Taunton Bay Mudflat Management Plan

A Case Study in Mudflat Fisheries Management Using Ecosystem-Based Principles

Photo by John Sowles

April 2007

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Prepared for
Friends of Taunton Bay

Prepared by
Barbara S. Arter
BSA Environmental Consulting
PO Box 141
Steuben, ME 04680
207-546-2018

BSA Environmental Consulting

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Acknowledgments

Will Ambrose	Bates College
Hannah Annis	Maine Department of Marine Resources
Kevin Athearn	University of Maine at Machias
Tom Atherton	Harvester, Town of Orland
Richard Bard	Maine Department of Inland Fish and Wildlife
Brian Beal	University of Maine at Machias
Jane Disney	Mount Desert Island Water Quality Coalition
Frank Dorsey	Friends of Taunton Bay
Stephen Eddy	University of Maine Center for Cooperative Aquaculture Research
John Fendl	Maine Department of Marine Resources
Tracey Gamache	Narraguagus/Pleasant Rivers Watershed Councils
Sherman Hoyt	University of Maine Cooperative Extension
Heath Hudson	Frenchmans Bay Fisheries
Lee Hudson	Frenchmans Bay Fisheries, Friends of Taunton Bay, & Maine Seaweed Council
Vanessa Levesque	NOAA Coastal Management Fellow
Dave Libby	Maine Department of Marine Resources
Barbara Maurer	Downeast Resource Conservation & Development Area
Hillary Neckles	US Geologic Survey
Laurie Osher	University of Maine
Steve Perrin	Friends of Taunton Bay
John Sowles	Maine Department of Marine Resources
Peter Thayer	Maine Department of Marine Resources
Lindsay Tudor	Maine Department of Inland Fish and Wildlife
Matt Young	Maine Department of Environmental Protection

.,..And countless harvesters and community members who contributed a wealth of information during public meetings and personal interviews.

List of Acronyms and Abbreviations

BMP	Best management Practice(s)
DOT	(Maine) Department of Transportation
EBM	Ecosystem-Based Management
FTB	Friends of Taunton Bay
GOM	Gulf of Maine
DEP	(Maine) Department of Environmental Protection
DMR	(Maine) Department of Marine Resources
IFW	(Maine Department of) Inland Fish and Wildlife
LWRC	Land and Water Resources Council
NOAA	National Oceanic and Atmospheric Administration
NPS	Nonpoint Source (Pollution)
OBD	Overboard Discharge (System)
SPO	(Maine) State Planning Office
TB	Taunton Bay
UMCCAR	University of Maine Center for Cooperative Aquaculture Research
UMM	University of Maine at Machias
USFWS	US Fish and Wildlife Service
USGS	US Geological Survey
WQM	Water Quality Monitoring

Executive Summary

In April 2006, the Friends of Taunton Bay received grants from the Gulf of Maine Council on the Marine Environment and the Maine Community Foundation to develop the Taunton Bay Mudflat Management Plan. The goal of the project was to determine the feasibility and local support for the use of ecosystem-based principles to manage mudflat fisheries in a small bay in the Gulf of Maine (GOM).

Information for the development of this plan was gathered between May 2006 and March 2007 employing a multi-stakeholder, bottom-up approach that uses the expertise of biologists, researchers, managers, local harvesters, municipal governments, conservation organizations, and community members to develop recommendations that are based on appropriate ecosystem-based principles.

The plan makes 28 recommendations regarding governance, education, habitat protection, research, and clam and worm fisheries management. Implementation of the plan and its recommendations will depend upon individual agencies, municipalities, and organizations adopting either individual recommendations or the plan in its entirety. Lead and partnering agencies have been assigned to each recommendation in order to facilitate the implementation process.

Located in eastern Hancock County, Maine, Taunton Bay (TB) drains portions of 8 towns and townships. The most defining feature of the bay is its extensive subtidal and intertidal mudflats which host a diversity of benthic invertebrates and provide forage for many predator species such as flounder, horseshoe crabs, and shorebirds. The intertidal mudflats also support economically viable clam and worm fisheries; an estimated 240,000 pounds of worms and 200,000 pounds of clams are harvested in a typical year in TB.

Although the bay is moderately undeveloped compared to other areas in the state or GOM, it is experiencing a number of threats that may jeopardize it. Land-based pollution (agricultural runoff, septic pollution), increased development (buildings, roads, culverts), global climate change (sea-level and temperature rises), governance issues, (lack of ordinances, bay-level data, and harvester associations) and potential fisheries mismanagement (overharvesting, bottom-dragging impacts) pose multiple threats to the health of TB.

Finally, the plan reviews management options for the clam and worm fisheries and suggests reasons for managing TB mudflats including maintaining sustainability, reducing use conflicts, enhancing marketability, reducing anthropogenic threats, improving governance, and ensuring traditional access to the bay.

Chapter 1: Introduction

Ecosystem-Based Management, Project Background, Goals and Objectives, Methodology, and Implementation

Ecosystem-Based Management

The term "ecosystem" is defined as an interacting system of living organisms and their physical environment (Smith and Smith, 2005). When the term is used as a type of management (i.e., ecosystem-based management), it refers to a management approach that considers all ecosystem components, including humans and the environment, rather than managing one issue or resource in isolation.

Ecosystem-based management (EBM) is a management approach that (NatureServe, 2006):

- integrates ecological, social, and economic goals and recognizes humans as key components of the ecosystem;
- considers ecological - not just political – boundaries;
- addresses the complexity of natural processes and social systems and uses an adaptive management approach in the face of resulting uncertainties;
- engages multiple stakeholders in a collaborative process to define problems and find solutions;
- incorporates understanding of ecosystem processes and how ecosystems respond to environmental perturbations; and
- is concerned with the ecological integrity of coastal-marine systems and the sustainability of both human and ecological systems.

In April 2006, the not-for-profit conservation organization, Friends of Taunton Bay (Hancock, Maine), initiated an effort to develop a plan for managing the intertidal mudflats of Taunton Bay, Hancock County, Maine, using these ecosystem-based principles. This document, which is funded by the Gulf of Maine Council and the Maine Community Foundation, is the product of that effort.

Project Background

The Taunton Bay Study: A Pilot Project in Collaborative Bay Management
Located in eastern Hancock County, Maine, Taunton Bay (TB) drains a watershed composed of portions of 8 towns and townships. In 2005, Friends of Taunton Bay (FTB) was awarded a grant from the Maine State Planning Office (SPO) to conduct a pilot project in local bay management as part of a two-year bay management study for the Land and Water Resources Council (LWRC). The mission of FTB is to understand and promote the health and integrity of the Taunton Bay ecosystem. The outcome of the grant was a report titled, "The Taunton Bay Study: A Pilot Project in Collaborative Bay Management." The report compiled and reviewed current environmental, biological, economic, governance, and fisheries management elements in the bay. Completed in early 2006, the project generated extensive GIS maps, environmental indicators data, an economic assessment of bay fisheries, governance recommendations, and outreach materials gleaned from public listening sessions and interviews.

Although the study thoroughly explored environmental indicators and governance issues, it was unable to adequately address the details of commercial fisheries and their management. Interviews with harvesters conducted in 2005 for the Economic Assessment of the Fisheries and Marine Resources of Taunton Bay (Arter, 2005) indicated that more work was needed. Specifically the interviews and research related to that report indicated that the TB mudflats are well known for the productivity of soft-shelled clams, bloodworms, horseshoe crabs, and several species of shorebirds. However, numerous factors unique to TB create potential threats and point to the need to manage this ecosystem:

1. An estimated 240,000 pounds of worms and 200,000 pounds of clams are harvested in a typical year in TB. These figures suggest that the bay could be subjected to over harvesting if the resource is not managed properly.
2. TB is less susceptible than most bays in Maine to red tide because of its deep mainland penetration, and as such it is subject to overharvesting of shellfish when other bays close due to red tide.
3. The enclosed nature of the bay may also reduce the amount of tidal flushing and therefore cause pollutants to accumulate in the bay.
4. The current dragging moratorium in TB has provided some protection to the mudflat habitat for the past 7 years. The expiration of the moratorium in 2008 may create potential dragging impacts on the mudflat fisheries (clam and worms).
5. Currently there is minimal state and/or local management of the mudflat fisheries and ecosystem. As a result, the current practice is one of "folk management" in which harvesters remove all they can in a season, then move to other bays leaving the depleted bay to recover on its own.

In light of this situation and the potentially threatening factors, the Taunton Bay Mudflat Management Plan was created as a case study that builds on the foundation of the pilot study and the Economic Assessment by attempting to work closely with the local municipalities, harvesters, landowners, conservation organizations, and the Maine Department of Marine Resources (DMR) to develop mudflat fisheries recommendations.

Project Goal and Objectives

Goal

The goal of the Taunton Bay Mudflat Management Plan is to determine the feasibility and local support for the use of ecosystem-based principles to sustainably manage mudflat fisheries (clam and worm fisheries) and their economy in a small bay in the GOM. Specifically the plan explores and makes recommendations regarding the use of various research, governance, and management tools (e.g., land-use regulation, license restrictions, season adjustments, access restrictions, etc) to create sustainable clam and worm fisheries while maintaining healthy populations of interrelated species in the bay community.

Objectives

The expected long-term outcome of this project is that municipalities, conservation organizations, and local harvesters will build stronger relationships with one another and with state and federal management agencies. As such, the objectives of the project are to:

- provide support and guidance to the DMR Taunton Bay Comprehensive Resource Management Plan (as mandated by the Maine state legislature in 2005, published Jan 2007),
- provide an example of how to manage specific mudflat species using EBM but be general enough to be used as a model for other bays in the Gulf of Maine (GOM),
- bring together a network of multi-agency, multi-organization, and multi-municipality stakeholders to facilitate the task of resolving conflicts between stakeholders with different management priorities,
- enhance local stewardship by gathering local input, knowledge, and support for local governance of the mudflat fishery, and
- build on current bay management momentum by utilizing existing and ongoing environmental data and information regarding management and ecosystem health indicators as an outreach, education, and management tool.

Related Projects

This planning project was conducted in conjunction with existing state and federal initiatives and the plan is designed to add value to these initiatives. Specifically, the project will enhance research associated with the dragging moratorium that was established in the bay as a response to public concern about benthic habitat alterations and overfishing. This legislation (See http://janus.state.me.us/legis/ statutes/12/title12ch627.pdf) allows DMR to provide comment and science-based information on the dragging moratorium. The project also contributed valuable information to the DMR TB Comprehensive Resource Management Plan (Jan 2007) and to the statewide Maine Bay Management Study.

The reader is encouraged to review the following documents for more information on Taunton Bay, bay management, and ecosystem-based management. These reports include physical and biological descriptions, status of ecological indicators, and fisheries management considerations.

1. **The Taunton Bay Assessment: A Report to the Maine Legislature Marine Resources Committee for Consideration of the 2000-2005 Dragging Prohibition.** 2004. By Slade Moore, Maine Department of Marine Resources.

2. **Commercial Mussel Dragging Experiment in Taunton Bay.** 2005. By Frenchmans Bay Fisheries, Inc. and the Maine Department Marine Resources.

3. **The Taunton Bay Dragging Experiment**. 2005. By Slade Moore. Maine Department Marine Resources Internal File.

4. **The Taunton Bay Study: A Pilot Project in Collaborative Bay Management**. 2006. Friends of Taunton Bay.

5. **Bay Management Planning.** Maine Coastline. Spring 2005. Maine Coastal Program. Maine State Planning Office.

6. **Report to the Joint Standing Committee on Marine Resources of the 123rd Maine Legislature on a Comprehensive Resource Management Plan for Taunton Bay, Maine** (also referred to as **The Taunton Bay Comprehensive Resource Management Plan)**. January 2007. Maine Department of Marine Resources. http://www.maine.gov/dmr/news/tauntonbayplan.htm

7. **Managing Maine's Nearshore Coastal Resources: Report of the Bay Management Study** (also referred to as **Maine Bay Management Study**). 2007. Maine State Planning Office and Maine Department of Marine Resources. http://www.state.me.us/dmr/baystudy/baystudy.htm

8. **Maine Statute Title 38: Waters and Navigation. Chapter 19: Coastal Management Policies §1801**. Findings and declaration of coastal

management policies.
http://janus.state.me.us/legis/statutes/38/title38ch19sec0.html

Methodology

Information for the development of this plan was gathered between May 2006 and March 2007 using the methodology described in Figure 1.1. This method employs a multi-stakeholder, bottom-up approach that uses the expertise of biologists, researchers, managers, local harvesters, municipal governments, conservation organizations, and community members to develop recommendations that are based on appropriate science. With the help of the consultant, FTB developed a project team of diverse organizations, agency staff, community members, local decision makers, harvesters, and businesses; and by so doing naturally collaborated and shared information and tasks. The objective of this approach is to enhance citizen ownership and stewardship of the local resource.

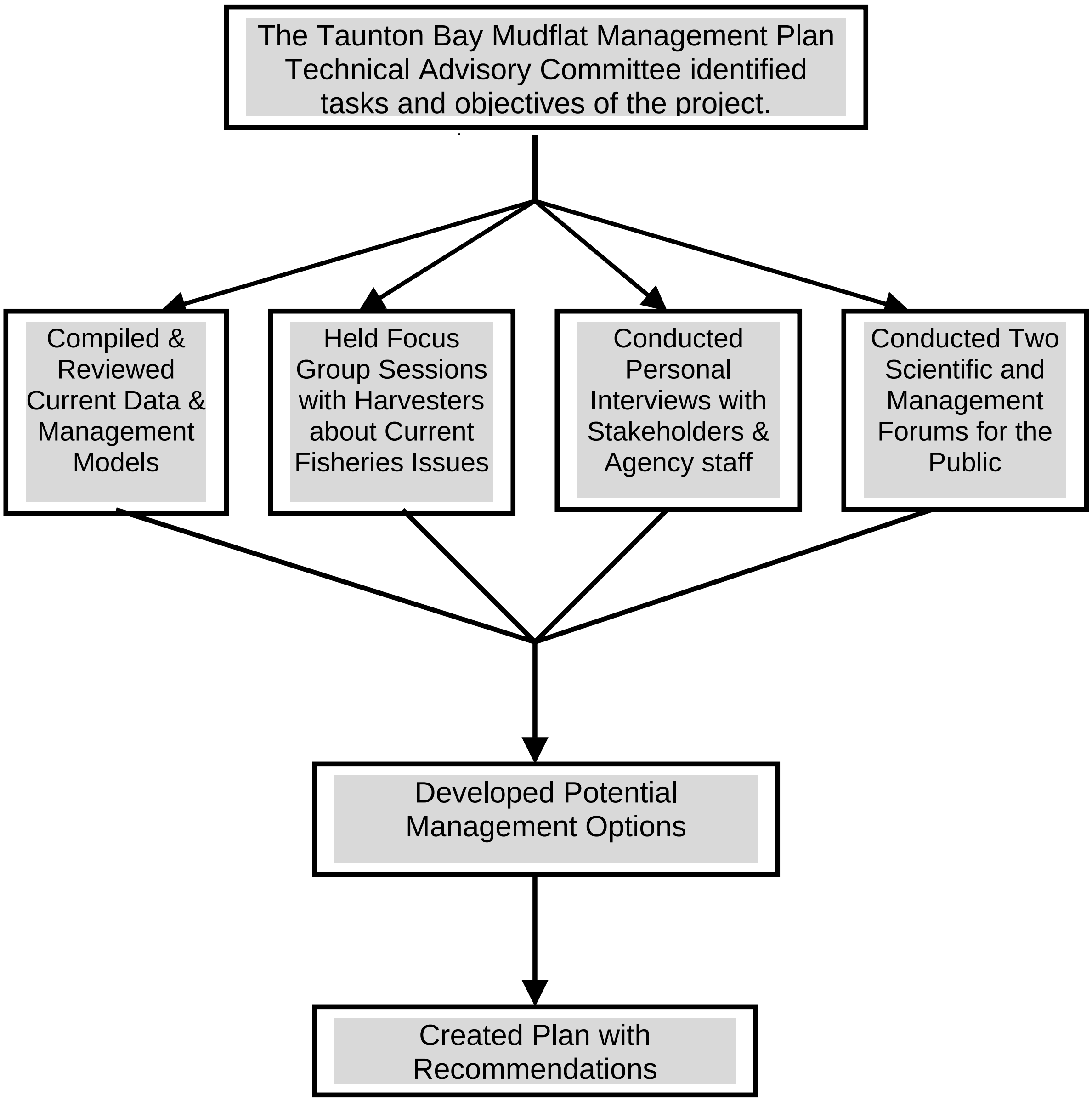
Each activity (press release, public meeting, interview, forum) conducted during this project was designed to:

- build stakeholder engagement/ownership,
- increase dialogue between/among all stakeholders,
- identify the issues of concern,
- identify the appropriate resources for solution building, and
- generate effective management recommendations.

Although some stakeholders were either unreceptive to the project or reluctant to participant in it initially, eventually many came to appreciate the value of the process. This was accomplished by providing numerous opportunities for stakeholders to participate including focus group sessions, public forums, and phone interviews. Although not everyone agreed on how to address the various issues, they eventually felt comfortable enough to participate and provide input into the process.

The greatest challenge to managing resources at the community level is balancing the concerns of the various stakeholders. What seems reasonable to one stakeholder might be considered unacceptable to another. In general, the areas of greatest debate during this project were the level of resource protection; balancing science with anecdotal information; interpretation of data; and specific methods of governance. The information and subsequent recommendations in this document therefore reflect a degree of consensus among stakeholders as well as objective reporting and best professional judgment from the consultant.

Figure 1.1. Taunton Bay Mudflat Management Plan Development Methodology



Plan Implementation

Recommendations

Recommendations for this plan are found in boxes throughout the document. In Chapter 2 the reader will find recommendations regarding biological communities, ecology, and economic and fisheries research. In Chapter 3 recommendations are made regarding threats such as nonpoint source pollution, development, ineffective fisheries management and governance. Chapter 4 discusses various management options for the clam and worm fisheries. Chapter 5 summarizes all of the recommendations

Implementation

This plan is not a legal or state policy document with agency or legislatively upheld directives. Rather it is a feasibility study with recommendations based on research and public input. Implementation of the plan and its recommendations will not necessarily become state policy but rather will depend upon individual agencies, municipalities, and organizations adopting either individual recommendations or the plan in its entirety.

Agencies and organizations are encouraged to use the plan as a tool or resource for decision making and planning. It may also be used as a support document for fundraising, project development, and research. Table 1.1 illustrates how the plan and its recommendations can be utilized by various agencies and organizations to achieve specific planning and management goals.

Possibly, the three most important uses for the plan and its recommendations are as a guidance document for:

1. interlocal agreements among neighboring towns and harvesters regarding shellfish and possibly worm management, conservation, and ordinances;
2. state and local management and conservation of the worm and shellfish fishery to ensure forage for predatory species (e.g., shorebirds, some finfish, other invertebrates); and
3. municipal-level decision making regarding shoreland zoning and land-based nonpoint source (NPS) pollution prevention.

Table 1.1. Possible Implementation of Plan Recommendations by Various Agencies and Organizations.

Governance Level	Committee/Agency/ Organization	Focus Area for Implementation of Recommendations
Municipal Government	Planning Board	Comprehensive planning; shoreland zoning
	Municipal Shellfish Committees	Shellfish ordinances and conservation
	Regional Shellfish Committees	Regional/interlocal ordinances and conservation
	Code Enforcement	Water quality and NPS pollution
Harvesters Associations	Shellfish Harvesters (possible*)	Shellfish ordinance, management, and conservation
	Worm Harvesters (possible)	Worm management and conservation
	Frenchman Bay Harvesters Association (possible)	All marine species management and conservation
County Government	Hancock County Planning Commission	Regional planning
Conservation Organizations	Friends of Taunton Bay Frenchman Bay Conservancy	Water quality and bay health indicators; community outreach
	MDI Water Quality Coalition	Water quality and bay health indicators; community outreach
State Agencies	DEP	Water quality & natural resource protection
	DMR	Marine fisheries management
	SPO	Coastal management and planning
	IF&W	Diadromous fish, shorebird and wading bird habitat
	Cooperative Extension/Sea Grant	Education and facilitation
Research Institutions	UM, UMM, Bates College, etc	Fisheries and ecology research
Federal Agencies	USFWS	Marsh restoration; diadromous fish and migratory bird management
	NOAA	Diadromous and marine fisheries management
	Gulf of Maine Council	Water quality and fisheries indicator collection

* These harvester associations currently do not exist. See Recommendation 3.14.

Chapter 2: Description of Taunton Bay Mudflat Ecosystem

Physical, Biological, and Ecological Characteristics and Human Uses

Physical Characteristics

The reader is encouraged to refer to The Taunton Bay Study, *2006 by the Friends of Taunton Bay for detailed information on physical, biological, and economic parameters and GIS maps of Taunton Bay.*

Located in eastern Hancock County, Maine, Taunton Bay (TB) drains portions of 8 towns and townships (T10SD, T9SD, Fletchers Landing Township, Eastbrook, Sullivan, Franklin, Waltham, and Hancock). The name, Taunton Bay, collectively refers to Taunton River, Hog Bay, and Egypt Bay and comprises 3,772 acres above the Tidal Falls (also known as Sullivan Falls or Hancock-Sullivan Falls). These are reversing falls produced by tidal flow between TB and Sullivan Harbor. The bay is the northernmost estuary at the head of Frenchman Bay and, along with Skillings River, Jordan River, Raccoon Cove and Flanders Bay, drains into the larger Frenchman Bay. (See Map: Taunton Bay Base Map)

Mudflats

The most defining feature of TB is its extensive subtidal and intertidal mudflats. A mudflat may be defined as a sedimentary habitat within the intertidal zone that is created by deposition in low energy coastal environments, particularly estuaries and other sheltered areas (Brian Beal, Taunton Bay Forum Presentation, 2006). Grain size can range from pure silt to mixtures of clay and sand and may contain a higher proportion of nutrient-rich, organic-mineral material than sediments in sandy habitats (Tyrell 2005).

Intertidal mudflats are defined as those muddy habitats exposed at low tide while subtidal mudflats are those muddy habitats generally not exposed at low tide. In TB, subtidal mudflats occur on either side of the channel, while intertidal flats are located closer to shore. Each of these muddy habitats hosts a different community of organisms. Species commonly found in the subtidal mudflats include blue mussels, eelgrass, seastars, green crabs, shrimp, and several species of finfish and baitfish. A description of species found in the intertidal mudflat is included in the next section.

Although both subtidal and intertidal mudflats share similar features, the intertidal mudflats support a very productive community of organisms that are actively harvested (i.e., bloodworms, sandworms, and soft-shell clams). These flats have on occasion experienced threats such as nonpoint and point source pollution, overharvesting, and a general lack of appropriate management and conservation measures. **Therefore, this plan will focus only on the intertidal mudflat and will not consider the subtidal muddy habitats.**

Biological Characteristics and Habitats

General Description

The TB intertidal mudflats (henceforth referred to as “mudflats”) typically occur next to eelgrass meadows, salt marshes, or are in direct contact with terrestrial communities (woods, fields, lawns). In the GOM, mudflats support a rich community of organisms, primarily benthic invertebrates and algae, living in or on the surface of the mudflat. Since oxygen typically becomes depleted within a few centimeters of the surface, many invertebrates live near the mud’s surface. Several species build and maintain burrows or tubes, while others have adaptations such as siphons or tubes for filter feeding in order to adjust to the low-oxygen environment (Watling 1998).

The mudflats also support a community of terrestrial organisms, such as shorebirds, raccoons, and otters that prey upon the benthic invertebrates as a food source. Furthermore, the mudflat supports several invertebrates and finfish living in the water column that washes over the mudflat at high tide. Table 2.1 lists species commonly found on and/or interacting with mudflats in the GOM.

Primary Mudflat Habitats

Microalgae and Diatoms

Most microalgae growing on the surface of mudflats are either green algae or diatoms (unicellular algae that require sunlight and dissolved silica to survive). The presence of these microalgae creates biofilms on intertidal mudflats that occur sporadically throughout the year and have a patchy distribution. Periods of extremely high primary production and sediment stabilization are interspersed with periods of low algal abundance. The biofilms stabilize the mud surface and prevent it from being eroded by tidal action or heavy rain (Trites et al. 2005). They are also significant in the diets of shorebirds and some invertebrates, such as snails.

Benthic Invertebrates
A pilot study to determine the array of benthic (infaunal) species that exist in the upper and lower intertidal zones in Hog Bay as well as to quantify their distribution and abundance was conducted in fall 2005 (Beal 2006). Though preliminary, the study suggests that there is a significant difference in diversity between the low and high tide plots (Table 2.2). This difference is natural and a function of nutrient availability and saltwater cover. The study also shows that diversity does not vary significantly from site to site within a tidal height. The three species found in greatest number were *Hydrobia,* the snail, *Gemma, the* brooding bivalve, and *Neanthes,* the sandworm. The samples from the low tide zone had approximately 30.4% more individuals per species than the high tide samples. Both *Gemma* and *Neanthes* were present in higher numbers in the low tide samples than in the high tide samples.

It should be noted that no bloodworms were found in the samples although they are actively harvested from the bay. It is possible that the location chosen for the survey was not the best bloodworm habitat or that the area had recently been harvested.

Table 2.1. Common Native Species Interacting with Mudflats in Gulf of Maine.

Species Living within or on the Surface of Intertidal Mudflat	**Species Which Prey on Intertidal Mudflat Species**	**Species Living in the Water Column at High Tide**
Algae (primarily green algae on surface)	Greater & Lesser Yellowlegs	Phytoplankton
Diatoms (on surface)	Whimbrel	Kelp and other seaweeds
Rockweed (on rocks)	Red knot	Shrimp
Amphipods (shrimp, scuds, etc)	Black duck	Brittle star
Snails and periwinkles	Canada goose	Seastar
Sandworm	25 species of shorebirds (plovers, sandpipers, peeps, etc)	Anemone
Bloodworm	Raptors (eagles, osprey, etc)	Atlantic mackerel
Softshell clam	Gulls	Red Hake
Rock crab (& other native crabs)	Terrestrial mammals (raccoons, otter, etc)	Alewife
	Humans	Winter Flounder
	Horseshoe crab	Rainbow Smelt
		Baitfish (stickleback, mummychug, etc)

Table 2.2. Benthic Invertebrate Species Found in Cores from High Tide and Low Tide Zones in Hog Bay (Beal 2006).

Low Tide Zone		**High Tide Zone**	
Scientific Name	***Common Name***	***Scientific Name***	***Common Name***
Neanthes virens	Sandworm	*Gemma gemma*	Brooding bivalve
Gemma gemma	Brooding bivalve	*Neanthes virens*	Sandworm
Hydrobia ulvae	Snail	*Polydora* spp.	Worm
Corophium volutator	Amphipod	*Hydrobia ulvae*	Snail
Lumbrenereis spp.	Worm	*Corophium volutator*	Amphipod
Eteone longa	Worm	*Lumbrinereis* spp.	Worm
Mya arenaria	Soft-shelled clam	*Littorina obtusata*	Northern yellow periwinkle
Littorina obtusata	Northern yellow periwinkle		

Ecological Relationships

Ecology is the study of how organisms (plants, animals, and humans) interact with each other and their physical environment. It may also include the study of the distribution and abundance of living organisms and how these properties are affected by the interactions between organisms and their biotic and abiotic environment (B. Beal, UMM, Taunton Bay Forum Presentation, Nov 2006).

Food Web

All organisms interacting with the mudflat are part of a food web in which energy and nutrients are exchanged from one organism to another and from one trophic (energy) level to another (Figure 2.1). At the base of the food chain are microalgae (primary producers), which require a source of nutrients (both land-based and marine) in order to grow and multiply. Both green algae and diatoms are the primary food source for grazing organisms (primary consumers) such as zooplankton, snails, and the amphipod, *Corophium*. Amphipods and other grazers are in turn a food source for shorebirds and other invertebrates (secondary consumers), such as softshell clams, which feed on both phytoplankton and zooplankton. Some organisms, including some worms, prefer to eat decaying material (detritus) and are thus called detritivores, while other organisms, including bloodworms are predatory and will eat other invertebrates (e.g., bloodworms will eat sandworms).

Trophic Level Considerations

The understanding of ecological relationships and the impacts of population shifts on higher order trophic levels form the foundation of ecosystem-based management decision making. Recent studies and indicator monitoring data from TB and statewide suggest that changes in one population of organisms may be linked to the status of another organism (i.e., food source).

Phytoplankton and Filter Feeders
At least two recent observations have been made regarding the status of phytoplankton and filter feeders in the bay. Although these observations are anecdotal or the results of preliminary studies, they raise questions regarding overall productivity and point to the need for further investigation.

- Number of total phytoplankton individuals may be on a short-term decline from 2002 to 2006. In previous years, summer phytoplankton ranged from 5 to 20 cells per slide. In 2006 summer phytoplankton ranged from 0 to 15 cells per slide and approximately half of the 2006 samples had less than 5 cells per slide. (S. Perrin, Friends of Taunton Bay, Personal Communication, Dec 2006). The reason for the observed decline is not known but may be linked to natural short-term weather patterns or longer-term productivity declines.
- A clam growth study conducted in a closed flat by Beal in December 2006 suggests that growth in TB clams was "very slow compared to any other site in Maine" (B. Beal, UMM, Personal Communication, Dec 2006). It is unknown why growth was slow but many harvesters report reduced growth in areas that have not been raked in several years.

Recommendation
2.1. Conduct a study that investigates overall bay productivity and specifically primary productivity, filter-feeder growth, and invertebrate population dynamics (diversity, population size, etc).

Shorebirds
The Taunton Bay Study Indicators Report and IFW data indicate that several species of shorebirds have experienced significant population declines throughout the state between 1970 and today (L. Tudor, IFW, Taunton Bay Forum Presentation, Nov 2006). These species include:

- black-bellied plover
- semipalmated sandpiper
- least sandpiper
- short-billed dowitcher
- ruddy turnstone
- red knot
- dunlin
- spotted sandpiper

Although the exact cause of the declines is unknown, biologists and managers have identified several threats to breeding areas (Hudson Bay area), wintering areas (South America) and staging areas (GOM). Specifically IFW has identified Hog Bay, Burying Island, and Dwelley Point/Springer Stream as shorebird staging areas and these areas are now protected under Maine's Significant

Wildlife Habitat Rules (See Map: Taunton Bay Shorebird Areas). IFW has identified the following threats to the GOM staging areas:

- shoreline development,
- human-related disturbances,
- docks and marinas,
- intertidal mussel dragging,
- clamming and baitworm harvesting,
- contaminants – oil spills, nonpoint source pollution, and
- predators (including terrestrial mammals and raptors).

These shorebird species have specific feeding and roosting requirements including a high density of invertebrates, low disturbance, undisturbed roosting areas above high water mark, and an environment free of contaminants. Shorebirds are opportunists so they will eat whatever intertidal invertebrates are most numerous. In Maine, they prey on biofilms, aquatic worms, amphipods (primarily *Corophium volutator*), marine worms (sandworms, bloodworms, and other polycheates), copepods (marine crustaceans), and gastropods such as snails and periwinkles (L. Tudor, IFW, Personal Communication, Jan 2007). While some researchers in Canada have found that turning over flats may benefit shorebird feeding, Shepherd and Boates (1999) have shown that worm harvesting reduces *Corophium volutator* numbers in half at each pass. The same study contends that the local decline in shorebirds coincided with a rapid increase in baitworm harvesting. Other studies suggest that human disturbance such as development (See Chapter 4), bird watching, pets, and resource harvesting may have long-term population effects since disruptions can occur during migration, wintering, breeding, and foraging (West et al. 2002; Burger et al. 2004).

Recommendation

2.2. Consider the establishment of a shorebird research reserve within the IFW-designated Shorebird Zone in Hog Bay where researchers can investigate the interactions between benthic invertebrates and shorebirds and the effects of clam and worm harvesting on associated predator and prey species. The reserve could also be used as a benthic invertebrate study area for the study of marine worms (see Chapter 4).

<u>Horseshoe Crabs</u>

Horseshoe crabs (*Limulus polyphemus*) often frequent mudflat habitats to feed on blue mussels, softshell clams, sandworms, and bloodworms. In turn, the crabs are preyed on by crows, gulls, eagles, and several species of small egg-eating fish. Horseshoe crabs in Maine are at the edge of their range and are therefore in low numbers relative to southern parts of the eastern seaboard. As a result of an apparent decline in numbers in 2003, Maine's horseshoe crab fishery was closed statewide during their breeding season (May through September). Although, the population appears to have stabilized, the unique or atypical isolation of horseshoe crabs within Egypt and Hog bays, as demonstrated by Moore (2004), indicates that these core breeding groups warrant extra management attention (DMR 2007).

Although undocumented in TB, many other regions in the Northeast have seen large numbers of horseshoe crabs killed by clam diggers in an effort to protect softshell clams (ARKive 2007; Rhode Island Sea Grant 2007). A major component of *The Taunton Bay Assessment* (Moore 2004) was a horseshoe crab tracking study to determine what habitats the species shared with shellfish in order to manage conflicts effectively. Data from that study are included in the Mapping Chapter of *The Taunton Bay Study* (FTB 2006).

Recommendation

2.3. Consider the establishment of a horseshoe crab research reserve within Egypt Bay where researchers can investigate the interactions between horseshoe crabs and other benthic invertebrates and the effects of clam and worm harvesting. The reserve could also be used as a benthic invertebrate study area for the study of marine worms and softshell clams (see Chapter 4).

Human Uses: Fishery Status and Economics

An economic assessment conducted as part of the Taunton Bay Study (Arter, 2005), indicated that soft-shell clams, bloodworms, and sandworms are regularly harvested from TB. A review of 2004 license data indicated that the top three species by percent of license holders in the TB area are lobsters/crabs at 36%, marine worms at 26% and shellfish (softshell clams) at 12% (Figure 2.1). It is estimated that the majority of lobster/crab license holders harvest outside TB (only 3-4 commercial lobster fishermen were identified as fishing within TB in 2004) and that the majority of marine worm and clam license holders harvest within TB. Therefore, worm and clam harvesting are considered the two species harvested with the greatest amount of effort (highest number of harvesters) in TB.

Softshell Clams

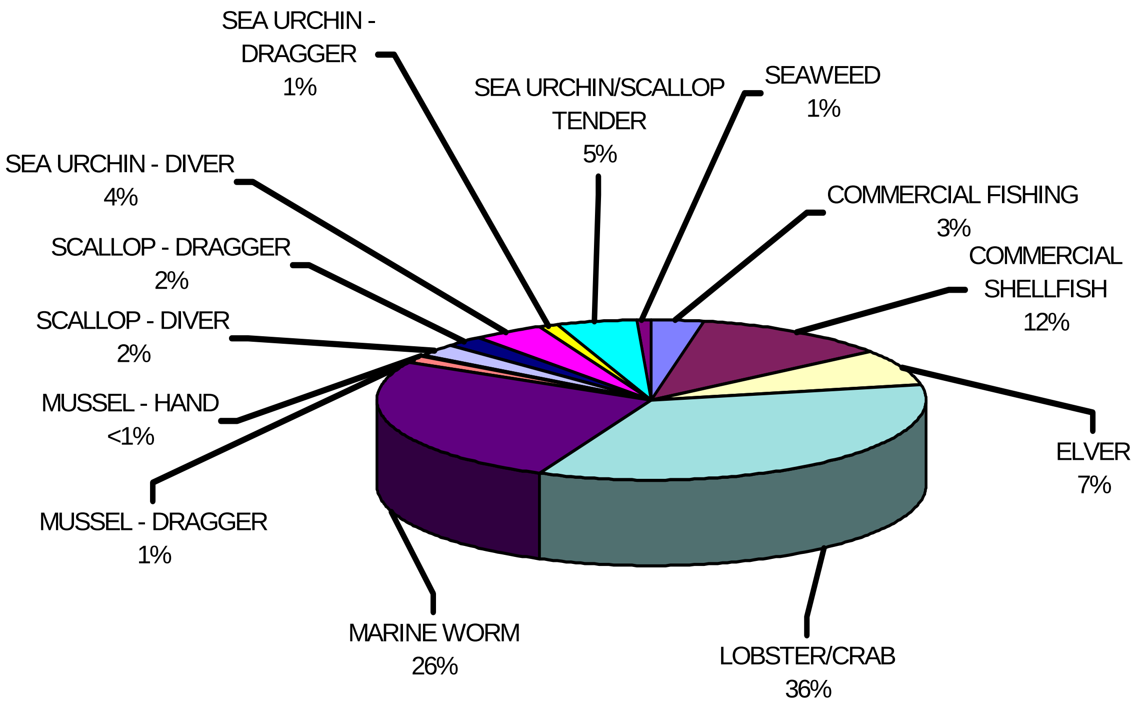
<u>*Fishery Status*</u>

The following information was provided by harvesters during a focus group session held in June 2006.

Softshell clams have been commercially harvested by hand from mudflats in Hog Bay, Egypt Bay, and Taunton River for the last century. With the exception of winter months when the flats are frozen, the season is generally year-round in those clamflats that pass the state's sanitation requirements for clean water (See Chapter 3 for more information on closed clamflats). Areas that are currently being harvested for clams in Taunton Bay include:

- Hog Bay both north and south of the channel
- Taunton River below Dwelley Point extending to Butler Point and on both sides of the channel, and
- Much of Egypt Bay and extending south to the sanitation closure at Carrying Place Inlet.

Figure 2.1. 2004 DMR Licenses Issued to Hancock, Sullivan, and Franklin Harvesters by Species (Arter, 2005).



The most productive of these areas is Taunton River, specifically between Dwelley and Butler points on the west side of the channel, and above and below Hatch Point on the east side of the channel. The current average harvest from this area is 2 bushels per harvester per day. Both Egypt and Hog bays are less productive and yields there average 1.5 bushels per harvester per day.

Harvesters agree that the TB flats are in good but not great condition today and that they have the capacity to be improved. The flats have greatly improved since 15-20 years ago but yield has diminished slightly since 2001-2002 when harvest rates were 3-4 bushels per harvester per day. The greatest amount of clams reported harvested from TB in recent years was 5-6 bushels per harvester per day in 2004 suggesting that the capacity is possible given the right conditions.

In a typical year approximately 20 clammers from the surrounding communities harvest clams in TB. During those years when other bays are closed due to Red Tide, it is estimated that at least 50 or more clammers come to harvest TB. These harvesters come from as far as Portland and Eastport. It is during Red Tide that the bay is under threat of over harvesting.

Most harvesters support ordinances, conservation measures, and some forms of flat closure but they state that flats with long-term closures (such as sanitary closures) have a tendency to become too dense and die off without producing sufficient spawn. Conservation measures and management considerations are discussed in Chapter 4.

Economics
Dealers report the amount (pounds) and value of clams as well as the town and shellfish sanitation area of all clams they purchase from harvesters to DMR. Because of this, there are more bay-level data on clams than any other species harvested. Unfortunately, dealers only report monthly summaries, so it is unknown how many clammers the data represent. The monthly summary also does not represent recreational landings. Of the three towns fronting TB, only the town of Sullivan has a clam ordinance and issues licenses to town residents and non-residents. Franklin and Hancock do not have clam ordinances; therefore it is unknown how many clammers harvest there. DMR landings data for 2003 indicate that the total revenue for clam landings for the three towns was $122,602. Assuming that 32 harvesters (based on licenses) operate in this region, this yields $3,831/harvester/year (Table 2.1). It should be noted that most harvesters believe this figure is a very low estimate of actual clam revenue in TB.

Figure 2.3 indicates that during the period 1999-2003, clam landings were highest in 2001 and 2002 and that in all years except 2003, landings were highest in Sullivan. It should be noted that both the towns of Hancock and Sullivan have shoreline and flats outside the Taunton Bay boundary. Only the Franklin shoreline is completely within the TB boundary. Therefore, the data only reflect regional productivity rather than bay-specific productivity.

Marine Worms

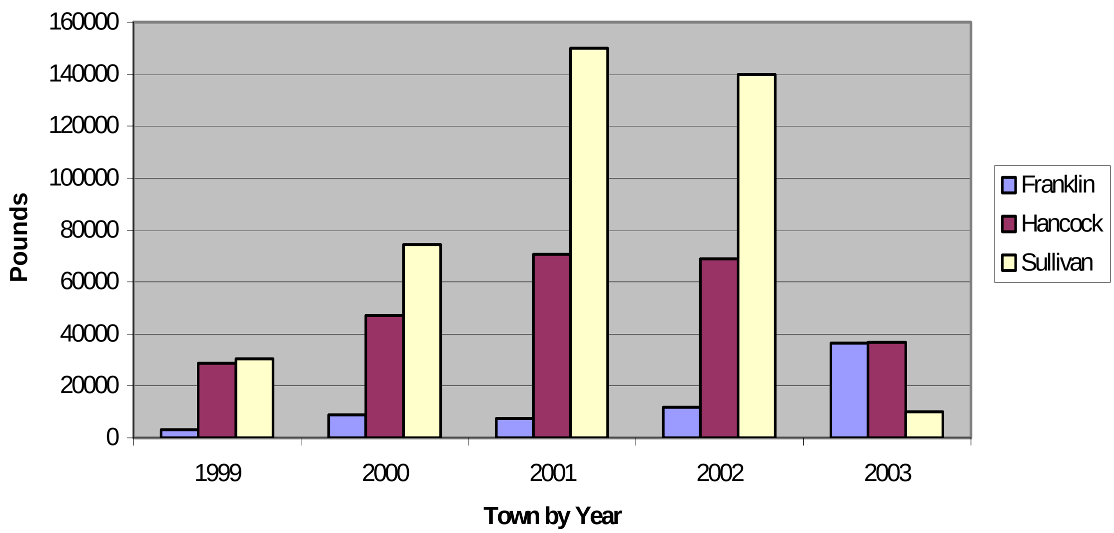
Fishery Status
The following information was provided by harvesters during a focus group session held in July 2006.

Bloodworms and sandworms are harvested from TB mud sediment by hand using a hoe and are sold to local dealers who sell/distribute them as bait for recreational marine fisheries (striped bass, rockfish, etc). Most wormers indicated that they harvest sporadically year round whenever the bay is not frozen. Harvesters indicated that all mudflats above the bridge are "good" worm habitat both in summer and winter and that no cove or flat in TB is more productive than another. Harvesters unanimously report that productivity is cyclical and unpredictable; worms that are there one day may be gone the next.

Table 2.1. Potential Annual Revenue Per Individual Harvester and Total Estimated Annual Revenue for Clams in Taunton Bay (Arter, 2005).

Fishery	Data Year	Potential Individual Annual Gross Revenue	Estimated # of Harvesters/ Entrepreneurs	Total Estimated Annual Gross Revenue for TB	Data Source
Clam	2003	$3,831	32	$122,602	DMR

Figure 2.3. DMR Clam Landings (Pounds) Reported Harvested from Franklin, Hancock, and Sullivan, Maine, 1999-2003 (Arter 2005).



In a good year, wormers report that "thousands of worms" can be harvested from the bay per tide. Although TB flats were less productive in 2000-2001, they are said to be rebuilding today and are considered fairly productive. Some areas along the coast are better than others for worm habitat. On a scale of 1-10 (10 is best), TB is considered a 6-7, whereas bays in Jonesport and Wiscasset are considered a 10. Full-time worm harvesters will travel from flat to flat up and down the coast in order to maintain year-round harvesting.

Worm growth is best between late May and early September. Spring and winter worms are generally smaller due to cold mud temperatures and spawning activity, whereas summer worms are generally larger. Furthermore, demand is highest in the summer. The greatest amount of harvesting occurs a few weeks out of the year, mainly from June to September. Although it is unclear if there are more or fewer worms today than in the past, most harvesters and dealers agreed that the worms are smaller today than in the past.

Although worm dealers support some form of conservation and management, most harvesters are unanimously opposed to any form of regulation, conservation, or management. Worm management options are discussed in Chapter 4.

Economics
According to 2003 licensing data, there are approximately 65 worm harvesters in the TB area. According to personal interviews, most worm harvesters can harvest an average of 500-600 worms from the bay per tide (Arter 2005). On those days when there are two daylight tides (every other week in summer), harvesters can harvest up to 1000-1200 worms in one day. The 2004 price was 30 cents/worm. At this price a dedicated harvester can make $150-$360/day. Using a 200-day year and adjusting for summer tides, an individual harvester can make $30,000-72,000/year (Table 2.2.) Given these values, the total value of worms in this area can be estimated as: 65 wormers x $30,000-72,000/year = $1,950,000 - $4,680,000/year.

DMR Hancock County landings data for the period between 1985 and 2000 indicate that more bloodworms than sandworms are harvested from the county (Figure 2.4) and that Hancock county landings have increased in recent years while landings in Lincoln and Washington counties have decreased (Figure 2.5). It is unknown if the increase is due to increased effort or increased productivity.

Table 2.2. Potential Annual Revenue Per Individual Harvester and Total Estimated Annual Revenue for Worms in Taunton Bay (Arter 2005).

Fishery	**Data Year**	**Potential Individual Annual Gross Revenue**	**Estimated # of Harvesters/ Entrepreneurs**	**Total Estimated Annual Gross Revenue for TB**	**Data Source**
Worms	2004	$30,000-72,000	65	$1,950,000 - $4,680,000	Personal Interview

The 2005 landings data for the 3 towns of Sullivan, Hancock, and Franklin indicate that they collectively produced 7.8% of the state's total landings for bloodworms and sandworms combined or approximately 70,000 lbs of the state's 895,000 total pounds (Peter Thayer, DMR, Written Communication, 2006).

Figure 2.4. Hancock County Bloodworm and Sandworm Landings, 1989-2001 (DMR Landings Database 2006).

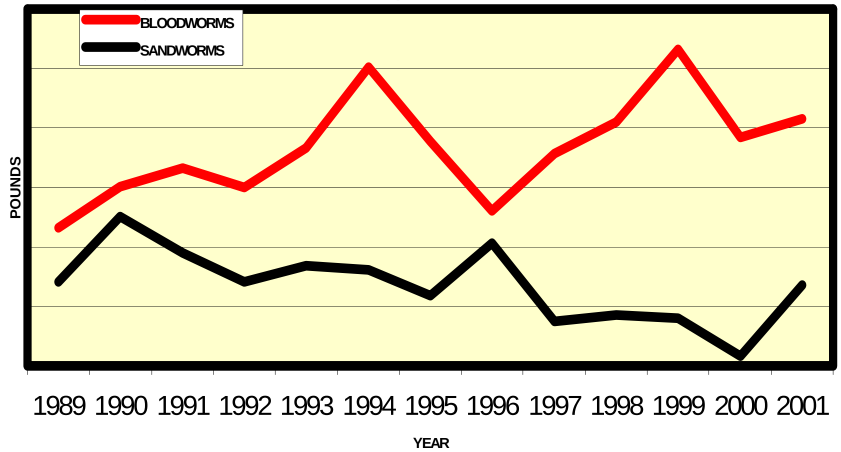
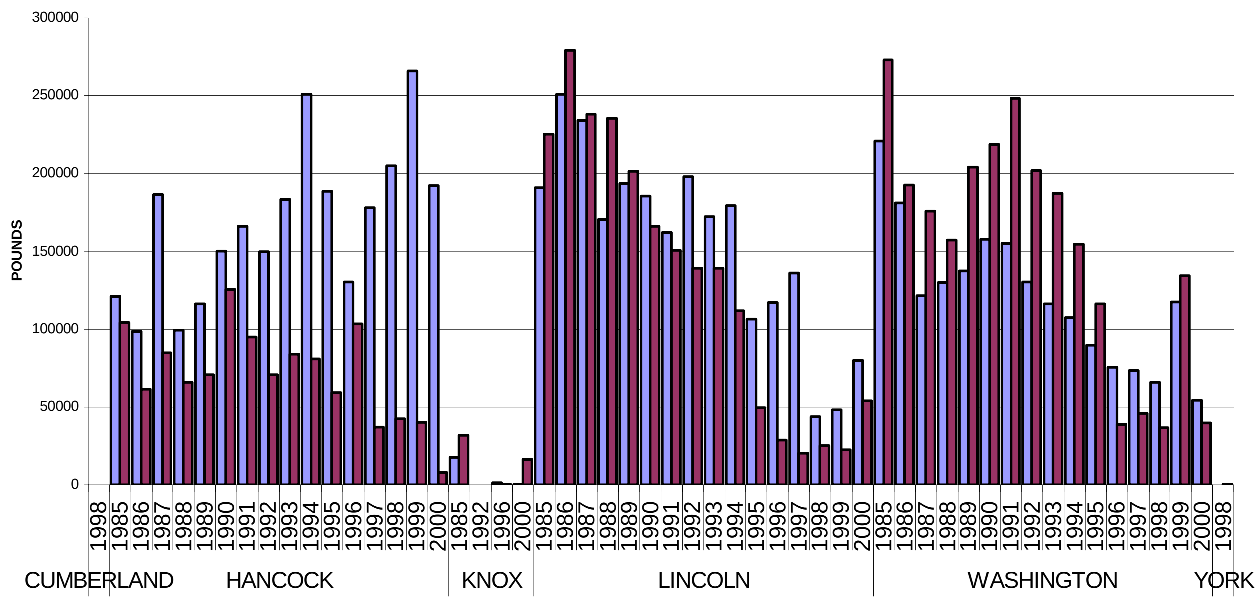


Figure 2.5. Sandworm and Bloodworm Landings Comparison by County (DMR Landings Database, 2006). Blue= Bloodworms. Red = Sandworms.



> ***Recommendation:***
>
> ***2.4. Improve the availability of bay-level or region-level data by working directly with local communities to devise a method whereby such data can be shared without threatening the confidentiality of harvesters. Furthermore, more specific bay-level data, such as size distribution and quantity, should be gathered.***

Chapter 3: Threats to Taunton Bay Mudflat Ecosystem

Development, Pollution, Harvesting Impacts, and Governance

Although TB is moderately undeveloped bay compared to other bays and estuaries in the state or GOM, it is experiencing a number of threats that may jeopardize its relatively intact nature. Land-based pollution, increased development and marine-based activities, global climate change, and potential fisheries mismanagement pose multiple threats to the health of TB.

Development

The reader is encouraged to refer to Conserving Wildlife in Maine's Coastal Habitats. *Maine Audubon. 2006. Falmouth, Maine.*

Buildings

According to Maine Audubon and IFW, the construction of houses and commercial properties in Maine's coastal communities destroys shorebird habitat and may degrade wildlife habitat by fragmenting land into smaller parcels that are too small to support most species (Maine Audubon 2006). This type of development can also increase the amount of erosion, sedimentation, unnatural shoreline destabilization, and pollution from bacteria, fertilizers, pesticides, and other chemicals (also called nonpoint source pollution, see below). Both development and the increased pollution associated with the development diminishes water quality and wildlife habitat including habitat for those species that are harvested for human use and consumption (i.e., worms and shellfish).

Although the exact number of new buildings and subdivisions was not readily available at the time of this report, it is widely accepted that the overall number of new shorefront homes and buildings in TB has increased dramatically over the past ten years and this trend is expected to continue in the near future. Furthermore, most of these buildings were only subject to the 75-foot shoreland zoning set back which is now considered insufficient to provide a buffer for wildlife and good water quality. A large shoreland/streamside forested buffer of 300 ft is generally recommended for most wildlife (Connecticut River Joint Commissions 1998), and a 100-meter buffer from human disturbance is recommended for shorebirds (Rodgers and Smith 1997). Some organisms require a buffer as small as 50 ft while others require as much as 600 ft (Table 3.1).

Table 3.1. Recommended Minimum Buffer Widths for Wildlife (Connecticut River Joint Commissions 1998).

Species	**Desired Buffer Width (Ft)**
Bald eagle, nesting heron, cavity nesting ducks	600
Pileated woodpecker	450
Beaver, mink, dabbling ducks	300
Bobcat, fox, fisher, otter, muskrat	330
Amphibians and reptiles	100-300
Belted kingfisher	100-200
Scarlet tanager, American redstart, rufous-sided towhee	600
Brown thrasher, hairy woodpecker, red-eyed vireo	130
Blue jay, black capped chickadee, downy woodpecker	50
Cold-water fisheries (brook trout, salmon, etc)	100-300

Recommendation;

3.1 Work with town planning boards to promote smart growth practices, enact setbacks that go beyond the 75 ft shoreland zoning, and enforce NRPA permitting requirements. Encourage and support the use of 200-300 foot buffers (either as a best management practice or as legislated) to reduce impacts on wildlife, fisheries, and water quality.

Culverts and Dams

Culverts and dams can minimize tidal and freshwater flow, reduce oxygen levels, alter salinity, and reduce natural sources of sediment that build marshes and mudflats. They can also disrupt passage of diadromous (migratory) fish species that spend part of their life cycle in freshwater and part in saltwater. In a report on nonpoint source pollution in the Narraguagus watershed (nearby in Cherryfield, Maine), Arter (2003) found that 68% of all documented nonpoint source pollution sites in that watershed were associated with paved and unpaved road and railroad crossings. Routes 182, 200, and 1 cross several waterways that enter the bay (Carrying Place, Egypt and Card Mill streams and Mill, Johnny's, and Clapham brooks) and as such may cumulatively contribute sediments to the bay.

In addition to the three primary roads ringing the bay, several secondary and private roads may also alter natural flow and sediment development. Routes 182, 200, and 1 are maintained by the state but municipalities or private landowners maintain all other roads. Small towns such as Franklin, Sullivan, and Hancock are often too underfunded and understaffed to properly maintain roads and associated culverts and dams. As development in the area increases, so will the number of roads, thereby placing mounting pressure on the municipalities to cope with associated road problems.

Recommendation:
3.2 Work with private landowners, towns, and state DOT to use best management practices that minimize flow alterations and erosion at road crossings.

Loss of Traditional Access
According to the Maine State Planning Office, “working waterfronts cover a mere 25 miles along Maine's 5,300-mile coastline” (SPO 2007). As development along Maine’s coast increases, those engaged in water-dependent businesses are driven from the waterfront thereby losing both their livelihood and their familiar way of life.

There is currently no public access within the boundaries of TB. Public access to the bay can be gained at landings at Hancock Point and Sorrento. Many harvesters put in at these landings at high tide and boat to Egypt and Hog bays and Taunton River. Most harvesters, however, still gain access to the bay via private property. Private access points to the flats include:

- Paddy Lane (West Franklin)
- Butler Point (West Franklin)
- Part of Shipyard Point (Franklin)
- Unnamed road in Hancock which comes out above Carrying Place
- Directly off Hog Bay Rd (East Franklin)

Many harvesters express frustration at the lack of public access and the loss of traditional private access to the bay. Settler’s Point/Landing (at the bottom of Hancock Hill), Shipyard Point, and Dwelley Point are no longer available for use due to new ownership and development.

Recommendations:
3.3 Ensure that access is provided for sustainable activities and fisheries by either ensuring historical access routes or providing new public access routes when private access is lost:
- ***Work with landowners and landtrusts to create binding easement agreements that allow shorefront access across private lands.***
- ***Work with towns and state agencies (e.g., SPO, DEP, etc) to purchase shorefront access points and establish public landings.***
- ***Work with towns to apply for "Working Waterfront" funding to purchase lands that allow traditional public access to flats.***

Nonpoint Source Pollution

Nonpoint source (NPS) pollution occurs when rainwater washes off driveways, roofs, parking lots, roads, agricultural fields, construction sites, forestry operations, and other surfaces carrying with it contaminants to streams, lakes, bays, ocean, and groundwater. This type of pollution diminishes water quality and may affect habitat for many species (both commercial and non-commercial) but probably most importantly those species, such as phytoplankton and zooplankton, that form the base of the food chain and those species that feed on them directly (Table 3.2). In the TB watershed, some important sources of NPS pollution include:

- runoff from paved roads and parking areas which may contain petroleum contaminants;
- erosion from developed or disturbed land that has diminished buffers and/or exposed soils;
- septic runoff that may contain both high levels of nutrients, toxins, and bacteria; and
- agricultural runoff which may contain pesticides and fertilizers.

Erosion and Sedimentation

While the transport of some sediment, and the nutrients carried on these sediment particles, is natural in any aquatic ecosystem, unusually high levels of sediment and attached toxins from eroded sites may diminish water quality. High sediment levels may reduce the sunlight available for phytoplankton and eelgrass growth and too many nutrients may lead to algal blooms, decreased oxygen, and diminished light. Toxins attached to the particles may kill plants and animals or cause disease and neurological, immune system, or reproductive damage. Mudflats are particularly vulnerable to diminished water quality since they tend to be poorly flushed (Maine Audubon 2006).

In TB, several indicators suggest that erosion, sedimentation, and associated NPS pollution may be increasing with increased development and rising sea levels. A study conducted by Maine Geological Survey for the Taunton Bay Study suggests that much of the bluff between Sullivan Falls and Carrying Place Inlet in Hancock is classified as unstable to highly unstable. Additionally, Hancock County Soil Conservation Service data indicate that most soils surrounding the bay are considered only medium to low potential for development. Very few places around the bay are considered high and none are considered very high. Lastly, aerial photographs indicate several areas of thin and unvegetated buffers along the bay shoreline.

Table 3.2. Types of Nonpoint Pollutants and Their Impacts (DEP 1998)

Pollutant	Nonpoint Source	Impacts
Bacteria	Livestock, pet waste, septic systems, and boat discharge	Introduces disease bearing organisms to surface water and ground water, resulting in shellfish bed closures, swimming restrictions, and contaminated drinking water
Nutrients (phosphates & nitrates)	Fertilizers, livestock, pet waste, septic systems, suburban & urban development, and soil erosion	Promotes algae blooms and aquatic weed growth that can deplete oxygen, increase turbidity, and alter habitat conditions.
Sediment (Soil)	Construction, driveways, ditches, earth removal, dredging, mining, gravel operations, agriculture, road maintenance, and forest operations.	Increases surface water turbidity, which in turn reduces plant growth and alters food supplies for aquatic organisms, decreases spawning habitat and cover for fish, interferes with navigation, and increases flooding risk.
Toxics & Hazardous Substances	Landfills, junkyards, underground storage tanks, hazardous waste disposal, mining, pesticides and herbicides, auto maintenance, runoff from highways & parking lots, boats and marinas	Accumulates in sediment posing risks to bottom feeding organisms and their predators, contaminates ground and surface drinking water supplies; some contaminants which may be carcinogenic mutagenic and/or teratogenic can bioaccumulate in tissues of fish and other organisms including humans.
Airborne Pollutants (i.e., acid rain, nutrients & metals)	Automobile and industrial emissions	Reduces pH in surface water which alters habitat and reduces natural diversity and productivity; increased nitrogen may enhance eutrophication of coastal waters. Mercury accumulates in fish tissue threatening bald eagles and people.

Recommendation

3.4 Conduct shoreline survey to determine buffer integrity and work with towns and landowners to enhance existing buffers and create buffers where needed.

Septic Pollution
NPS pollution from sewage disposal systems is caused primarily by septic system failure and the subsequent discharge of untreated wastewater and household toxins into the watershed. Untreated wastewater may contain bacteria known as fecal coliform, which may result in clamflat closures, swimming restrictions, contaminated drinking water, and disease-bearing pathogens hazardous to other warm blooded organisms. The number of septic systems ringing the bay was estimated to be approximately 1,033 in 2005 (Friends of Taunton Bay 2006).

The goal of the DMR Shellfish Sanitation Program is to protect public health by ensuring that shellfish are harvested from pollution-free areas and are processed and transported under sanitary conditions. DMR maintains 23 water quality monitoring sites in the bay (See Map: Taunton Bay Shellfish Classification) and due to high levels of coliform, the following flats are currently closed to shellfish harvesting (J. Fendle, DMR, Personal Communication, 2007).

- East side of Route 1 Hancock-Sullivan Bridge (West Sullivan) - Prohibited
- Evergreen Point (West Sullivan) – Restricted: slightly polluted; depuration harvest only.
- Springer Creek (West Franklin) – Prohibited
- Mill Brook (West Franklin) – Prohibited
- West Brook (West Franklin) – Prohibited
- Johnny’s Brook and Card Mill Stream (Hog Bay, East Franklin) – Prohibited
- Egypt Stream (NW End of Egypt Bay, Hancock and Sullivan) – Prohibited
- Carrying Place Inlet (East Hancock) – Prohibited

Most of the flats that are closed to shellfish harvesting occur in coves at the mouths of streams. The fecal coliform causing the closure may be coming from anywhere in the stream’s watershed (i.e., upstream, on a secondary tributary, or on bay shorefront). Table 3.3 illustrates the estimated number of septic systems in each town and its percent of the total TB watershed (Friends of Taunton Bay 2006). The data indicate that the town of Franklin contributes the greatest number of septic systems to the TB watershed. Subsequently the town has the greatest potential for septic discharge from runoff. It is therefore important to conduct a watershed-level shoreline survey in order to locate the sources of fecal coliform causing closures, especially since fecal coliform bacteria may also emanate from farm animals, pets, and wildlife in addition to faulty septic systems.

Table 3.3. Estimated Number of Septic Systems per Town in Taunton Bay Watershed (Friends of Taunton Bay 2006).

Town	Parcels	Estimated Septic Systems	% Watershed Total
Eastbrook	2 (estimate)	2	0.2%
Fletcher's Landing	6	5	0.5%
Franklin	641	513	49.7%
Hancock	339	271	26.2%
Sullivan	262	210	20.3%
T 9 SD	21	17	1.6%
T 10 SD	9	7	0.7%
Waltham	10	8	0.8%
Total	1290 (estimate)	1033	100.0%

Recommendation:

3.5 Work with DMR, DEP, municipal governments, and landowners to open clamflats closed due to sanitation closures:

- ***Work with DMR to conduct sanitation surveys, intensified water quality monitoring (WQM), and tracking in order to identify faulty septic systems that may contribute to closure.***
- ***Work with towns to apply for SPO Community Development Block Grant to help pay for replacement of faulty septic systems.***

Pesticides and Fertilizers

Blueberry fields within the TB watershed may use fertilizers and pesticides to enhance productivity (Table 3.4), and via runoff, these chemicals may enter the bay and cause nutrification and/or toxic effects. Insecticides have been linked to acute toxicity in marine invertebrates (Guzzella 1997) and many wormers share concern that worm recruitment may be directly impacted. Although herbicides may only be slightly toxic to invertebrates, bioaccumulation, and multiple stressor effects are currently unknown. Herbicides and nutrification from agriculture are suspected to play a role in recent eelgrass die off in TB (L. Osher, UM, Personal Communication, Sept 2006).

Table 3.4. Commonly Used Pesticides in Blueberry Cultivation (Arter, 2003).

PESTICIDE NAME Trade Name (Common Name)	**TYPE OF PESTICIDE**	**TIME OF APPLICATION**	**TYPE OF APPLICATION**
Orbit (Propiconazole)	Fungicide	Spring	Liquid: air/ground
Bravo (Chlorothalonil)	Fungicide	Spring	Liquid: air/ground
Imidan (Phosmet)	Insecticide	Spring/Summer	Liquid: air/ground
Biobit (*Bacillus thuringiensis*)	Biological Insecticide	Spring/Summer	Liquid: air/ground
Mycotrol (*Beauveria bassiana*)	Biological Insecticide	Spring/Summer	Liquid: air/ground
Sevin (Carbaryl)	Insecticide	Spring/Summer	Liquid: air/ground
Velpar (Hexazinone)	Herbicide	Spring	Liquid: ground
Karmex (Diuron)	Herbicide	Spring	Liquid: ground
Sinbar (Terbacil)	Herbicide	Spring	Liquid: ground
Pronone (Hexazinone)	Herbicide	Spring	Granular: ground
Roundup (Glyphosate)	Herbicide	Spring	Spot application
Poast (Sethoxydim)	Herbicide	Spring	Spot application
Select (Clethodim)	Herbicide	Spring	Spot application
Fusilade (Fluazifop-p butyl)	Herbicide	Spring	Spot application

Recommendation:
3.6 Work with growers and state agencies to reduce agricultural runoff by using larger buffers and less toxic cultural methods.
3.7 Encourage continued studies that investigate the link between pesticides, fertilizers, eelgrass die off, and invertebrate impacts.

Point Source Impacts

Maine law makes it illegal to discharge wastes to Maine waters without a state-issued license. To receive a state license, an applicant has to provide treatment prescribed for the type of facility and must show that the discharge will not impair designated water uses. Discharges are currently relicensed every five years. Virtually all point source discharges in Maine receive treatment.

Land-based Aquaculture Facility
The only known licensed point source in the bay is the University of Maine Center for Cooperative Aquaculture Research (UMCCAR) and the USDA Atlantic Salmon Hatchery, which is a land-based aquaculture facility producing worms, salmon, halibut, and other marine species. In this operation, water is pumped from the bay into the facility where it circulates through various growing tanks.

Per licensing requirements, the facility may only pump/discharge 1.27 MGD (million gallons per day). Solids are removed via mechanical filtration and settling tanks before the discharge water is released back into the bay (S. Eddy, UMCCAR, Personal Communication, January 2007). The permit requires that they submit a composite sample of their discharge to an independent water quality lab for analyses of BOD (biological oxygen demand), TSS (total suspended solids), ammonia, pH, and total discharge flow. Unlike a municipal sewage treatment plant, there is no chemical treatment of waste (e.g., chlorine, UV, etc) since there is no threat of fecal coliform or other human pathogens. This type of point source only becomes a threat if the permitting requirements are not maintained. In the past, TSS testing procedures of the discharge waters have been problematic, but DEP and the facility are working to ensure that those levels stay within permit requirements (M. Young, DEP, Personal Communication, January, 2007).

Recommendation:
3.8 Work with DEP and UMCCAR to ensure that discharge permit requirements are being met and that the aquaculture facility discharge does not diminish water quality.

Overboard Discharge Septic Systems

Many estuaries and embayments in the GOM contain residential overboard discharge septic systems (OBDs). In these systems, wastewater high in nutrients and household toxins is treated with chlorine tablets before it is discharged into the river or bay. It should be noted that while most neighboring bays and estuaries in the area have several licensed OBD systems (e.g., Cherryfield has 42), TB currently has no such systems. There were two historic systems that have since been removed (See Map: Taunton Bay Shellfish Classification).

Harvesting Impacts

Mudflat Harvesting Impacts

Potential Overharvesting of Commercial Species

Focus group discussions and interviews of both clam and worm harvesters signify that although the status of both fisheries in TB is better than in the past, there is room for improvement (See Chapter 2). Worm dealers report a concern that worms are smaller today than in the past and that prices at times reflect the reduced quality. Likewise, clammers report that some flats are not as productive as they once were. Although it is unknown why productivity is reportedly less today than in the past, there is a concern that overharvesting may be a factor. There is also concern that smaller worms are being harvested then discarded if they are too small for market, although most harvesters claim that they do not harvest smaller worms since the market does not demand them. Brown (1993) reported that the sharp declines in worm landings in 1970s and early 1990s may have been due to overharvesting. Management options for commercial worm and clam fisheries will be discussed in Chapter 4.

Mudflat Harvesting Impacts on the Benthic Organisms
Over the past 20 years, many studies investigating the impacts of baitworm and clam digging on the benthic community and water quality have been conducted both in Europe and in the US. Most of these studies report some negative impact to the benthic community. Ambrose et. al. (1998) found that baitworm digging negatively affects the survival of softshell clams by directly damaging shells and by exposing clams to increased risk of predation. He also found that the worm-digging rate efficiency in mudflats in Wiscasset, Maine averaged approximately 33% and varied from 12-60% from flat to flat (W. Ambrose, Bates College, Taunton Bay Science and Management Forum, Nov 2006). Emerson et. al. (1990) concluded that the impacts of clam digging are not only removal of market-sized clams but shell breakage of remaining ones. He also found that exposure of pre-recruits may increase susceptibility of unharvested clams to predation, desiccation, or freezing, with effects depending on different sediment types. Heiligenberg (1987) found that hand digging of *Arenicola* (50% removal) in California caused a significant reduction in many of the common species, including *Scoloplos armiger* (bristleworm), *Nereis diversicolor* (ragworm), and *Heteromastus* (a capitellid worm). A total of 1.9 g of other benthic animals were removed for every 1 g of *Arenicola* (lugworm).

Broad (1997) studied the effects of disturbing the ecological balance of intertidal communities through the hand raking of cockles in Wales and found that signs of recovery were seen after 2.5 months in small treatment plots, but large ones took longer to colonize and recover. Observed changes in community structure were probably due to release of sulphides, destruction of diatom/bacterial layer, tubes and burrows within and on the sediment surface, and interference with normal predator/prey relationships. Finally, some studies indicate increases in surface and suspended sediments (Anderson 1986) and the bio-availability of toxins such as lead and cadmium (Howell 1985) after any type of intertidal benthic digging, and trampling studies suggest that biofilms may be disrupted by digging and trampling (Ghazanshahi 1983).

Mudflat Harvesting Impacts on Benthic Predators
As stated in Chapter 2, some studies suggest that worm harvesting may impact shorebird predation. A study conducted by Shepherd and Boates (1999) found that semipalmated sandpiper foraging efficiency decreased by 68.5 % in areas disturbed by worm digging. Researchers suggest that the reduction is related to direct reductions in prey (*Corophium volutator*) and the obstruction of visual and tactile cues caused by the turning and loosening of the surface sediment. A study in a British nature reserve (Townshend 1993) suggests that the average peak winter numbers of wigeon and two of the main wader species (bar-tailed godwit and redshank) before and after restrictions on bait digging showed that in

years when bait digging took place on all or parts of the Bay the numbers were substantially lower than in years when there was no bait digging.

Other organisms that prey on sandworms, bloodworms, and clams include flounder, horseshoe crabs, and some crabs. Unfortunately, less is known about the effects of worm and clam extraction on these predator populations because there are currently few studies.

Recommendation:

3.9 Encourage DMR and university researchers to conduct benthic invertebrate studies that are specific to TB, include all trophic levels, and are designed to tell us more about overall productivity and the effects of benthic harvesting. The study should be conducted in conjunction with experimental conservation measures, such as seeding, fallowing, etc, and with recommendations 2.2 and 4.1-4.7

Bottom Dragging Impacts

Before 2000, commercial shellfish dragging was limited to occasional use by small vessels due to the low clearance height of the pre-existing Route 1 Hancock-Sullivan Bridge. When the bridge was replaced with a taller structure in 2000, concerns arose that a larger size class of commercial mussel draggers would now have access to the bay and cause large-scale seabed disturbance. Specifically, concerns regarding dragging include potential:

- destruction of benthic fauna and flora,
- loss of eelgrass nursery beds,
- diminished water quality caused by disturbance of sediment,
- overharvesting of existing mussel beds,
- overharvesting of seed mussels (for reseeding in other flats),
- alteration of bay drainage (via changes in sediment and channel),
- loss of food for birds feeding directly on shellfish, and
- indirect damage of non-target species and their predators.

In response to these concerns, the Maine Legislature placed a dragging moratorium on the bay until 2005 (this was later extended to 2008). During this time, the DMR was directed by the legislature to assess the impacts of mussel dragging and to draft a comprehensive resource management plan for the bay. The mussel dragging study conducted by DMR (Moore 2005) in 2002 in TB indicated that a single dragging event can "cause at least dramatic short-term changes in the benthic community structure." Although the study was inconclusive with respect to long-term impacts and changes, the data suggest that dragged areas sustain at least a short-term dramatic loss of species diversity and abundance. The study also suggests that the recolonization rate of a dragged area is variable and depends on drag size, type of equipment, and timing, and many other environmental factors.

An unpublished report by Atherton (2006) suggests that mussel dragging on intertidal flats off Deer Isle, Maine may affect sandworm growth. Sites that were not dragged had a significantly higher number of larger sandworms than the dragged sites. Furthermore, dragging studies conducted by Neckles et al. (2005) in Maquoit Bay, Maine indicate that commercial mussel dragging "poses a severe and long-lasting threat to eelgrass." Specifically, the study indicated that:

- dragging uprooted eelgrass plants,
- impacted areas can be very large (i.e., up to 79 acres in some bays in Maine), and
- revegetation of dragged areas requires an average of 11 years under the best environmental conditions.

Several dragging studies (Schmechel 2001) suggest that large-scale mechanized harvest of mussel beds may have a long-term impact on shorebird populations by reducing the amount of food available to those birds that directly feed on mussels or by indirectly impacting other benthic communities and their predators. Studies in Europe show a link between the state of shellfish stocks and oystercatcher survival. Bird numbers/densities did not need to be at carrying capacity to be negatively impacted by changes in their food supplies, but only within a range where density-dependent factors were operating. In addition to the direct impacts of food loss, there could also be indirect impacts of harvesting on non-target invertebrates such as tube-dwelling polychaete worms on which shorebirds feed.

Studies in the Dutch Wadden Sea (Ens 2000) indicate that in the early 1990s intertidal mussel beds and eelgrass beds had almost completely disappeared and high mortality was reported for oystercatcher and eider ducker, the two species feeding on the sizes of cockles and mussels that are also preferred by harvesters. As a result of these findings, the Dutch government passed new policies that 1) designated a large portion of the sea as a Special Protection area, 2) closed 26% of intertidal flats to harvesting, and 3) prohibited harvesting in open flats when stocks of mussels and cockles reach a minimal size.

Finally, both clam and worm harvesters interviewed for this report voiced overwhelming opposition to commercial dragging in TB. Many stated that they witnessed first hand the loss of clam and worm habitat as a result of dragging. When asked by vote, area wormers (approximately 35 wormers) voted unanimously against dragging in TB.

It is currently unclear if the impacts from small-scale dragging differ greatly from those of large-scale dragging since studies in Maine have not made that distinction. It stands to reason, however, that a small-scale drag site would recolonize at a faster rate and generate less damage than a large-scale drag site. In light of this consideration, the Taunton Bay Comprehensive Resource

Management Plan (DMR 2007) recommends that any future dragging in TB be small scale, selective, and restrictive in order to avoid large-scale impacts.

Recommendation:

3.10 Work with DMR and mussel dragging industry to develop voluntary "No-Go Zones" and other best management practices that reduce impact to the benthic environment and prohibit dragging in sensitive areas of the intertidal zones.

3.11 Work with DMR, researchers, and mussel dragging industry to conduct studies that test the impacts from various types of mussel dragging gear on marine sediment with the hopes of ultimately finding low-impact gear.

Aquaculture

Aquaculture becomes a threat if nonnative species become introduced into the bay or if water quality becomes compromised. There is one marine-based aquaculture operation currently permitted within TB. The operation consists of two leases for eastern oysters; one is a nursery site in Hog Bay and the other is a bottom grow-out site in the channel off Dwelley Point. According to historical records, there is currently no evidence to suggest that oysters were ever native to TB. Therefore the species is considered nonnative and as such part of the permit includes monitoring the bay each year for indications whether or not oyster spat settles out of the water column and attaches to rocks in the vicinity of the grow-out site. If oysters were to reproduce successfully in Taunton Bay, the ecological impact on other species would be uncertain. 2005 and 2006 monitoring data indicate that to date no oysters have become established in the bay.

Recommendation

3.12 Work with aquaculture industry, local conservation groups, and DMR to continue monitoring for oyster set.

3.13. Explore the feasibility and comparative benefits/impacts of converting from wild harvesting to aquaculture in Taunton Bay thereby encouraging stewardship with legislated rights and responsibilities.

Governance

Perhaps the greatest threat to TB is not from ecological or commercial harvesting impacts but from the lack of appropriate governance. The results of several focus group discussions and the Taunton Bay Study Governance Report identify numerous governance concerns that may ultimately jeopardize the health of the bay:

1. Of the three towns with shoreline in the bay, only the town of Sullivan has a shellfish ordinance that regulates the number of clammers and supports conservation. Neither the town of Hancock nor Franklin have ordinances and this lack of management leads to several ramifications:
    a. The flats of Franklin (the town with the largest shorefront in TB) and Hancock may become overharvested because there is no ordinance regulating the number of harvesters digging there.
    b. Due to the enclosed nature of TB, it is less susceptible to Red Tide outbreaks. When other bays close, TB often remains open and is under threat of becoming overharvested due to the lack of an ordinance. Local harvesters report that the number of harvesters in TB doubles or triples when Red Tide outbreaks close other flats.
    c. Although most harvesters support conservation, there is currently no mechanism to enforce conservation measures without an ordinance.
    d. Although the three towns (Hancock, Franklin, and Sullivan) share the shellfish resources of Taunton Bay there is currently no shared management or conservation of those resources. Multi-town ordinances have been established and are successful in other regions in the state.
2. Unlike other fisheries such as, shellfish and lobster, DMR has very few rules regulating size, amount, or harvesting location of marine worms. Lack of regulation and conservation may lead to lack of control and sustainability. Furthermore, although the worm fishery is one of the highest revenue-generating fisheries in the state, there is no division within DMR dedicated to its management. Lack of regulations and management may lead to overharvesting.
3. There are currently no regional clam or worm harvesters associations or bay-level fisherman's associations. Lack of an organized stakeholder group may inhibit appropriate management decision making.
4. The Taunton Bay Study Economic Assessment found that for most fisheries in the state there is little bay-level data. This lack of data hinders any bay-level and ecosystem-level management and decision making. Although many harvesters and dealers keep personal journals or logs, this information is not available for public stakeholder decision-making purposes.
5. Currently there is no cooperative governance whereby multiple agencies would work together to manage, regulate, and conserve fisheries. A cooperative governance model would allow both state and local agencies and non-governmental organizations to work together in decision-making.
6. Other than the implied increased productivity over time, there are currently no incentives (such as tax incentives, expanded access, etc) to practice conservation. There are several plans and related documents recently created by the FTB, SPO, and DMR.

7. In order for any plan to be successful, there must be an educational advocacy component supporting it. This could include more educational forums, an educational facility, and/or distribution of educational materials.

Recommendations:

3.14 Create regional, species-specific harvesters associations (Clammers Association or Wormers Association or combined) in order to engage their input into future management strategies.

3.15 Once a regional clam management committee is formed, meet with officials from Hancock, Sullivan, Franklin, and possibly Lamoine and the DMR regional shellfish biologist to create an ordinance and interlocal agreement that allows for conservation measures.

3.16 Support recommendations from other governance documents and plans created for bay management:

- ***Title 38, §1801 Findings and Declaration of Coastal Management Policies.***
- ***Taunton Bay Comprehensive Resource Management Plan.***
- ***Taunton Bay Study: A Pilot Project in Collaborative Bay Management***

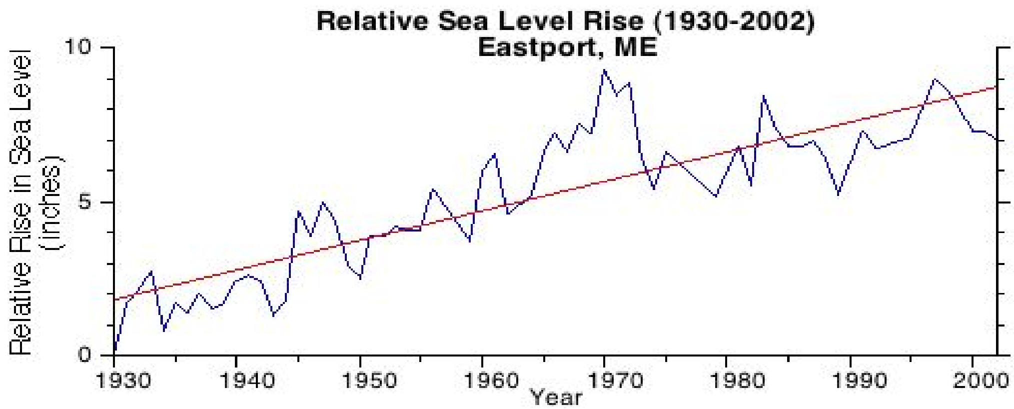
3.17 Conduct educational programs related to ecosystem-based fisheries management (shorebird zones, global climate change, habitat protection, water quality, commercial fisheries management, etc).

Climate Change

Many global climate studies suggest that the expected global warming from the greenhouse effect could raise sea level 50 to 200 centimeters (1.6 to 6.6 feet) in the next century (Titus et. al 1991). Data from various locations suggest that sea level rise may already be occurring. NOAA data (Figure 3.1) indicates that the mean sea level rise in Eastport, Maine is 2.12 millimeters/year (0.70 feet/century) based on monthly mean sea level data from 1929 to 1999 (NOAA 2007). In Bar Harbor Maine, the mean sea level trend is 2.18 millimeters/year (0.72 feet/century) based on monthly mean sea level data from 1947 to 1999.

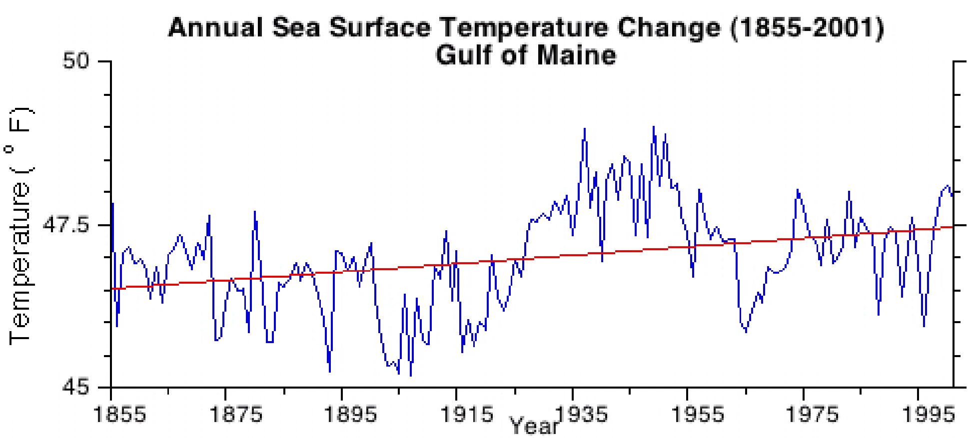
Sea level rise becomes a threat when it undermines or destabilizes shorelines. The resulting erosion and sedimentation may increase turbidity and temperatures, reduce transparency for photosynthetic organisms, and reduce feeding capabilities of fish and marine invertebrates. It would also alter the physical makeup of the mudflat through deposition of new materials. Furthermore, rises in sea level may also cause increases in tidal range and fish yields. According to Environment Canada (Daborn 1995), there would be an influx of cold water, increase in fog, a shift in areas of productivity, and changes in overall productivity.

Figure 3.1. Relative Sea Level Rise in Eastport, Maine from 1930 to 2002 (New England Integrated Science and Assessment 2007)



Global warming may also be responsible for increases in sea surface temperature. Changes in surface temperature may be stressful to native species (e.g., increase disease, alter reproduction), cause an increase in the number of nonnative species, and cause changes in nutrient cycling. Increases in surface temperature may also cause thermal expansion and add to localized sea level rise. NOAA data indicates that annual sea surface temperatures in the GOM have increased approximately 1° F since 1855 (Figure 3.2).

Figure 3.2. Annual Sea Surface Temperature Change from 1855-2001 (New England Integrated Science and Assessment 2007)



Recommendation:

3.18 Establish a long-term index station in TB that monitors sea level rise, sea surface temperature, air temperature, and other related indicators and use data to predict changes in other shallow embayments throughout the Gulf of Maine.

Chapter 4: Options for Mudflat Fisheries Management

Management Objectives and Options for Worm and Clam Fisheries Management

Management Objectives and Considerations

As stated in Chapter 1, ecosystem-based management principles include consideration of all species, including humans, interacting in a particular ecosystem and the ecological and abiotic integrity of the entire ecosystem. Mudflat fisheries management recommendations should therefore reflect these principles as well as address the question: why should we manage the mudflat? Focus group discussions, interviews, and forums held over the past two years have suggested several reasons to manage the mudflats of TB:

1. Maintain sustainability:
    a. conserve the population integrity of the target species for short and long term
    b. improve quality (size, health, etc) of stocks
    c. maintain economic sustainability of the community depending upon the resource
    d. ensure the ecological integrity of interdependent species
2. Reduce use conflicts among multiple users (e.g., mussel dragging and worm harvesting)
3. Enhance the marketability of product (e.g., using the Marine Stewardship Council labeling)
4. Reduce anthropogenic threats, such as pollution and development, to the integrity of the ecosystem (both target and nontarget species)
5. Improve governance, stakeholder engagement, and overall management
6. Ensure traditional access to the resource.

Several options for clam and worm management have been proposed for TB and statewide in the past yet there is currently little management or conservation currently in this bay. Most neighboring bays in Hancock and Washington counties are practicing some form of clam management and conservation at the municipal level. As public sentiment moves toward supporting more sustainable harvesting practices, harvesters and agencies (local and state) will need to consider changing management practices.

Management Options for the Worm Fishery

Current Regulations

Current state regulations make it unlawful to take or possess more than 125 worms in a day without holding either a marine worm digger's license or a marine worm dealer's license. Additionally, marine worms may only be taken by 'devices or instruments operated solely by hand power', and it is illegal to dig worms commercially on Sundays.

Proposed Conservation and Regulation Measures

Over the past five years, DMR has proposed several management and conservation options (P. Thayer, DMR, Personal Communication, July 2006). The response to the measures from harvesters has been mixed; some support the measures but many do not think they are feasible. Table 4.1 lists some of the measures and the reasons given by harvesters for their lack of feasibility.

Table 4.1. Potential Conservation Measures and Reasons for Lack of Support Given by Worm Harvesters.

Conservation Measure	Feasibility
Minimum Size Standard	It is too difficult to measure and to enforce due to the worm's shrinking/expanding nature and difficult to enforce. Also market does not want smaller worms.
Maximum Size Standard	The market wants the bigger worms so harvesters should be permitted to harvest large worms.
Weight Standard, Per X Number of Worms	Too difficult to enforce. Unnecessary since market regulates the amount of worms buyers will take.
Winter or Spawning Closures	Unnecessary since the market controls digging rates and subsequently there is less winter /spring digging.
No Night Digging	Since worms are unpredictable, harvesters should have access to them whenever they find them.
Closed/Conservation Areas	If one area is closed, then harvesters will concentrate efforts on the remaining open areas and overharvest there. Also, recruitment to the closed area is unpredictable.
Zone/Flat Rotation	Same as previous
East/West Zones (Penobscot River boundary)	Since worms relocate from flat to flat and bay to bay, wormers need to be able to access and utilize the entire state's mudflats in order to meet the expected amount of worms needed by the buyer/dealer. Also, worm populations are generally on a 10-year growth cycle and productivity is higher in some years than in others.
Limit Annual # Worm Licenses/Limited Entry	Restricting other harvesters from trying to make a living would be unfair.
Seeding Program	This is unnecessary since wormers return culls (worms that are too small for market) to flats.

Need for Management in Taunton Bay

There is disagreement among TB worm harvesters, dealers, and scientists regarding the best method for conservation. Some feel that conservation is needed in order to improve the fishery and encourage recruitment, productivity, and growth. Many of these individuals support conservation measures such as, no night digging, spawning season closure, and seeding. Conversely, other harvesters contend that management may harm the fishery because it is nearly impossible to manage their natural cycle and not enough is known about the consequences of management on the worm life cycle. Lastly, scientists contend that harvest limits should be based on sustainable yield and ecological limits rather than market demand. Market demand does not guarantee that the resource will not be depleted. There is agreement among most that if conservation measures are adopted, they should:

- be enforceable,
- be acceptable to most harvesters and dealers, and
- conserve size, population, and ecological integrity.

Conservation Proposals in Canada and the UK

Marine worm conservation has been explored and in some cases adopted in other countries. Nova Scotia has developed a Marine Worm Conservation Harvesting Plan that employs several different measures including (Fisheries and Oceans Canada 2004):

- three designated provincial harvesting areas,
- 17 designated winter closures,
- weight limits specific to each harvesting area,
- restricted licensing, and
- restricted access.

In the United Kingdom, commercial baitworm collection is not considered part of the public right to fish and is therefore not regulated by any national or regional laws (The Nature Conservation Bureau 1999). Instead, nongovernmental conservation organizations and local/regional agencies are working together with harvesters to:

- develop both national and regional "codes of conduct" (similar to Best Management Practices);
- encourage the participation of harvesters in local management plans;
- encourage the use of farmed (aquaculture) stocks;
- have open licensing – no discrimination to license holders;
- establish regulatory legislation; and
- use of a number of voluntary conservation measures to reduce impact (e.g., bag limits, harvest zones, seasonal and conservation closures.

Other efforts in the UK suggest that harvesters set up their own means of policing a voluntary code of conduct, but if no progress is made, control is recommended. Other options include permits and wardening at key points. A total ban is not considered acceptable or necessary and a working group should be set up to consider recommendations (Babbs et. al. 1998).

Recommendations for Taunton Bay Worm Fishery:

4.1 ***Form a regional Wormers Association comprised of wormers and DMR specialists that addresses management issues specific to the TB Ecosystem. (This may also be accomplished by a larger regional committee or zone committee, e.g., Frenchman Bay Association, etc.) See Governance recommendation 3.14.***

4.2 ***Once a Wormers Association has been formed, they should work with DMR to establish a program and regulations that effectively foster a sustainable fishery. DMR should create a program with dedicated staff to explore conservation possibilities.***

4.3 ***Work with DMR and university researchers to conduct worm surveys that assess stock volume, size-frequency distribution, productivity, and migration patterns. Studies should be correlated with shorebird research (Rec. 2.2).***

4.4 ***Work with DMR staff, wormers, and university specialists to consider at least the following conservation measures:***

- ***spawning season closure (possibly May – June)***
- ***seeding of spawners/ worms from possibly Southern Maine, where they are more prevalent.,***
- ***no night digging,***
- ***a closed area for the seed population, and***
- ***dealers adopt conservation best management practices (BMPs) such as not accepting small worms, returning culls, etc.***

Management Options for Softshell Clam Fishery

The reader is encouraged to review The Maine Clam Handbook: A Community Guide for Improving Shellfish Management *by Maine /New Hampshire Sea Grant College Program, 1998.*

Current Regulation

Maine law requires commercial softshell clam harvesters to purchase a state shellfish license and to limit the harvest of softshell clams to animals over two inches in shell length (Maine/ New Hampshire Sea Grant 1998). Furthermore, it is unlawful to fish for or take softshell clams by implements other than those operated solely by hand, and a person may not take or sell clams from any closed area (sanitation or conservation closure).

<u>*Municipal Shellfish (Clam) Ordinance*</u>

The softshell clam fishery is the only Maine fishery that is co-managed between the state and coastal municipalities. In 1963, the legislature passed legislation that permitted towns to establish ordinances regulating softshell clam harvesting in exchange for town enforcement and other specific management responsibilities (Maine/ New Hampshire Sea Grant 1998).

The primary goals of ordinances and clam management programs are to (H. Annis, DMR, Personal Communication, June 2006):

- provide a living wage for commercial harvesters;
- provide recreational clamming opportunities for residents;
- provide incentives for OBD removal and in-ground septic system repairs/replacements;
- maintain the resource (including clams and their habitat); and
- provide a chance for the harvesters to be directly involved in management decisions and activities.

There are 12 communities in Hancock County and 17 in Washington County currently with clam ordinances (H. Annis, DMR, Personal Communication, June 2006). Maine's municipal shellfish ordinance allows towns to make local decisions about:

- limiting the number of licenses sold per year and develop a price structure for licenses;
- restricting the harvest volumes per person or per area;
- limiting the harvests to commercial-only, recreational-only, or mix of both; and
- limiting when harvesting can occur (e.g., no Sunday digging).

The ordinance may also include measures specifically designed to encourage conservation and stock enhancement such as (B. Beal, UMM, Taunton Bay Forum, Oct 2006):

- restricting the areas where harvesting can occur (flat closure/rotations);
- applying tree brush or fencing to encourage the settlement of juvenile clams;
- applying wire fencing or plastic netting to deter green crab predation and encourage juvenile clam recruitment to the flats;
- assessing stock volume and size-frequency distributions (clam surveys);
- transferring clams from areas of high population densities and slow growth to low density areas where animals grow faster;
- enhancing stocks on flats with hatchery-reared, or cultured clam seed;
- improving water quality by installing municipal sewage treatment systems and repairing faulty septic systems; and
- municipal leasing of flats (up to 25% of the flats in a community may be set aside for private clam farming operations).

Municipal and regional ordinances are important because without an ordinance restricting access, any state-licensed commercial clammer can access and harvest flats within a town. Generally, the towns that choose not to enter into a shellfish management program either lack sufficient commercial clam resources or funding, or prefer to leave access to the fishery open and assume no local management responsibilities. Challenges to community-based ordinance development are listed in Table 4.2.

Table 4.2. Challenges to Clam Management (H. Annis, DMR, Clam Focus Group Session, June 2006).

GOAL	CHALLENGE
Build Support: What Are the Incentives for Local Management?	Reasons a town may adopt, examples: protect stock from over harvesting by large numbers of harvesters, a sudden decline in resource, a desire to control access, or neighboring towns have management.
Create & Keep a Management Committee	Because committees are made up of volunteers, sustaining an effective committee is one of the major challenges facing a program. Committees may include but are not limited to: selectmen, harvesters, public.
Develop a Shellfish Management Plan	Usually the first task of newly formed committee. Plan usually includes inventory or description of the resource, general goals, and steps to accomplish those goals.
Establish Funding	1. The major expense for a shellfish program is usually the warden's salary (full or part-time) and any equipment or gear the warden may need. 2. Some towns rely solely on income from license fees and ordinance violation fines. Other towns allot considerably more resources.
Write a Shellfish Ordinance	Options made available through an ordinance: ▪ issue municipal licenses ▪ establish qualifications, application and fees for licenses ▪ set limits on harvest amount ▪ open/close flats ▪ regulate the time of harvesting ▪ transplant seed
Enforce the Local Ordinance	1. The other major challenge facing a program is finding and keeping a municipal warden 2. State regulations require towns to enforce their own ordinance if they adopt one. 3. The DMR commissioner can revoke a local ordinance if the town fails to provide enforcement. 4.Towns can hire their own warden(s) or work in cooperation with another town. 5. Specific qualification and job descriptions need to be written by each town based on their program and needs.
Maintain Access to Flats	Sometimes committees can help establish informal or formal agreements with landowners to allow continued access over private property.

Regional Clam Ordinances and Interlocal Agreements
Only the town of Sullivan has a municipal clam ordinance; the towns of Franklin and Hancock do not believe they have enough citizen support for an ordinance and therefore do not have one. There have been recent efforts to institute a Regional Shellfish Conservation Program for the Towns of Franklin, Hancock, Lamoine, and Sullivan but as yet, this has not been successful.

Some communities in Maine, such as the St. George Region, have been very successful at forming a regional ordinance and an interlocal agreement. While the regional ordinance describes the responsibilities of the shellfish committee and the regulations to which the towns agree, the interlocal agreement describes how the towns will work together to manage the shared resource (S. Hoyt, Maine Sea Grant, Clam Focus Group Session, June 2006). A regional ordinance and interlocal agreement have been successful in the St George region because there were common threats identified in the bay: many closures, a high number of clammers, and crews harvesting restricted flats for depuration. Towns agreed that they would benefit from the regional ordinance because it provides control of the fishery, shares the costs of enforcement and conservation, and provides political influence.

The towns of Taunton Bay will need both a regional ordinance and an interlocal agreement in order to move forward on shared resource management. All clammers who participated in the Taunton Bay project support some form of conservation to improve stocks (Table 4.2). Most, but not all, clammers support the use of an ordinance as a tool to manage access, however, most clammers do not want to restrict other clammers from the bay. Since conservation is not enforceable without an ordinance, towns should consider working together to develop a regional ordinance and interlocal agreement that does not restrict the number of licenses. For more information regarding interlocal agreements and regional ordinances, contact Sherman Hoyt at UM Cooperative Extension or Hannah Annis at DMR.

Table 4.2. Potential Conservation Measures and Feasibility Stated by Area Clammers.

Conservation Measure	Feasibility
Clam Survey	Most clammers supported
Reseeding	Most agreed that this is not necessary; there is enough spawn in the bay
Brushing/fencing	Most clammers supported
Conservation Closures	Most did not support; need more information
Opening of Sanitation Closures	Unanimous support
Leasing	No support
Ordinance (Municipal or Regional)	Most clammers supported; some feel uncomfortable restricting fellow harvesters

Recommendations for Taunton Bay Clam Fishery:

4.5 Form a regional clam management committee comprised of clammers, municipal officials, and DMR shellfish specialists to address management issues specific to the TB Ecosystem. (This may also be accomplished by a larger Frenchman's Bay Committee. See Governance recommendation 3.15.)

4.6 Once a regional clam management committee is formed, meet with officials from Hancock, Sullivan, Franklin, and possibly Lamoine, and the DMR regional shellfish biologist to create an ordinance that allows for conservation measures.

4.7 Once an ordinance is developed, work with DMR staff, clammers, and university shellfish biologists to consider at least the following conservation measures:

- ***Clam survey to determine densities, productivity, and size-class distribution***
- ***Stock enhancement measures such as brushing, fencing, and predator control***
- ***Pilot study using conservation closures with rotations to determine effectiveness.***

Chapter 5: Recommendations and Conclusion

Recommendation Focus Areas, Potential Partners, and Next Steps

Recommendations

Table 5.1 summarizes all of the recommendations made in this plan. In an effort to help guide potential user groups (agencies, organizations, scientists, municipal governments, etc) of this plan, the recommendations are arranged by the following focus areas based on the roles of various potential users:

- Governance
- Education
- Habitat Protection
- Fisheries Management
- Research

This approach is intended to allow different user groups to identify the focus areas in which they might be the most effective. Furthermore, the user groups, or partners, are identified in the last column and an attempt is made to identify a potential lead partner (in bold). Finally, no attempt is made to prioritize each recommendation at this time. Prioritization should be completed when recommendations are adopted.

Conclusion

Although Taunton Bay is a relatively undeveloped bay with much of its shoreline and buffers still intact, numerous factors threaten its ecological integrity (e.g., pollution; development; and lack of appropriate data, science, governance, and fisheries management). The information and recommendations presented here are designed to either prevent or at least reduce the impacts of these threats using an ecosystem-based approach that recognizes the needs of all species including humans.

As stated in Chapter 1, implementation of the recommendations will depend on the plan's adoption by various partners as suggested in Table 5.1. It will be the task of each of these entities to review this plan and adopt those recommendations that are within their organizational or agency purview.

The Next Steps

The effectiveness of this plan will depend on the next steps taken. Some suggestions for immediate next steps include:

- issue press releases to public via area newspapers;
- issue announcements via email to agencies and organizations;
- create a brief summary fact sheet and presentation; and
- arrange to meet and present fact sheet, plan, and presentation to town governments and local organizations (historical societies, schools, etc).

In order for implementation to take place, the following steps should be taken:

- identify lead representatives from each of the various partnering stakeholder groups (agencies, organizations, etc);
- gather stakeholder representatives to present plan and discuss possible adoption, prioritization, and implementation strategies; and
- work with state and federal agencies, harvester associations, and town governments to officially adopt plan recommendations as part of larger planning efforts (See Table 1.1).

Table 5.1. Summary of Recommendations. Recommendations are not arranged in numerical order but by focus areas: governance, education, habitat protection, fisheries management, and research.

Focus Area	Rec. No.	Recommendation Description	Potential Partners (Lead in Bold)
Governance	2.4	Improve the availability of bay-level or region-level data by working directly with local communities to devise a method whereby such data can be shared without threatening the confidentiality of harvesters. Furthermore, more specific bay-level data, such as size distribution and quantity, should be gathered.	**Clammer and Wormer Associations,** DMR, FTB,
	3.3	Ensure that access is provided for sustainable activities and fisheries by either ensuring historical access routes or providing new public access routes when private access is lost:	**Clammer and Wormer Associations,** FTB, Community Members, SPO, DMR, Frenchman Bay Conservancy
		▪ Work with landowners and landtrusts to create binding easement agreements that allow shorefront access across private lands.	
		▪ Work with towns and state agencies (e.g., SPO, DEP, etc) to purchase shorefront access points and establish public landings.	
		▪ Work with towns to apply for "Working Waterfront" funding to purchase lands that allow traditional public access to flats.	
	3.5	Work with DMR, DEP, municipal governments, and landowners to open clamflats closed due to sanitation closures:	**Clammer Associations,** Town Governments, Community Members, SPO, DMR, DEP
		▪ Work with DMR to conduct sanitation surveys, intensified WQM, and tracking in order to identify faulty septic systems that may contribute to closure.	
		▪ Work with towns to apply for SPO Community Development Block Grant to help pay for replacement of faulty septic systems.	

	3.14	Create regional, species-specific harvesters associations (Clammers Association or Wormers Association or combined) in order to engage their input into future management strategies.	**Clammer and Wormer Associations,** FTB, Community Members, Cooperative Extension, DMR
	3.15	Once a regional clam management committee is formed, meet with officials from Hancock, Sullivan, Franklin, and possibly Lamoine and the DMR regional shellfish biologist to create an ordinance and interlocal agreement that allows for conservation measures.	**Clammer Associations,** Town Governments, Community Members, DMR
	3.16	Support recommendations from other governance documents and plans created for bay management:	**All Stakeholders**
		▪ Title 38, §1801 Findings and Declaration of Coastal Management Policies	
		▪ Taunton Bay Comprehensive Resource Management Plan	
		▪ Taunton Bay Study: A Pilot Project in Collaborative Bay Management	
	4.1	Form a regional Wormers Association comprised of wormers and DMR specialists that addresses management issues specific to the TB Ecosystem. (This may also be accomplished by a larger regional committee or zone committee, e.g., Frenchman Bay Association, etc) See Governance recommendation 3.14.	**Wormer Association,** DMR, FTB, Community Members
	4.5	Form a regional clam management committee comprised of clammers, municipal officials, and DMR shellfish specialists to address management issues specific to the TB Ecosystem. (This may also be accomplished by a larger Frenchman's Bay Committee. See Governance recommendation 3.15.)	**Clammer Association,** DMR, FTB, Community Members
	4.6	Once a regional clam management committee is formed, meet with officials from Hancock, Sullivan, Franklin, and possibly Lamoine, and the DMR regional shellfish biologist to create an ordinance that allows for conservation measures. See Governance recommendation 3.15.	**Clammer Association,** DMR, FTB, Cooperative Extension, Town Governments
Education	3.17	Conduct educational programs related to ecosystem-based fisheries management (shorebird zones, global climate change, habitat protection, water quality, commercial fisheries management, etc).	**FTB**, Historical Societies

Habitat Protection	3.1	Work with town planning boards to promote smart growth practices, enact setbacks that go beyond the 75 ft shoreland zoning, and enforce NRPA permitting requirements. Encourage and support the use of 200-300 foot buffers (either as a best management practice or as legislated) to reduce impacts on wildlife, fisheries, and water quality.	**Clammer and Wormer Associations,** Community Members, Frenchman Bay Conservancy
	3.2	Work with private landowners, towns, and state DOT to use best management practices that minimize flow alterations and erosion at road crossings.	**Town Governments,** DOT, DEP, Community Members, FTB
	3.4	Conduct shoreline survey to determine buffer integrity and work with towns and landowners to enhance existing buffers and create buffers where needed.	**FTB**, Town Governments, DEP, Community Members
	3.6	Work with growers and state agencies to reduce agricultural runoff by using larger buffers and less toxic cultural methods.	**Harvester Associations, FTB**, Community Members, DEP, Board of Pesticide Control
	3.8	Work with DEP and UMCCAR to ensure that discharge permit requirements are being met and that the aquaculture facility discharge does not diminish water quality.	**Harvester Associations, FTB**, Community Members, DEP, Board of Pesticide Control
	3.12	Work with aquaculture company, local conservation groups, and DMR to continue monitoring for oyster set.	**Aquaculturalist,** FTB, Harvesters Associations, DMR
Fisheries Management	3.10	Work with DMR and mussel dragging industry to develop voluntary “No Go Zones” and other best management practices that reduce impact to the benthic environment and prohibit dragging in sensitive areas of the intertidal zones.	**DMR, Mussel Dragging Industry**, All Harvesters
	4.2	Once a Wormers Association has been formed, they should work with DMR to establish a program and regulations that effectively foster a sustainable fishery. DMR should create a program with dedicated staff to explore conservation possibilities.	**Wormer Association,** DMR, FTB, Community Members
	4.4	Work with DMR staff, wormers, and university specialists to consider at least the following conservation measures:	**Wormer Association,** University Researchers, DMR, FTB,

		▪ spawning season closure (possibly May – June)	
		▪ seeding of spawners/worms from possibly Southern Maine, where they are more prevalent.	
		▪ no night digging	
		▪ a closed area for the seed population	
		▪ dealers adopt conservation best management practices (BMPs) such as not accepting small worms, returning culls, etc.	
	4.7	Once an ordinance is developed, work with DMR staff, clammers, and university shellfish biologists to consider at least the following conservation measures:	**Clammer Association,** University Researchers, DMR, FTB,
		▪ Clam survey to determine densities, productivity, and size class distribution	
		▪ Stock enhancement measures such as brushing, fencing, and predator control	
		▪ Pilot study using conservation closures with rotations to determine effectiveness	
Research	2.1	Conduct a study that investigates overall bay productivity and specifically primary productivity, filter-feeder growth, and invertebrate population dynamics (diversity, population size, etc).	**University and Government Researchers**, DMR, Harvesters Associations, FTB
	2.2	Consider the establishment of a shorebird research reserve within the IFW-designated Shorebird Zone in Hog Bay where researchers can investigate the interactions between benthic invertebrates and shorebirds and the effects of clam and worm harvesting on associated predator and prey species. The reserve could also be used as a benthic invertebrate study area for the study of marine worms (see Chapter 4).	**IFW,** USFWS, DMR, University Researchers, Harvester Associations, FTB, Community Members
	2.3	Consider the establishment of a horseshoe crab research reserve within Egypt Bay where researchers can investigate the interactions between horseshoe crabs and other benthic invertebrates and the effects of clam and worm harvesting. The reserve could also be used as a benthic invertebrate study area for the study of marine worms and softshell clams (see Chapter 4).	**DMR,** USFWS, University Researchers, Harvester Associations, FTB, Community Members

	3.7	Encourage continued studies that investigate the link between pesticides, fertilizers, eelgrass die off, and invertebrate impacts.	**University Researchers,** DMR, FTB, Harvester Associations
	3.9	Encourage DMR and university researchers to conduct benthic invertebrate studies that are specific to TB, include all trophic levels, and are designed to tell us more about overall productivity and the effects of benthic harvesting. The study should be conducted in conjunction with experimental conservation measures, such as seeding, fallowing, etc, and with recommendations 2.2 and 4.1-4.7	**University Researchers**, DMR, FTB, Harvester Associations
	3.11	Work with DMR, researchers, and mussel dragging industry to conduct studies that test the impacts from various types of mussel dragging gear on marine sediment with the hopes of ultimately finding low-impact gear.	**DMR,** University Researchers, Mussel Draggers, FTB, Harvester Associations
	3.13	Explore the feasibility and comparative benefits/impacts of converting from wild harvesting to aquaculture in Taunton Bay thereby encouraging stewardship with legislated rights and responsibilities.	**DMR,** University Researchers, Mussel Draggers, Aquaculture Association
	3.18	Establish a long-term index station in TB that monitors sea level rise, sea surface temperature, air temperature, and other related indicators and use data to predict changes in other shallow embayments throughout the Gulf of Maine.	**FTB,** University Researchers, DMR, Harvester Associations, NOAA
	4.3	Work with DMR and university researchers to conduct worm surveys that assess stock volume, size-frequency distribution, and migration patterns. Studies should be correlated with shorebird research (Rec. 2.2).	**DMR,** Worm Association, FTB

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Appendix A: Maps

The following maps are PDF files that are electronically separate from the plan text.

Map 1 – Taunton Bay Watershed and Estuary Base Map
College of the Atlantic 2005

Map 2 – Taunton Bay Shorebird Areas
Maine Department of Inland Fish and Wildlife 2006

Map 3 – Taunton Bay Shellfish Classifications as 12/28/06 and Licensed Overboard Discharges
Maine Department of Marine Resources 2006