef (>50% shell cover and live oysters). This provided near-continuous classification of the seafloor along each shiptrack.

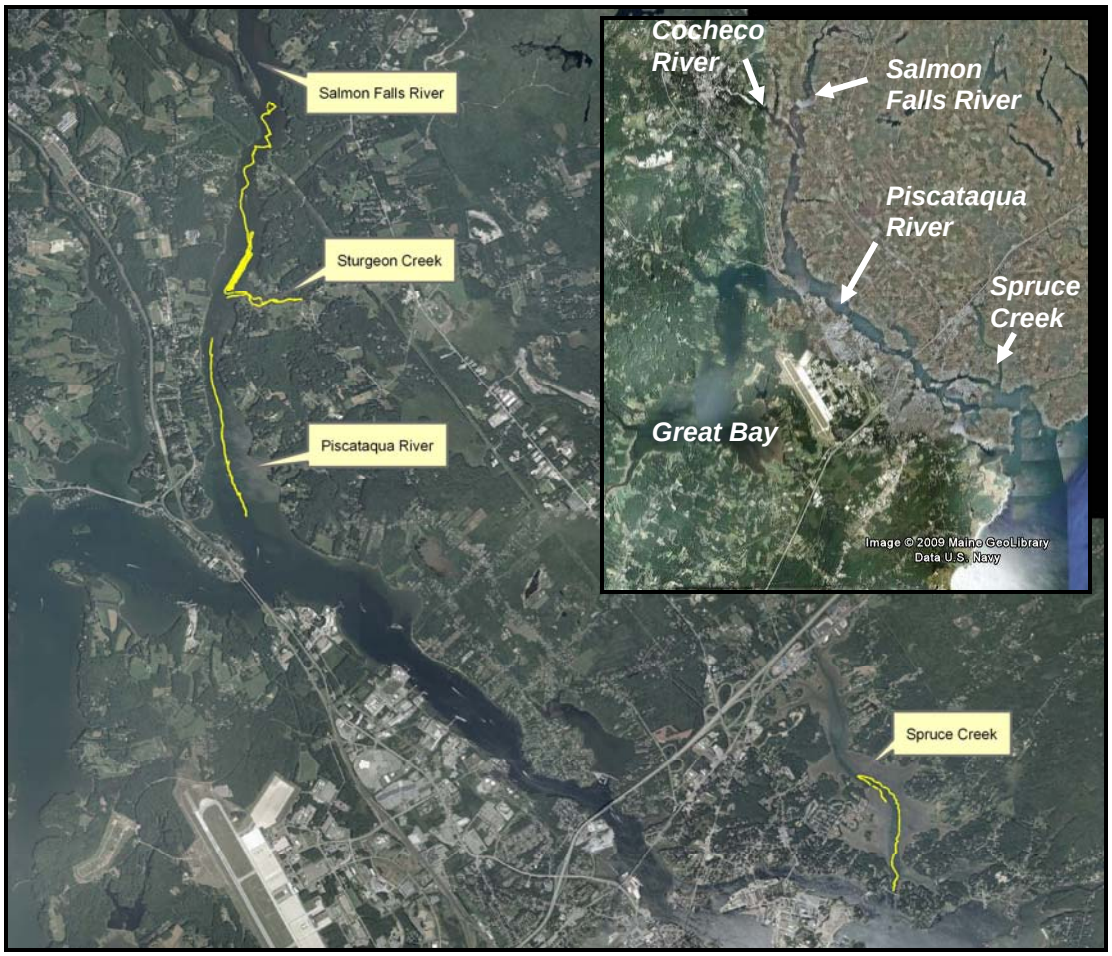

Fig. 1. Shiptracks (yellow lines) showing three general areas where georeferenced underwater video imagery was recorded in 2008: Spruce Creek, Piscataqua River, and Sturgeon Creek.

Fig. 2. Towed underwater video system showing major components when deployed in sled mode (see text for details).

Results and Discussion

Georeferenced video imagery was recorded along a total of 12.3 km of shiptracks during the five days of field work. Significant amounts of shell bottom were only found in the upper Piscataqua River area (Fig. 3). A relatively large live oyster reef was encountered at the mouth of Sturgeon Creek on the eastern side of the Piscataqua River channel, extending northward parallel to the channel for about 1 km; this reef is referred to hereafter as the "Sturgeon Creek reef" (Fig. 4). The total area covered by low and high density shell and including live oysters in many areas was 15.6 acres (~63,000 m^2). Live oysters with vertical extension several centimeters above the bottom were observed throughout the area, but mainly in the high density areas which covered 5.5 acres (~22,000 m^2). Although the video imagery cannot be used to accurately determine size or age of individual oysters, most live oysters appeared to be less than 100 mm shell height. This would suggest an age of less than 3 years. Thus, much of the live oyster population on this reef appears to be from the excessively high 2006 spat set that occurred in many areas.

In comparison to other oyster reefs in the Piscataqua region, the Sturgeon Creek reef ranks third in total bottom areal coverage (low and high density shell combined) behind only the Nannie Island reef which covered 24.7 acres in 2002 (Smith 2002; Trowbridge 2005) and the Piscataqua River reef which covered 19.9 acres in 2003 (Grizzle and Brodeur 2004). Thus, the Sturgeon Creek reef represents a major addition to the oyster resource inventory.

Continuous video was also recorded from the Sturgeon Creek reef northward to the confluence of the Cocheco and Salmon Falls Rivers. This transect ran through the previously surveyed Piscataqua River reef described in Grizzle and Brodeur (2004). Although sufficient imagery was not obtained to allow a detailed comparison to the previous survey, low and high density shell bottom was observed in the same overall area as when the reef was mapped in 2003 (Fig. 3). This indicates that at least its north-south (along-channel) dimension was similar in 2008 compared to 2003.

Although outside of the study area in the approved work plan, a partially successful attempt was made to obtain imagery in Salmon Falls River. This was done because shell bottom was encountered further upstream than expected from previous work in the area (see Fig. 3). Also, a reef restoration project had been completed in the Salmon Falls River in 2000 but no monitoring of the project had occurred since 2002 (Grizzle et al. 2003). Unfortunately, no usable imagery for mapping purposes was recorded. However, oyster bottom was visible in some imagery and live oyster bottom was verified by divers in an area about 0.5 km upstream from the Cocheco/Salmon Falls confluence. There is probably a live oyster reef in this area covering a substantial bottom area.

Finally, most of the areas surveyed in Sturgeon Creek proper appeared to be soft mud, and very little shell was observed. Spruce Creek, however, had a wide diversity of bottom types ranging from soft mud to rock outcrops. Dense, live blue mussel (*Mytilus edulis*) reefs were observed in several areas, but no live oysters or significant oyster shell bottom were observed. Some areas in Spruce Creek that may have live oysters were not surveyed.

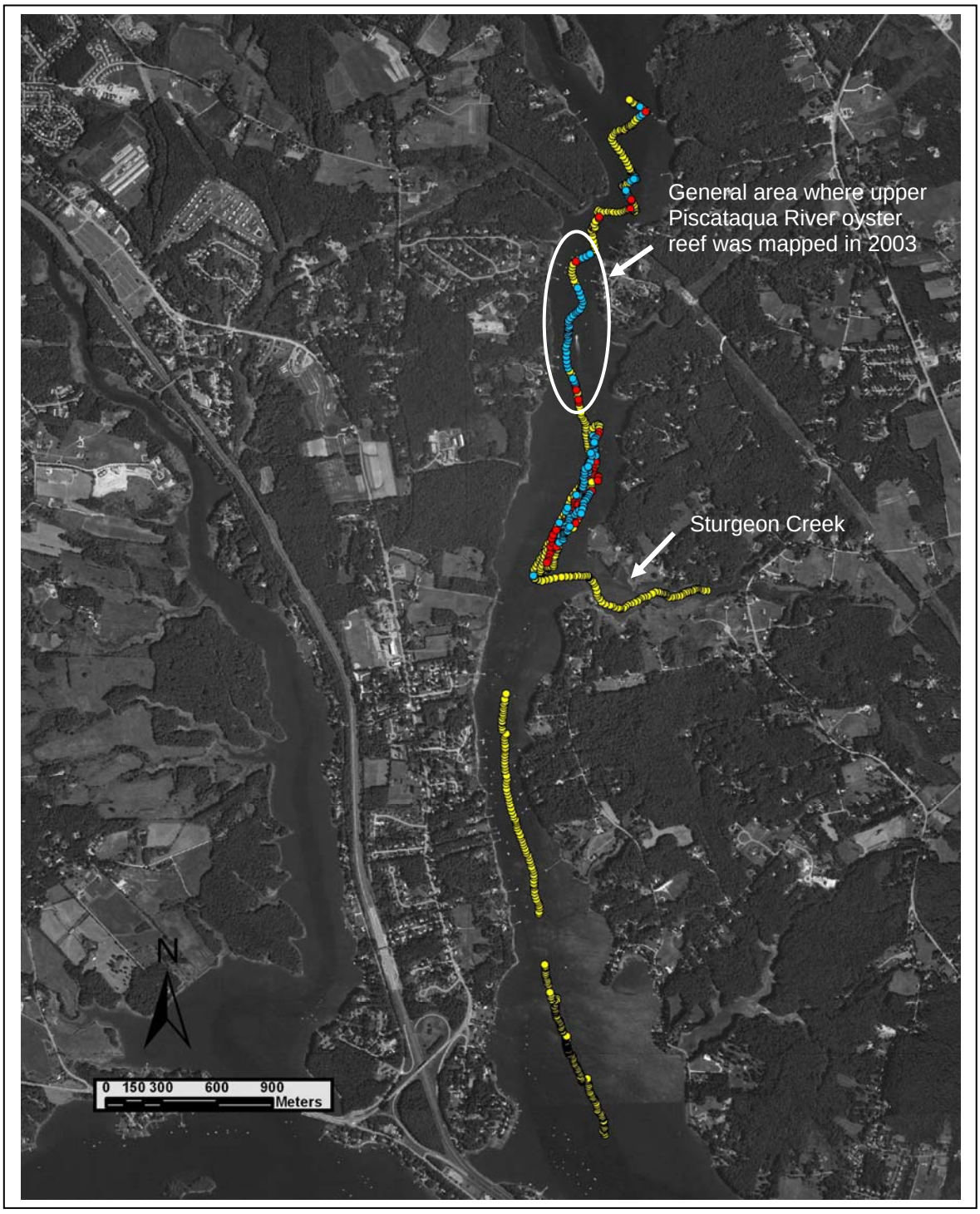

Figure 3. Classified shiptracks where video imagery was recorded in 2008: yellow = “non-reef” (i.e., no oyster shell), red = low density oyster shell, blue = high density oyster shell.

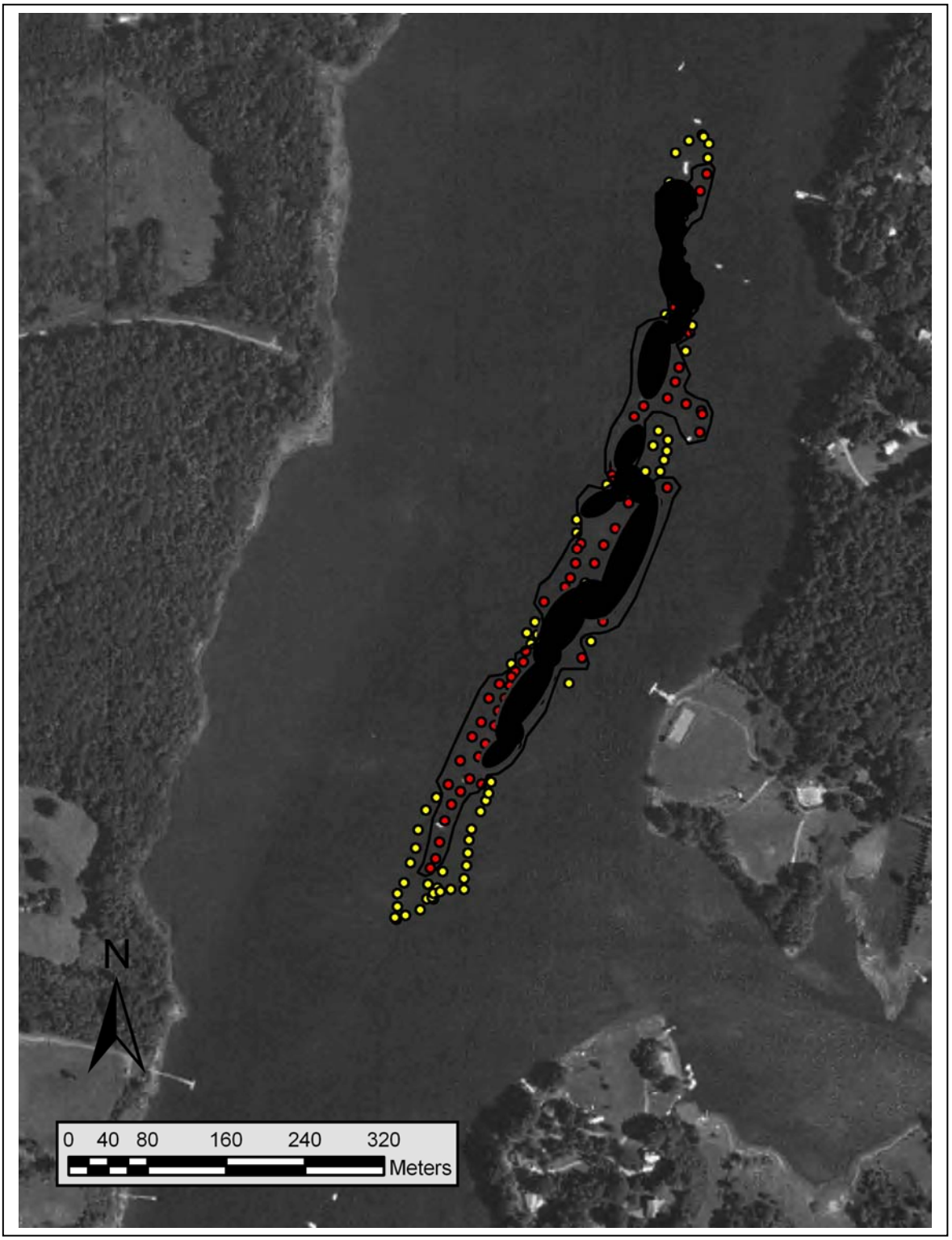

Figure 4. Sturgeon Creek oyster reef showing extent of overall reef (outermost black line), low density (red dotted area) and high density (black polygons) areas.

Conclusions

The major result of the study was mapping and characterizing shell density on a large oyster reef off the mouth of Sturgeon Creek that had not been previously surveyed. This reef covers a total of 15.6 acres bottom area, and is the third largest in the Pisacataqua River region. This new information, in combination with previous mapping efforts, indicate that the upper Piscataqua River from Sturgeon Creek northward into the lower Salmon Falls River may have at one time been a contiguous live oyster reef. Some combination of live and dead oyster shell exists along most of the entire stretch today.

Both guaranteed deliverables (see above) were produced. Figure 1 shows the shiptracks of all recorded video. An ArcGIS shapefile for the only mapped reef (Sturgeon Creek reef; Fig. 4) was submitted with the present report. Both potential deliverables were partially addressed. The previously surveyed Piscataqua River reef (general location shown on Fig. 3) was only partially re-surveyed, so a new map could not be produced. A map showing shell bottom in areas not able to be fully mapped was not produced. However, two areas that need further survey work were identified: the Salmon Falls River and Spruce Creek. The implications of not fully meeting the requirements of the potential variables are discussed in the Recommendations section below.

Recommendations

Based on findings from the present project and previous work in some areas, the following three major recommendations are offered. These recommendations are made so that a more complete inventory of the areal extent of oyster resources in the Piscataqua region can be achieved.

First, it is recommended that the entire upper Piscataqua River from the known reef surveyed in 2003 (Grizzle and Brodeur 2004) northward, and the lower Salmon Falls River from its confluence with the Cocheco River several kilometers upstream be completely surveyed. This area encompasses the previously restored reef in the Salmon Falls River and other areas in the vicinity with similar environmental conditions and thus potential oyster habitat. It is possible that live oyster bottom covering several acres exists in this area.

Secondly, it is recommended that the Cocheco River from its confluence with the Salmon Falls River to urban areas in the City of Dover be surveyed at least along mid-channel, and any shell bottom areas mapped with multiple transects. Previous sampling with tongs in the lower Cocheco revealed oyster shell bottom in at least one area.

Finally, it is recommended that the present survey in Spruce Creek be expanded to include areas not imaged. Substantial hard bottom (mostly rock outcrops) and live blue mussel reefs were encountered during the present project, indicating potential oyster habitat. Also, areas further upstream that could not be navigated because of tidal restrictions during the present project may well have live oysters.

References

Grizzle, R.E., S. Jones, R. Mann, M. Luckenbach. 2003. Restoring an oyster reef for mitigation of estuarine water quality. Final Report submitted to the NOAA/UNH Cooperative Institute for Coastal and Estuarine Environmental Technology (CICEET), Durham, NH.

Grizzle, R.E. and M.A. Brodeur. 2004. Oyster (*Crassostrea virginica*) reef mapping in the Great Bay Estuary, New Hampshire – 2003. Final Report submitted to the New Hampshire Estuaries Project, Portsmouth, NH.

Grizzle, R.E., L.G. Ward, J.R. Adams, S.J. Dijkstra, and B. Smith. 2005. Mapping and characterizing oyster reefs using acoustic techniques, underwater videography, and quadrat counts. pp. 153-160 In: *Benthic Habitats and the Effects of Fishing.* P.W. Barnes and J.P. Thomas (eds.) American Fisheries Society Symposium 41.

Grizzle, R.E., M. Brodeur, H. Abeels, and J.K. Greene. 2008a. Bottom habitat mapping using towed underwater videography: subtidal oyster reefs as an example application. *Journal of Coastal Research* 24:103-109.

Grizzle, R.E., S. Dijkstra, and B. Smith. 2008b. Development of a general protocol for characterizing subtidal oyster reefs using remote sensing techniques. Final Report submitted to New Hampshire Sea Grant, Durham, NH. Project No. R/MED-2.

Langan, R. 1997. Assessment of Shellfish Populations in the Great Bay Estuary. Final Report submitted to the New Hampshire Estuaries Project. Office of State Planning, Concord, NH

Smith, B. 2002. Shellfish population and bed dimension assessment in the Great Bay Estuary. Final Report submitted to the New Hampshire Estuaries Project. Office of State Planning, Concord, NH

Trowbridge, P. 2002. Environmental Indicators Report: Shellfish. New Hampshire Estuaries Project, Office of State Planning, Concord, NH

Trowbridge, P. 2005. Environmental Indicator Report: Shellfish. New Hampshire Estuaries Project, Department of Environmental Services, Concord, NH