1-25-2006

# Soft-Shell Clam (Mya Arenaria) Distribution & Abundance at Selected Sites in the Great Bay Estuary

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

Jennifer K. Greene
*University of New Hampshire - Main Campus*

Holly Abeels
*University of New Hampshire - Main Campus*

# SOFT-SHELL CLAM (*MYA ARENARIA*) DISTRIBUTION & ABUNDANCE AT SELECTED SITES IN THE GREAT BAY ESTUARY, NEW HAMPSHIRE

A Final Report to

The New Hampshire Estuaries Project

Submitted by

Raymond E. Grizzle, Jennifer K. Greene, and Holly Abeels
University of New Hampshire
Zoology Department and Jackson Estuarine Laboratory
85 Adams Point Road
Durham, NH 03824

Date of Report

25 January 2006

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

NewHampshire EstuariesProject

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## Executive Summary

Previous surveys (1996 to 2002) provided distribution and abundance data for soft-shell clam (*Mya arenaria*) populations in ten areas of the Great Bay and Piscataqua River estuaries identified as potentially good clam habitat. The present study was designed to complete the overall survey by sampling six remaining areas: Weeks Point, Brackett's Point, Squamscott River mouth, Moody Point, Herods Cove, and Upper Little Bay (western shore). The objectives of the present project were to: (1) visually inspect the six study areas for the general distribution of sediment types and soft-shell clams, (2) quantitatively sample the six areas to determine densities of soft-shell clams, (3) produce GIS maps based on the survey data, and (4) assess clam distributions considering data from the present study and previous research.

At each of the six sampling areas, the approximate boundary of "potential clam habitat" (=intertidal soft sediments) was determined by visual inspection at low tide. Notes were made on changes in major sediment types, the presence of clam siphon holes, and empty clam shells. At each site, nine to fourteen 0.125 $m^2$ quadrats were haphazardly tossed onto the sediment surface, excavated to at least 20 cm depth using clam rakes, and all excavated sediments washed through a 5 mm mesh sieve. All clams retained on the sieve were measured (shell length to nearest mm with calipers), counted, and returned to the general area. A sample of the upper 5 cm of sediment was collected from each quadrat and stored at Jackson Estuarine Laboratory. Quadrat locations were geo-referenced using DGPS.

The general environmental conditions in all six areas appeared suitable as soft-shell clam habitat. However, very few live clams were collected and very few empty shells were observed. From a total of 65 excavated quadrats, only 8 live clams were collected with mean densities ranging from 0.0 to 3.1/$m^2$ at the six sites. It was concluded that none of the six areas were productive clam flats at the time of sampling, and they probably had not been in the recent past.

Previous research and the present study indicate that many of the expansive intertidal flats in the Great Bay/Piscataqua River system have not been productive clam habitat for decades, probably since at least the 1940s in some areas. However, moderate to high densities of clams have been reported in some areas, particularly in sandy sediments. Previous research also showed high densities of early post-set clams in some areas, suggesting that spat mortality (probably predation effects) may be an important cause of low densities of larger clams in these areas.

Future research should focus on sandy sediments and mixed soft sediments with cobble to better characterize the distribution and abundance of clams in the Great Bay/Piscataqua River system. Future research also should assess the role of predation on newly set spat in controlling clam populations.

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## Introduction

Studies during 1996 to 2002 yielded quantitative information on distribution and abundances of soft-shell clam (*Mya arenaria*) populations in some areas of the Great Bay and Piscataqua River estuaries (Jones 2000; Smith 2002; Trowbridge 2002). Study areas were chosen based on the Banner and Hayes (1996) model that identified areas of potential clam habitat. A total of sixteen (16) areas were identified and ten (10) had been sampled through 2002 (Fig. 1). The present contract required assessment of the remaining six (6) areas: Weeks Point, Brackett's Point, Squamscott River mouth, Moody Point, Herods Cove, and Upper Little Bay (western shore). The study locations for this project, and the predicted clam habitat suitability index (HSI) values from Banner and Hayes (1996), are shown in Figure 1.

## Project Goals and Objectives

The objectives of the present project were: (1) visually inspect the six study areas for the general distribution of sediment types and soft-shell clams, (2) quantitatively sample the six areas to determine soft-shell clam densities, (3) produce GIS maps based on the survey data, and (4) assess clam distributions considering previous research.

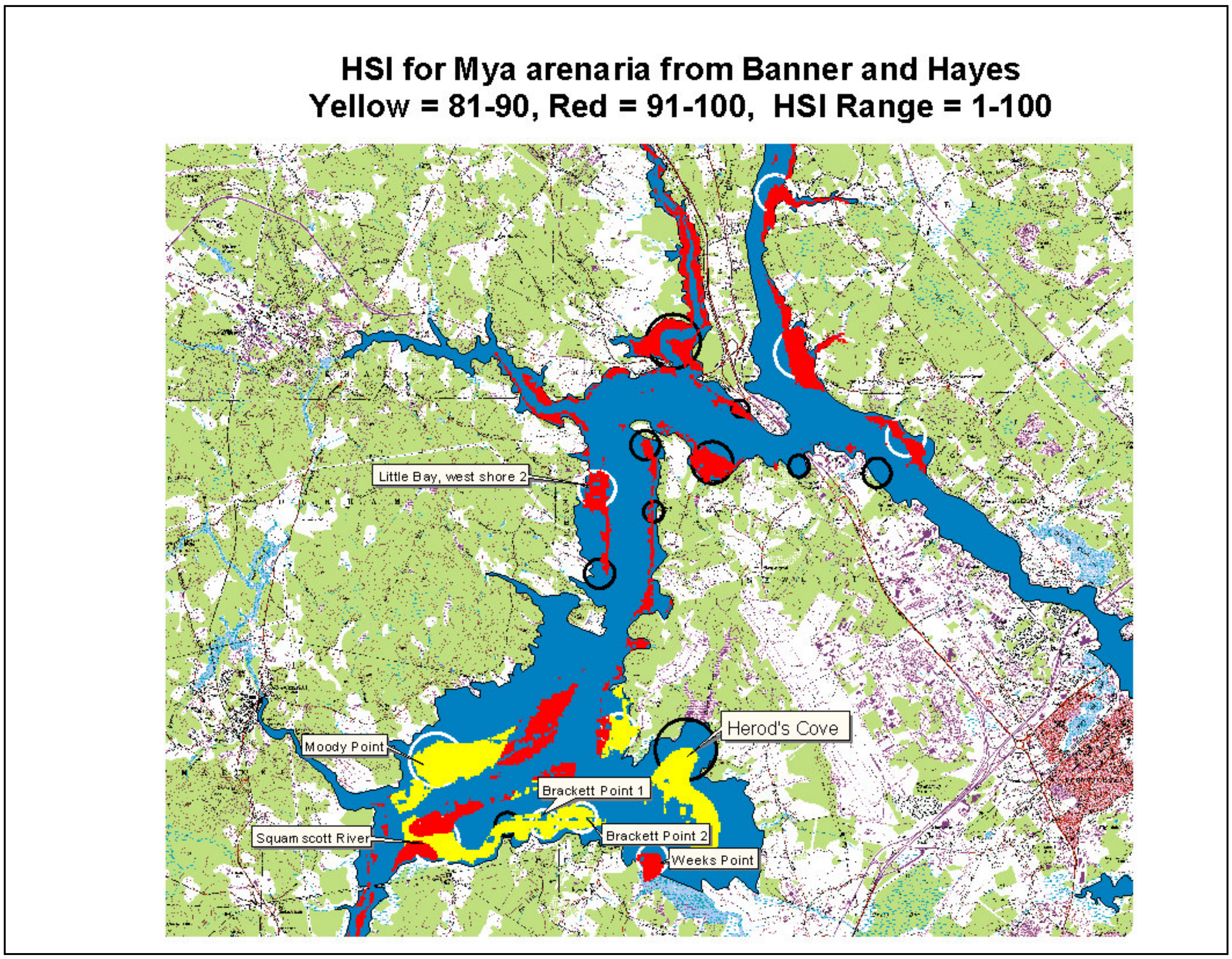


Fig. 1. Six sampling areas (each circled and labeled) for present study showing Habitat Suitability Index values from Banner and Hayes (1996).

## Methods

The methods used in the present study were similar to Langan (1997) and Smith (2002). At each of the six sampling areas (Fig. 1), the approximate boundary of "potential clam habitat" (=intertidal soft sediments) was determined by visual inspection at low tide. Notes were made on changes in major sediment types (e.g. sand, mud, cobble), the presence of clam siphon holes, and empty clam shells. At each site, nine to fourteen 0.125 $m^2$ quadrats were haphazardly tossed onto the sediment surface, excavated to about 20 cm depth using clam rakes, and all excavated sediments washed through a 5 mm mesh sieve. All clams retained on the sieve were measured (shell length to nearest mm with calipers), counted, and returned to the general area. A sample of the upper 5 cm of sediment was collected from each quadrat and stored at Jackson Estuarine Laboratory. Quadrat locations were geo-referenced using DGPS.

The resulting field data and notes were used to produce four deliverables: (1) an ArcView-compatible GIS file showing the boundaries of each study site, major sediment type distributions at each site, and the locations of all quadrat samples, (2) documentation/ metadata for the GIS files, (3) Excel file of raw data for clam counts and measurements, and (4) an assessment of clam distribution and abundance patterns compared to previous studies.

## Results and Discussion

All six areas were predominantly intertidal mudflats, and general environmental conditions in all six areas appeared suitable as soft-shell clam habitat (Table 1; Fig. 1). However, very few live clams were collected and very few empty shells were observed. From a total of 65 excavated quadrats, only 8 live clams were collected with mean densities ranging from 0.0 to 3.1/$m^2$ at the six sites (Table 1). Hence, it is concluded that none of the six areas were productive clam flats at the time of sampling, and they probably had not been in the recent past.

Table 1. Mean soft-shell clam densities and general environmental conditions at the six study areas (Figs. 1-3) relevant to soft-shell clam habitat suitability.

| Sampling Area | Date(s) Visited | Major Sediment Type(s) | Total Quadrats Excavated | Mean *Mya* Density (#/$m^2$, 1 SD) | Notes |
|---|---|---|---|---|---|
| Upper Little Bay | 11/10/03; 3/30/05; 8/10/05; 10/19/05 | soft to firm mud, some clay | 9 | 0.0 (0.0) | no siphon holes observed; sparse empty clam shells in some areas |
| Moody Point | 11/11/03; 8/10/05 | soft mud | 7 | 1.1 (2.96) | no siphon holes observed; some empty clam shell along eastern edge of mudflat |
| Squamscott River Mouth | 10/19/2005 | soft mud | 10 | 0.0 (0.0) | (none) |
| Brackett's Point | 11/12/03; 8/25/05 | soft mud | 13 | 3.1 (6.96) | (none) |
| Weeks Point | 11/12/03; 8/24/05; | soft mud | 12 | 1.4 (3.28) | no siphon holes observed; some empty clam shell near high-tide line west of point |
| Herods Cove | 10/18/2005 | soft mud | 14 | 0.0 (0.0) | no siphon holes; sparse empty clam shells in som areas; widgeon grass (*Ruppia*), some eelgrass scattered throughout area |

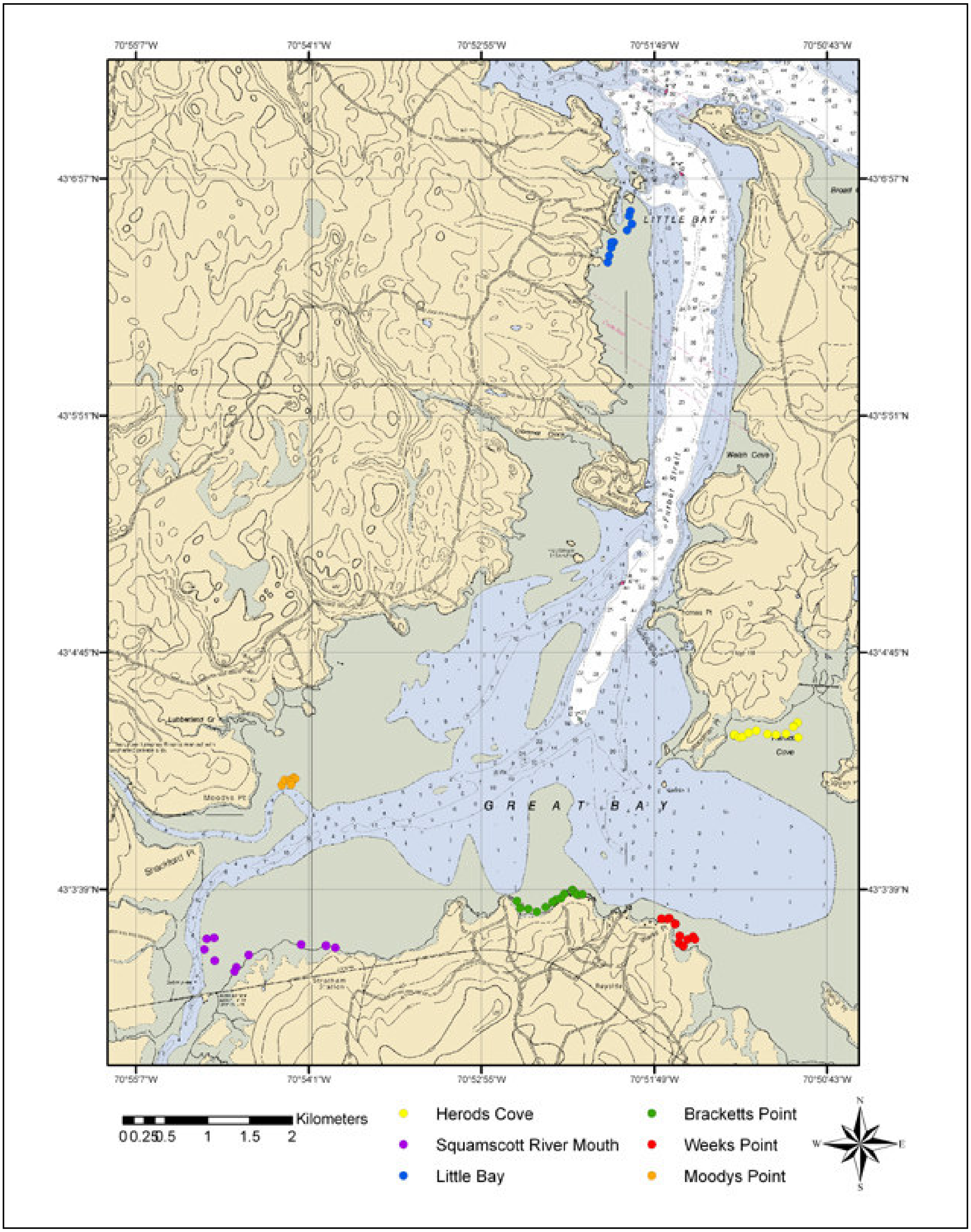


Fig. 2. Locator map of six study areas showing locations of quadrat samples (see Fig. 3 for details for each study area).

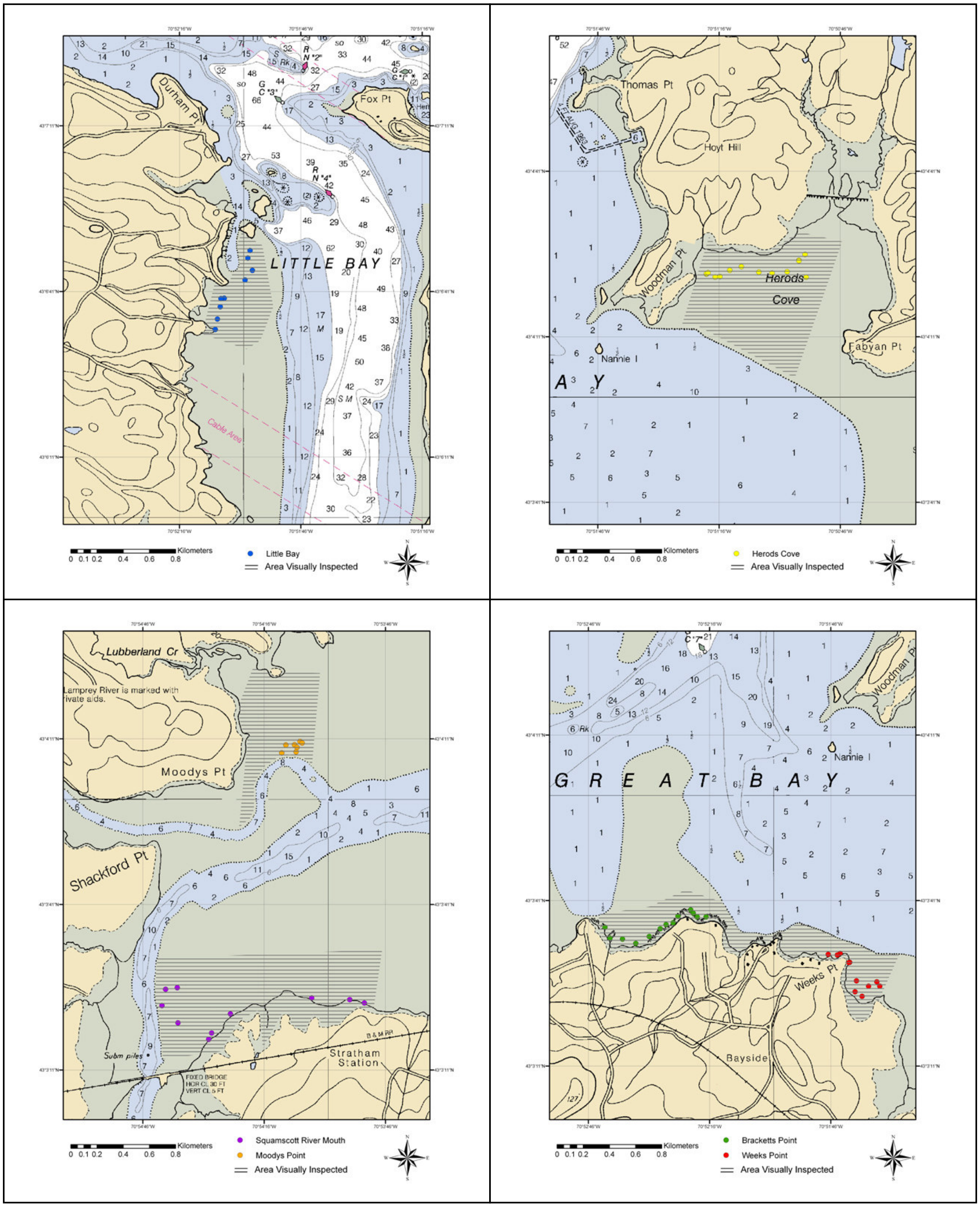


Fig. 3. Locations of quadrat samples and areas visually inspected for soft-shell clam habitat (cross hatched) in each of the six study areas.

Table 2. Summary of softshell clam data from Great Bay/Piscataqua River estuarine system.

| LOCATION | Jackson, 1944 | Nelson, 1981 (#/m$^2$) | Jones & Langan, 1996 (#/m$^2$) | Langan, 1997 (#/m$^2$) | Smith, 2002 (#/m$^2$) | Present Study* (#/m$^2$) |
|---|---|---|---|---|---|---|
| **Great Bay & Tributaries** | | | | | | |
| Squamscott River (mouth) | | | | | | 0 (10 Quadrats) |
| Sandy Point | | | | <20mm length: 3<br>>20mm length: 14 | | |
| Great Bay (overall descrip.) | 500-600 ac "productive" | | | | | |
| Moody Pt. | | | | | | 1.1 (7 quadrats) |
| Weeks Pt. | | | | | | 2 (12 quadrats) |
| Bracketts Pt. | | | | | | 3.1 (13 quadrats) |
| Woodman Point | | <20mm length: 110<br>>20mm length: 35 | | | <20mm length: 0<br>>20mm length: 8.5 | |
| Herods Cove | | | | | | 0 (14 quadrats) |
| **Little Bay** | | | | | | |
| Upper Bay, western shore | | | | | | 0 (9 quadrats) |
| Fox Point (eastern shore) | | <20mm length: 170<br>>20mm length: 30 | | <20mm length: 2<br>>20mm length: 9 | <20mm length: 0<br>>20mm length: 1.8 | |
| Little Bay/SW Durham Pt. | | | | <20mm length: 5<br>>20mm length: 11 | | |
| Little Bay (eastern shore) | | <20mm length: 90<br>>20mm length: 10 | | | | |
| **Upper Tributaries** | | | | | | |
| Bellamy River (Royalls Cove) | | <20mm length: 30<br>>20mm length: 10 | | | <20mm length:0<br>>20mm length: 8.7 | |
| Cocheo River | none | | | | | |
| Salmon Falls River | none | <20mm length: 62<br>>20mm length: 8 | | | | |
| **Upper Piscataqua River** | | | | | | |
| Dover Pt/Boston Harbor | | | | <20mm length: 14<br>>20mm length: 50 | | |
| Upper Piscataqua | 100's of bushels | | | | | |
| **Lower Piscataqua River** | | | | | | |
| Ordiorne: East | | | 4.4 (85 quadrats) | | | |
| Triangle | | | 12.5 (30 quadrats) | | | |
| Wentworth | | | 2.0 (75 quadrats) | | | |
| Seavey | | | 5.1 (90 quadrats) | | | |
| Berrys Brook | | | 4.7 (50 quadrats) | | | |
| Witch Creek | | | Unsuitable substrate | | | |
| | | | | | | |
| **Methods:** | (qualitative surveys) | 1/10 m$^2$ quadrats, washed on 1 mm mesh | 1/8 m$^2$ quadrats, visual inspection | 1/8 m$^2$ quadrats, visual inspection | 1/8 m$^2$ quadrats, visual inspection | 1/8 m$^2$ quadrats, washed on 5 mm mesh |

*All size classes combined.

Table 2 summarizes clam data available from the Great Bay/Piscataqua River estuarine system beginning with Jackson's (1944) surveys and concluding with the present study. Overall, these studies indicate that most of the potential clam habitat—the expansive intertidal flats found throughout the system—have only supported meager clam populations since at least the 1940s. Nelson (1981), however, reported high densities of juveniles and moderate densities of adult clams in some areas, and Langan (1997) found moderate to high densities of larger clams in some areas. Although it is not possible to rigorously assess the available data spatially or temporally, the trend over the past several decades seems to be a decline in overall densities of soft-shell clams since Nelson's (1981) studies.

Two findings from this research suggest that more focused studies are needed to fully characterize clam habitat in the Great Bay/Piscataqua system. First, Nelson (1981) provides some of the only data on densities of early post-set clams because the excavated sediments were washed on a 1 mm mesh sieve. High densities of small clams were found in several areas, suggesting that spat mortality (probably predation effects) may be an important cause of low densities of larger clams. Secondly, most reports note that substantial densities of clams were found in a few areas, suggesting that habitat requirements in the Great Bay system may be more restrictive than the Banner and Hayes (1996) model predicts. Sediment characteristics in particular may need more attention.

Most of the areas surveyed in the present study consisted of soft muds that probably are not good clam habitat (Table 1). Soft-shell clams typically prefer "stiff sands and muds" that do not collapse against the closed shell (Abraham and Dillon 1986). The highly productive Hampton-Seabrook clam flats consist largely of firm, sandy sediments (Beal 2002). Langan (1997) noted that the highest densities of clams in several areas of Great Bay occurred in firmer, sandy sediments (Table 2). Cobble/soft sediment mixtures, which occur in narrow zones along the shoreline in many areas, may also be good clam habitat in the Great Bay system (REG, pers. obs.).

## Recommendations

Although the general conclusion that can be drawn from the present study and previous research is that most of the intertidal flats in the Great Bay/Piscataqua River estuarine system are not productive soft-shell clam habitat, some areas are (or have been) productive. This suggests that more focused research is needed to better understand the causes for increased clam abundances in some areas. This knowledge would particularly be important for assessing whether clam restoration efforts are warranted, and if so, how to effectively accomplish such a goal. It is recommended that future research be focused in two related topic areas:

(1) Sediments that provide the best habitat for soft-shell clams are stiff sands and muds, and cobble/soft sediment mixtures. Future research should target areas with these types of sediments. This research should have the overall goal of determining how sediment characteristics affect clam populations. It should involve characterizing sediments and distribution and abundance patterns for clams in each study area. The excavated sediments should be washed through a small mesh (1 -2 mm) sieve so that early post-set clams are retained. If productive clam habitats are located and characterized, then further studies should focus on experimental research involving the potential effects of predators.

(2) Predation has been demonstrated in many areas to be a major factor limiting soft-shell clam populations. Green crabs have been shown to be a major predator in many areas, but horseshoe crabs may also be important in Great Bay. Future research should focus on determining the extent of predation, what species are involved, and how different sediment types affect predation rates. Recent research in the Hampton-Seabrook Estuary could provide information on how to best design experiments in the Great Bay system.

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## Appendix A - Raw Data

| Site | Date | Lat_DMS | Long_DMS | Mya arenaria # | Mya (mm) |
|---|---|---|---|---|---|
| Moody Point | 8/10/2005 | 43 4.138 | 70 54.189 | 1 | 8.8 |
| Moody Point | 8/10/2005 | 43 4.162 | 70 54.172 | | |
| Moody Point | 8/10/2005 | 43 4.163 | 70 54.137 | | |
| Moody Point | 8/10/2005 | 43 4.173 | 70 54.114 | | |
| Moody Point | 8/10/2005 | 43 4.168 | 70 54.105 | | |
| Moody Point | 8/10/2005 | 43 4.155 | 70 54.126 | | |
| Moody Point | 8/10/2005 | 43 4.141 | 70 54.130 | | |
| Weeks Point | 8/24/2005 | 43 3.494 | 70 51.684 | 1 | 9.2 |
| Weeks Point | 8/24/2005 | 43 3.493 | 70 51.687 | 1 | 11.4 |
| Weeks Point | 8/24/2005 | 43 3.438 | 70 51.656 | | |
| Weeks Point | 8/24/2005 | 43 3.405 | 70 51.662 | 1 | 55.7 |
| Weeks Point | 8/24/2005 | 43 3.391 | 70 51.633 | | |
| Weeks Point | 8/24/2005 | 43 3.422 | 70 51.606 | | |
| Weeks Point | 8/24/2005 | 43 3.435 | 70 51.572 | | |
| Weeks Point | 8/24/2005 | 43 3.422 | 70 51.56 | | |
| Weeks Point | 8/24/2005 | 43 3.521 | 70 51.723 | | |
| Weeks Point | 8/24/2005 | 43 3.516 | 70 51.735 | | |
| Weeks Point | 8/24/2005 | 43 3.517 | 70 51.773 | | |
| Weeks Point | 8/24/2005 | 43 3.518 | 70 51.773 | | |
| Bracketts Point | 8/25/2005 | 43 3.652 | 70 52.340 | 1 | 9.8 |
| Bracketts Point | 8/25/2005 | 43 3.642 | 70 52.329 | | |
| Bracketts Point | 8/25/2005 | 43 3.631 | 70 52.313 | 1 | 9.6 |
| Bracketts Point | 8/25/2005 | 43 3.631 | 70 52.276 | | |
| Bracketts Point | 8/25/2005 | 43 3.633 | 70 52.392 | | |
| Bracketts Point | 8/25/2005 | 43 3.613 | 70 52.412 | | |
| Bracketts Point | 8/25/2005 | 43 3.608 | 70 52.441 | | |
| Bracketts Point | 8/25/2005 | 43 3.595 | 70 52.465 | | |
| Bracketts Point | 8/25/2005 | 43 3.572 | 70 52.511 | | |
| Bracketts Point | 8/25/2005 | 43 3.551 | 70 52.566 | | |
| Bracketts Point | 8/25/2005 | 43 3.564 | 70 52.621 | | |
| Bracketts Point | 8/25/2005 | 43 3.567 | 70 52.673 | | |
| Bracketts Point | 8/25/2005 | 43 3.600 | 70 52.693 | 3 | 11.8, 17.5, 9.9 |
| Herods Cove | 10/18/2005 | 43 4.370 | 70 51.314 | | |
| Herods Cove | 10/18/2005 | 43 4.371 | 70 51.314 | | |
| Herods Cove | 10/18/2005 | 43 4.374 | 70 51.307 | | |
| Herods Cove | 10/18/2005 | 43 4.361 | 70 51.278 | | |
| Herods Cove | 10/18/2005 | 43 4.362 | 70 51.258 | | |
| Herods Cove | 10/18/2005 | 43 4.381 | 70 51.218 | | |
| Herods Cove | 10/18/2005 | 43 4.392 | 70 51.170 | | |
| Herods Cove | 10/18/2005 | 43 4.376 | 70 51.098 | | |
| Herods Cove | 10/18/2005 | 43 4.373 | 70 51.043 | | |
| Herods Cove | 10/18/2005 | 43 4.377 | 70 50.981 | | |
| Herods Cove | 10/18/2005 | 43 4.360 | 70 50.903 | | |
| Herods Cove | 10/18/2005 | 43 4.429 | 70 50.907 | | |
| Herods Cove | 10/18/2005 | 43 4.411 | 70 50.932 | | |
| Herods Cove | 10/18/2005 | 43 4.410 | 70 50.932 | | |

**Appendix A - Raw Data** (cont.)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Little Bay | 10/19/2005 | 43 | 6.804 | 70 | 51.971 | | |
| Little Bay | 10/19/2005 | 43 | 6.781 | 70 | 51.980 | | |
| Little Bay | 10/19/2005 | 43 | 6.744 | 70 | 51.961 | | |
| Little Bay | 10/19/2005 | 43 | 6.715 | 70 | 51.991 | | |
| Little Bay | 10/19/2005 | 43 | 6.660 | 70 | 52.077 | | |
| Little Bay | 10/19/2005 | 43 | 6.659 | 70 | 52.091 | | |
| Little Bay | 10/19/2005 | 43 | 6.634 | 70 | 52.094 | | |
| Little Bay | 10/19/2005 | 43 | 6.597 | 70 | 52.105 | | |
| Little Bay | 10/19/2005 | 43 | 6.566 | 70 | 52.114 | | |
| Squamscott River Mouth | 10/19/2005 | 43 | 3.375 | 70 | 54.683 | | |
| Squamscott River Mouth | 10/19/2005 | 43 | 3.323 | 70 | 54.617 | | |
| Squamscott River Mouth | 10/19/2005 | 43 | 3.429 | 70 | 54.620 | | |
| Squamscott River Mouth | 10/19/2005 | 43 | 3.424 | 70 | 54.668 | | |
| Squamscott River Mouth | 10/19/2005 | 43 | 3.292 | 70 | 54.478 | | |
| Squamscott River Mouth | 10/19/2005 | 43 | 3.273 | 70 | 54.490 | | |
| Squamscott River Mouth | 10/19/2005 | 43 | 3.350 | 70 | 54.401 | | |
| Squamscott River Mouth | 10/19/2005 | 43 | 3.398 | 70 | 54.066 | | |
| Squamscott River Mouth | 10/19/2005 | 43 | 3.393 | 70 | 53.909 | | |
| Squamscott River Mouth | 10/19/2005 | 43 | 3.383 | 70 | 53.849 | | |