

# **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

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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<sup>2</sup> 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<sup>2</sup> 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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Table 2. Summary of soft-shell clam data from previous research and the present study.

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

Figure 2. Locator map of six study areas showing locations of quadrat samples.

Figure 3. Locations of quadrat samples and areas visually inspected in each of the six study areas for soft-shell clam habitat.

## 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.

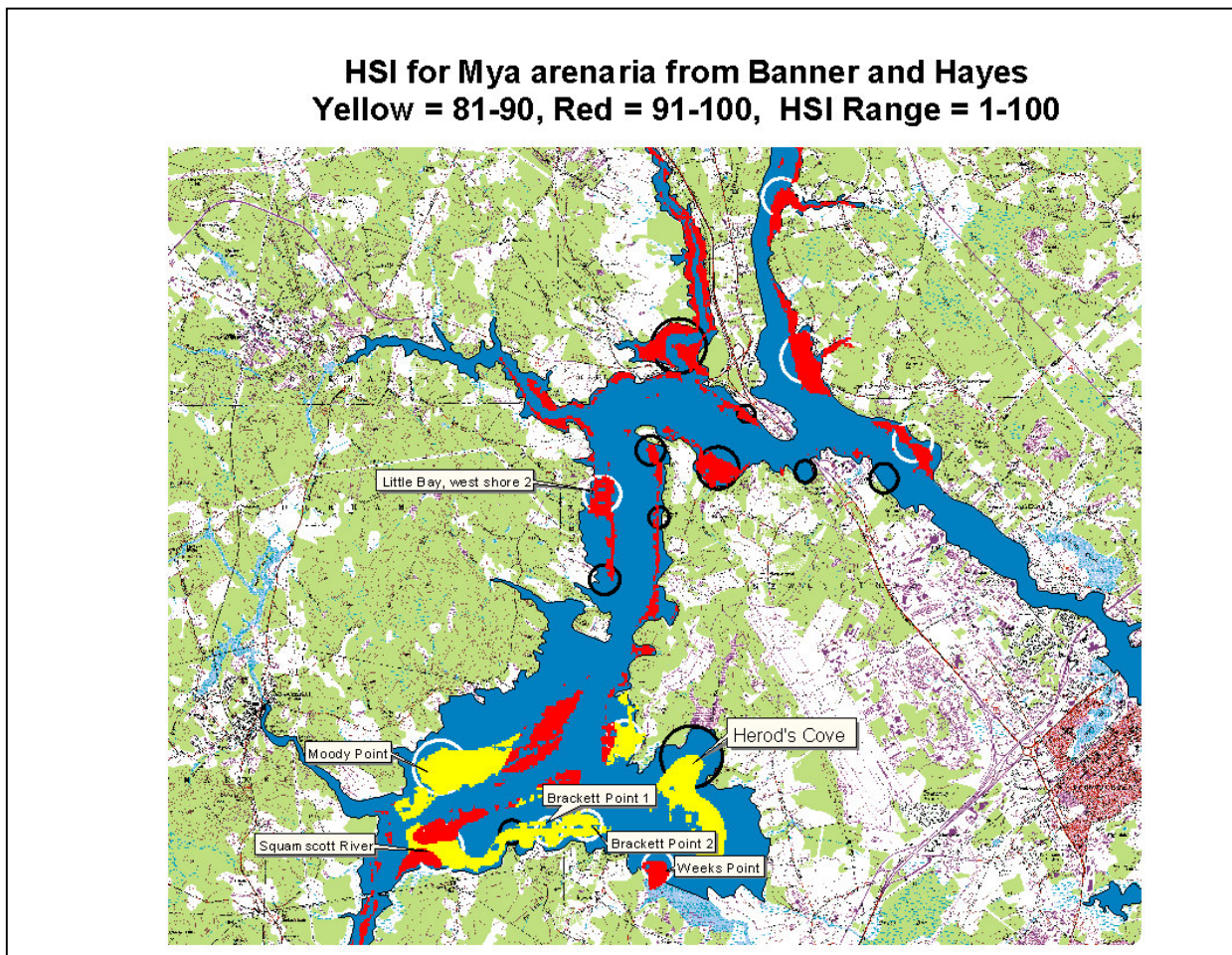


Fig. 1. Six sampling areas (each circled and labeled) for present study showing Habitat Suitability Index values from Banner and Hayes (1996).

## 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<sup>2</sup> 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<sup>2</sup> 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 <i>Mya</i> Density (#/m <sup>2</sup> , 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 some areas; widgeon grass ( <i>Ruppia</i> ), some eelgrass scattered throughout area

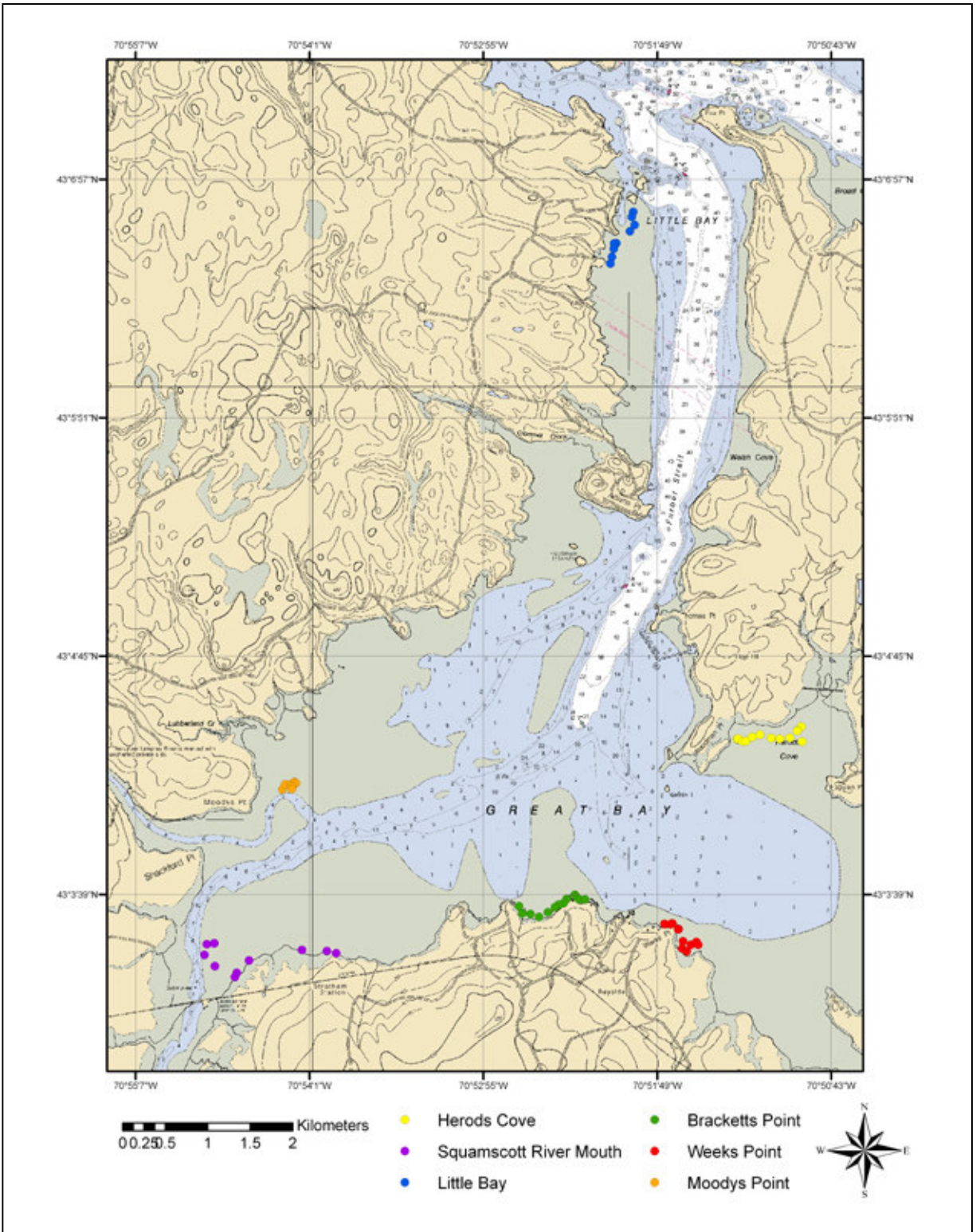


Fig. 2. Locator map of six study areas showing locations of quadrat samples (see Fig. 3 for details for each study area).

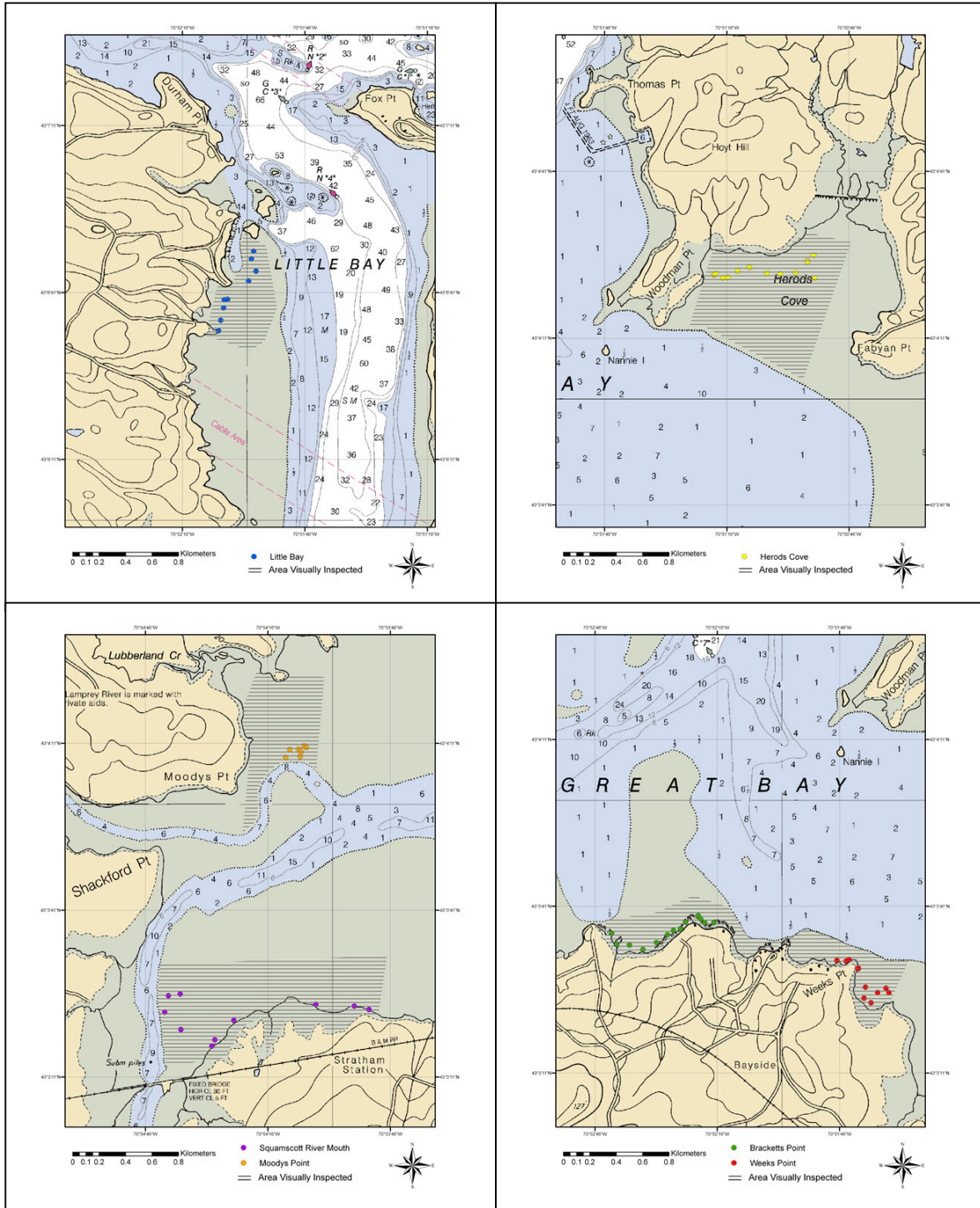


Fig. 3. Locations of quadrat samples and areas visually inspected for soft-shell clam habitat (cross hatched) in each of the six study areas.

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

LOCATION	Jackson, 1944	Nelson, 1981 (#/m <sup>2</sup> )	Jones & Langan, 1996 (#/m <sup>2</sup> )	Langan, 1997 (#/m <sup>2</sup> )	Smith, 2002 (#/m <sup>2</sup> )	Present Study* (#/m <sup>2</sup> )
<b>Great Bay &amp; Tributaries</b>						
Squamscott River (mouth)						0 (10 Quadrats)
Sandy Point				<20mm length: 3 >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 >20mm length: 35			<20mm length: 0 >20mm length: 8.5	
Herods Cove						0 (14 quadrats)
<b>Little Bay</b>						
Upper Bay, western shore						0 (9 quadrats)
Fox Point (eastern shore)		<20mm length: 170 >20mm length: 30		<20mm length: 2 >20mm length: 9	<20mm length: 0 >20mm length: 1.8	
Little Bay/SW Durham Pt.				<20mm length: 5 >20mm length: 11		
Little Bay (eastern shore)		<20mm length: 90 >20mm length: 10				
<b>Upper Tributaries</b>						
Bellamy River (Royalls Cove)		<20mm length: 30 >20mm length: 10			<20mm length: 0 >20mm length: 8.7	
Cocheo River	none					
Salmon Falls River	none	<20mm length: 62 >20mm length: 8				
<b>Upper Piscataqua River</b>						
Dover Pt/Boston Harbor				<20mm length: 14 >20mm length: 50		
Upper Piscataqua	100's of bushels					
<b>Lower Piscataqua River</b>						
Ordione: 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			
<b>Methods:</b>	(qualitative surveys)	1/10 m <sup>2</sup> quadrats, washed on 1 mm mesh	1/8 m <sup>2</sup> quadrats, visual inspection	1/8 m <sup>2</sup> quadrats, visual inspection	1/8 m <sup>2</sup> quadrats, visual inspection	1/8 m <sup>2</sup> 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		