

CASCO BAY ESTUARY PROJECT

Expanding and Sustaining the Shellfisheries of Casco Bay

Maine's natural resources have always been important to its people. Timber, tourism, agriculture and fisheries are hallmarks of the state's economy. The urbanization of southern Maine contributes to the impoverishment, contamination and outright destruction of vital components of Maine's environment.

Clamming represents an important tradition as well as a livelihood for residents of the Casco Bay region. Water contamination has limited the economic value of this resource in recent years. Malfunctioning septic systems, overboard discharge systems, boat discharges and non-point source of pollution have caused closure of many shellfish flats to harvesting. Due to the threat or existence of bacterial pollution 37 percent of the clam flats in Casco Bay were closed to shellfish harvesting in May 1995. Water contamination from sewage also causes closures of swimming areas in Portland and Peaks Island.

The Casco Bay Estuary Project (CBEP) is one of 28 estuary projects administered nationwide to develop practical and innovative ways to revitalize and protect estuary ecosystems. The program highlighted in this fact sheet integrates environmental protection, economic prosperity and community well-being by optimizing the utilization of shellfish resources in Casco Bay. Less obvious,

but just as important, is the informal use of the status of shellfish flats as an indicator of environmental quality.

The Casco Bay Estuary Project established the following goal and objectives in order to protect and restore clam flats and swimming areas in Casco Bay.

GOAL:

- *Open and protect shellfish impacted by water quality.*

OBJECTIVES:

- *Reduce bacterial contamination in Casco Bay;*
- *Increase open shellfish acreage currently impacted by poor water quality;*
- *To promote sustainable management of shellfish resources thereby clearly establishing the link*

In 1999 the CBEP received a grant from the US Environmental Protection Agency under their Sustainable Development Challenge grant program. To begin work on addressing the goal and some of the objectives, the CBEP developed an approach in the grant, which will address bacterial contamination of shellfish growing areas in Casco Bay that comes from several sources, management of shellfish to prevent over harvesting of shellfish in newly opened, and other areas.

Casco Bay Estuary Project has already made a lot of successful efforts: straight pipes that discharged raw sewage have been removed, and the plumbing code has been revised to regulate design and construction of onsite wastewater disposal systems. Overboard Discharge Systems that impact clam flats are gradually being replaced; and in the past year, 20 shellfish areas have been reopened in Cumberland, Yarmouth, Freeport, Harpswell, and Brunswick.



Project Tasks

Phase I: During this phase a Project Team was made up of shellfish harvesters and managers, concerned citizens, potentially affected homeowners and businesses, municipal and regional planning staff, and state regulatory staff. Accurate resource maps, areas classified by the Maine Department of Marine Resources as “Closed to Shellfish Harvesting,” were reviewed and associated sources of pollution were identified. Shellfish inventories were used to rank flats according to their potential for remediation. Steps necessary to achieve sustainable harvest were described.

Phase II: The objectives are to work with property owners, communities, and the Maine Department of Environmental Protection to eliminate sources of pollution and provide technical and financial assistance to municipalities that elect to protect flats. Mechanisms for eliminating existing or preventing new sources of bacterial contamination were implemented (e.g., removal of overboard discharges (OBDs), replacement of faulty septic systems).

Phase III: This phase involved integrating shellfish management into a comprehensive shellfish management plan for Casco Bay. Regional sustainable shellfish harvest management must consider requirements for inventory and landings data, likely annual red tide closures, limitations on winter digging in some areas, sources of seed clams, and effects of predation. Sustainability includes educational outreach programs to publicize the economic and community benefits of protecting Casco Bay harvesting and a plan for the coordinated and regional management of soft shell clams in Casco Bay. In this phase we will explore the feasibility of new management tools, such as coordinated shellfish management, privatizing shellfish growing areas with aquaculture leases, and regional marketing.

Priorities for Pollution Abatement

In Phase I we investigated and prioritized shellfish harvesting areas. Shellfish inventories, surveys of shoreline pollution sources, existing data on water quality and local knowledge were used to rate closed or threatened shellfish growing areas according to their potential for successful pollution abatement. Several factors are important in the evaluation and remediation of shellfish harvesting areas including the density of clams and likelihood of remediation of pollutant sources causing the closure.

CBEP established a committee of stakeholders concerned about environmental quality as it pertains to shellfish harvesting. Committee members met at the beginning of the project to set the course for the project and then several times to review information and determine the next steps for the project. Shellfish resource maps with shellfish harvest areas were sent to coastal towns for review and update.

Task 1: Informational compilation

The project focused on clam habitat in areas defined as prohibited in the Towns of Falmouth, Cumberland, Long Island, Yarmouth, Freeport, Brunswick, Harpswell, West Bath, and the west side of Phippsburg (Figure 1). As a first step, we identified potential soft-shell clam harvest areas that were within areas prohibited for harvest along with priorities for remediation. These areas were named and assigned a station number and an estimated acreage. Maine Department of Marine Resources shared information on shellfish resources, likely causes of closure, and water quality monitoring results. Maine Department of Environmental Protection provided information on the location and license number of overboard discharges (OBDs). Friends of Casco Bay provided additional water quality data. The closure surrounding each flat was listed, where available, as well as the reasons for closure and the number of OBDs.

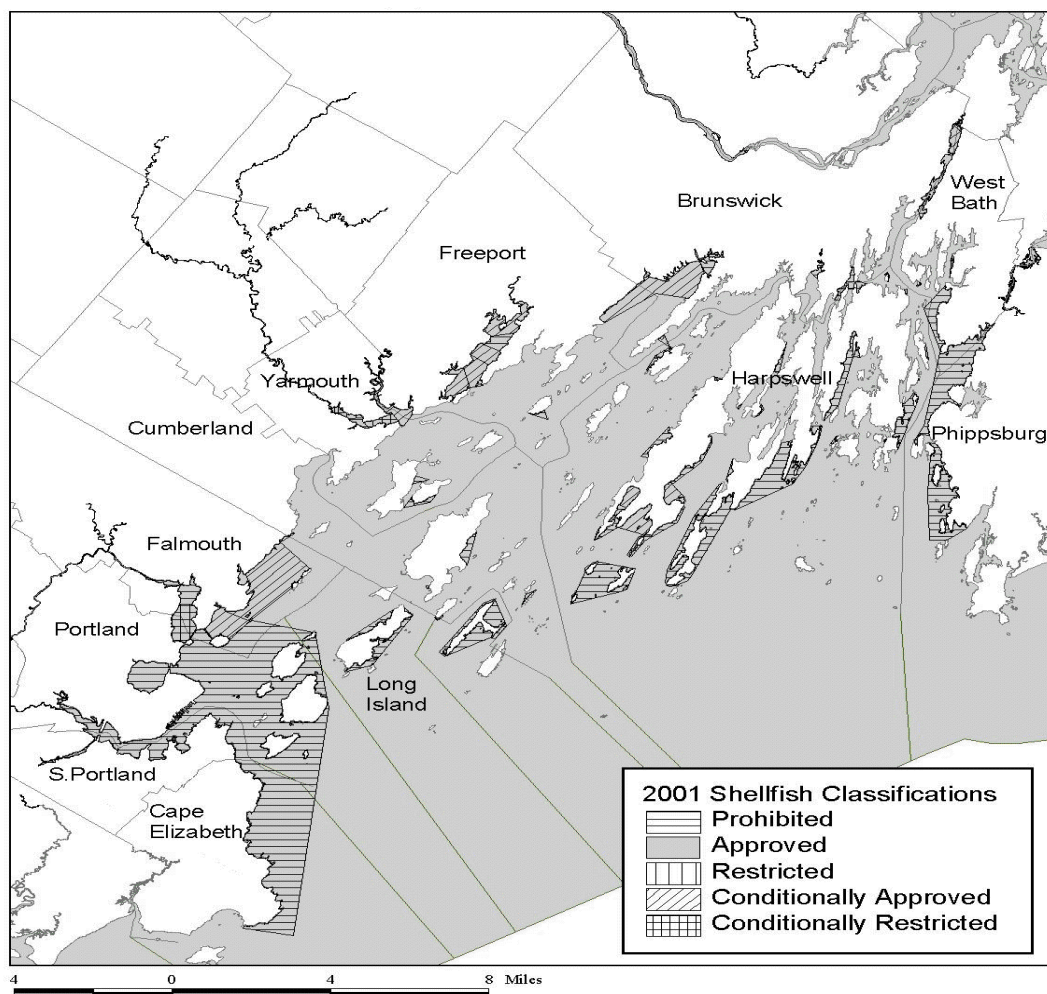
Task 2: Shellfish screening

The compilation process identified 57 potential soft-shell clam habitats in areas defined as prohibited. The Town of Brunswick generously provided its airboat and operator for much of the screening process. Additional site visits were made to flats in Yarmouth, Freeport, Harpswell, and Brunswick. Each site was evaluated in terms of its potential to provide harvestable levels of soft-shell clams. Each flat was assigned a rank (low, moderate or high) for its harvestable soft-shell clam resources based on estimated density and breadth of size-classes, using best professional judgment. GPS coordinates were collected in order to define the limit of soft-shell clam habitat, to be included in future GIS maps.

Task 3: Ranking process

The resulting information was reviewed and a preliminary rank was assigned to each flat. The rank was based on the estimated size of the flats, the value of the resource, and reasons for closure. All areas with resources rated as low were assigned a preliminary rank of "low". All areas with resources categorized as high or moderate-high that were at least 2.5 acres in size were ranked as high. All areas rated as having low- moderate resources were ranked as moderate. Any areas larger than 2.5 acres that were not visited were assigned a rank of moderate in order to keep them in the ranking process. The Committee decided to focus on areas ranked high and moderate in terms of clam resources, which composed approximately

FIGURE 1. Casco Bay Closed Clam Flats



Sources: Marine Department of Marine Resources and Casco Bay Estuary Project, 2002

TABLE 1. High priority flats, acreage, and sources of contamination

Town	#	Acreage	OBD's	Other Sources
W. Bath	8	97	22	Septic
Phippsburg	1	8	0	Septic, NPS
Harpswell	8	84	11	Marina, septic, NPS
Bridges Harpswell and Brunswick	1	20	0	Houseboat
Brunswick	2	163	5	NPS
Freeport	1	2	0	NPS

Sources: Casco Bay Estuary Project, 2000

But there is still a significant pollutant load reaching Casco Bay due to increased vehicles and development in the area. Approximately 57 clam flats in Casco Bay (800 acres of soft-shell clam habitat) were closed to harvesting due to actual or potential contamination, based on analysis by the Casco Bay Estuary Project and Maine Department of Marine Resources.

Septic Systems

Although, over the last 20 years construction of new municipal sewage treatment plants took place, septic systems still constitute the principal form of residential wastewater treatment. A septic system acts as an individual sewage treatment and disposal system buried in the ground. Typically, "gray" waste from kitchen sinks, washing machines, baths and showers, along with "black" water (human waste), is piped to a septic treatment tank where the solids settle out and decompose by bacterial action. The partially treated wastewater in the tank (effluent)-which is high in nitrogen and bacteria-flows into the disposal area (leach field), usually through a distribution box and a series of underground pipes. The soil in the disposal area serves to filter, clean and absorb the wastewater before it is infiltrated to groundwater. Typically, the septic tank provides primary treatment, while the disposal area provides secondary treatment.

a third of the total number. Additional information about water quality, shoreline survey, and sources of bacterial contamination was gathered for all flats ranked high or moderate in terms of the feasibility of remediation. In some cases, fecal coliform levels were low enough to consider opening the flat and only a shoreline survey or removal of a nearby OBD was needed.

From 57 areas identified as potential clam flats three (Merritt Island in West Bath, Stover Cove and Bethel Point in Harpswell) were opened to harvest during our assessment. The reasons for closure, which were based on poor water quality, included OBDs, poorly functioning septic systems, marinas, a houseboat, and non-point sources (run off from agricultural sources and upstream wildlife).

Water Quality Problems

During natural cycling storm-water that runs along the ground after a rainfall or during snowmelt picks up a variety of pollutants as it runs across lawns, roofs, driveways, parking lots, and residential, commercial, and industrial sites. Loaded with sediments, bacteria, nutrients, chemicals, and debris stormwater then flows into water bodies and storm sewers that drain into Casco Bay. Stormwater causes periodic closures of productive shellfish flats and swimming beaches.

The water quality of Casco Bay has improved over that last years with construction of municipal sewage treatment plants and industrial treatment.



When a septic system fails, untreated nitrogen and bacteria may flow directly into groundwater or coastal waters that cause closure of clam flats and swimming areas. Septic systems fail due to inadequate maintenance, overloading, or poor design and construction. Inadequate septic system maintenance results from failure to pump out the sludge at the bottom of septic tanks once every two to five years. Therefore, septic systems require routine inspections to make sure the system is operating properly.

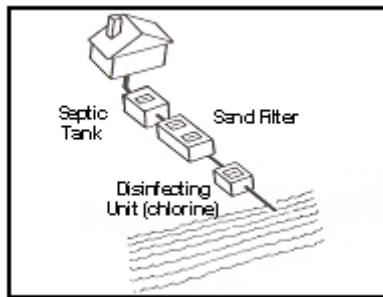
Overboard Discharge Systems

Between 1974 and 1987, Maine Department of Environmental Protection

regulations allowed treated, chlorinated overboard discharge systems to be built as a replacement for straight pipes or as an alternative to conventional inground septic systems.

By 1987, nearly 400 overboard discharge units had been installed in the towns surrounding Casco Bay. An overboard discharge system is similar to a septic system except that the leach field is replaced by a combination of a sand filter or mechanical aerobic

FIGURE 3. Overboard Discharge System



Sources: Maine Department of Environmental Protection and Maine Department of Community and Economic Development, 1993

Pollution Sources

Point-Source Pollution

Point sources convey polluted water into rivers and the bay through direct conveyances such as pipes and storm drains, which collect storm-water from roadways, parking lots, and other built-up areas. Much of the first waste in Casco Bay goes to a treatment plants. Each sewage treatment plant is designed to handle a certain amount of flow. During heavy rains, a portion of the combined sewage (sewage and storm-water) must be diverted without treatment through relief points known as combined sewer overflows. Combined sewer overflows are a major problem in the Portland area, with 59 points that discharge into Casco Bay during storms.

Point sources of bacterial contamination that cause clam flat closures:

- Wastewater treatment plants
- Residential septic systems
- Combined sewer overflows
- Overboard discharge (OBD)
- Straight pipes
- Marine toilet discharge

Non-point Source Pollution

Non-point source pollution includes runoff from land, rain, or snowfall, or groundwater seepage that enters rivers and the bay from diffuse locations. According to national studies, non-point sources of pollution now contribute up to 60 percent of the pollutant load. High fecal coliform in the bay was determined to be the result of non-point sources in some areas once other likely sources were eliminated. Common non-point sources of bacterial contamination in the Casco Bay watershed include:

- Wildlife, Waterfowl
- Pet, livestock waste
- Agricultural runoff
- Storm-water runoff from construction sites, urbanized areas, and highways
- Impervious surfaces
- Air deposition

Malfunctioning subsurface disposal systems, direct outfall pipes, and overboard discharges together with agricultural runoff and overflows from sewage treatment plants devalue property, close clam flats, and put public health at risk on Maine's coast. In fact:

- *There are over 2,500 licensed overboard discharge systems along Maine's coast;*
- *Contamination from licensed overboard discharges, failing subsurface disposal systems and straight pipes are responsible for the closing of 25% of Maine's productive mussel and clam flats that composes 9,000 acres;*
- *Contamination from failing subsurface disposal systems on Maine lakes contributes to rising phosphorus levels, falling oxygen levels and a build-*

The Overboard Discharge Grant Program

If you are considering replacement of your system with one of the alternative systems in compliance with the Maine Subsurface Wastewater Program contact your town office and the Department of Environmental Protection to obtain more information about the funding programs and your eligibility for assistance.

Anyone with a licensed overboard discharge system will be eligible for this program. The Maine Department of Marine Resources works with towns and the Maine Department of Environmental Protection to identify closed shellfish flats that are priority areas for using the overboard discharge grants and to ensure that areas designated for OBDs removal are not affected by non-point fecal contamination. The current list of towns with redeemable shellfish areas includes:

Beals	Camden	North Haven	South Thomaston
Boothbay	Edgecomb	Owls Head	Steuben
Bremen	Friendship	Phippsburg	Vinalhaven
Bristol	Georgetown	St. George	Wiscasset
Brunswick	Harpswell	Southport	

tank and a chlorination unit to disinfect the effluent before it is discharged into a water body. Overboard discharges require more maintenance than conventional septic systems. In addition to having the septic tank pumped, homeowners must ensure that the sand filter or mechanical aerator is working properly, and that chlorine tablets are in place in the disinfections unit. Because the required maintenance cannot be ensured, overboard discharge systems are considered a potential source of bacterial and chlorine contamination.

The Maine Department of Environmental Protection licenses and periodically inspects existing overboard discharge units to make sure that they are not discharging unacceptable levels of bacteria. Overboard Discharge Law in 1987 prohibited all new non-municipal overboard discharges and established a procedure for replacing existing overboard discharge units with alternative treatment. If your house or business has an overboard discharge system or mal-functioning subsurface

disposal system, or if your wastewater system was installed prior to July 1974, you may be part of the water quality problem in some Maine towns. Likewise, if you suspect that there are problem systems or discharges in your town, you can help lead a community effort to clean up the river, lake and ocean near you.

The Casco Bay Estuary Project (CBEP) provides project management for removing overboard discharges and water quality data collection from certain towns in their jurisdiction in Casco Bay. In the larger communities around the

Bay, sewage is now collected and treated. Where homeowners are responsible for the treatment of their wastewater, inground septic systems have replaced straight pipes and cesspools. Therefore, this phase of the Casco Bay estuary project targets two remaining sources of bacterial contamination: overboard discharges and non-point source pollution. The project provides technical support in obtaining state pollution abatement funds and implementing pollution abatement projects, identifying opportunities for preventing new sources of contamination. Since the new law took effect, 23 of the initial 33 designs have been completed, allowing some shellfish flats to be reopened, and two more are in progress. With state and local approval, we could complete most of the Brunswick and West Bath systems and get the majority of them out to bid. The Towns of Harpswell and

TABLE 2. Progress to date

Town	Systems Started in Program	Systems Completed	Out-to-bid	Construction Pending	In Process	On Hold
Brunswick	10	6	3			
Harpswell	2	1			1	
West Bath	21	16		1	1	3

Sources: Casco Bay Estuary Project, 2001

Phippsburg are already actively working on OBD removal. Freeport has successfully removed all OBDs within their town. When all of these OBDs are replaced, an additional 100 acres of harvestable shellfish flats will open.

disposal systems and individual septic systems. Septi-tech, a pretreatment system which allows for a reduction in the size of a leach field; was used in conjunction with Elgin-In-Drain leach field systems. The project demonstrates solutions for areas with limited soil capacity and small lots.

Creative Alternatives for Wastewater Disposal

There are many alternatives to overboard discharge and other failing or outdated wastewater systems. Not only are there different subsurface disposal options available to serve one home or a group of homes, but there are also experimental systems, municipal sewage districts, and holding tank systems. Depending on the site size, there are different recommendations on the system types that would be appropriate. Few lots were able to use conventional septic tank systems, most had to use a space saving leach field system because of space limitation.

Removal of overboard discharge systems becomes more complicated on waterfront lots where soil is inadequate or where lots are too small for an inground septic system. The Town of Brunswick devised a creative solution for 53 homes and cottages on Mere Point that had overboard discharges or substandard systems. With help from the U.S. Environmental Protection Agency, the Maine Department of Environmental Protection, the Maine Department of Economic and Community Development, and the Casco Bay Estuary Project the town replaced the existing systems with subsurface “cluster” wastewater

Illegal Boat Sewage Discharges

Casco Bay has approximately 1,900 boat slips at 19 privately owned marinas and 3,400 moorings controlled by towns. Illegal discharge of sewage from boats presents a public health problem for both swimmers and shellfish consumers. Although sewage pumpout is only permitted in waters three miles out from the coastline (i.e., outside the bay) it is suspected that many boats discharge into bay waters. A mobile pumpout boat operated by the regional nonprofit group, Friends of Casco Bay, helps tremendously with reducing boat discharges.

Licensed Wastewater Discharges

Among the potential sources of nutrients, municipal wastewater discharges contribute the most nitrogen to Casco Bay's ecosystem. Flats near combined sewer overflows, municipal sewage treatment plants, and other licensed discharges are permanently closed to shellfish harvesting. Many of these discharge sites in Casco Bay are in the Fore River, Back Cove, and Presumpscot River, where other contributing factors (e.g., bacteria-laden storm-water runoff from a densely populated area) could precipitate closure. Permanent closures are also in place around municipal sewage treatment plant discharges in Freeport and Yarmouth.

Sustainable Harvest

Shellfish harvesting provides an ideal opportunity to demonstrate the integration of environmental protection, economic development and community well-being. All of the municipalities on the rim of Casco Bay with the exception of Cape Elizabeth,

TABLE 2. Alternative Wastewater Systems

Option	Comments
Individual Replacement Subsurface Disposal System (with one or two septic tanks and one of various types of effluent disposal beds)	These are standard systems that work well provided adequate soils for subsurface disposal are available or can be trucked to the site.
An Individual Holding Tank	A holding tank should be considered as a last resort; they have to be pumped out frequently at considerable cost.
Group (or Cluster) Subsurface Disposal System with one or more septic tanks and disposal beds or one or more holding tanks, serving number of homes.	A group system is often the answer when a number of homes, close to one another, lack suitable soil for individual systems. A group system requires cooperation and a long-term commitment to maintenance.

Sources: Maine Department of Environmental Protection and Marine Department of Community and Economic Development, 1993

South Portland, Portland and Long Island have clam management programs. The programs vary greatly in scope and license allocation. Current management practices are based upon the clam flat survey. The survey provides information including: the location and clam producing areas, clam size distribution, the presence or absence of clam spat, the average clam density and estimated standing crop. State regulations require municipalities with clam management programs to survey their clam producing flats at least once every three years. Survey data is also used for determining the appropriate status for conservation areas (open or closed) and in re-seeding decisions.

Although clam management has been practiced in Casco Bay for decades and the most active municipalities have set the standard for the rest of the state, there are many weaknesses in the current management practices. The project will lay the groundwork for future conservation efforts by creating a collaborative network among the Bay's coastal communities. This network will provide a forum for the development of new approaches to shellfish management and environmental protection.

Shellfish resource management falls essentially into two categories: 1) fishing effort or pressure control and 2) resource protection and enhancement.

Fishing effort control

Shellfish resources, particularly intertidal resources, are, by their nature, susceptible to overexploitation. Fishing effort control has a number of techniques to maintain sustainable harvest. Perhaps the most important tool in fishing effort control is the imposition of limits on the number of licenses that are issued granting individual rights to harvest shellfish. Towns operating under approved shellfish ordinances are granted the right to limit the number of licenses issued within the municipality, although certain restrictions apply.

In addition to limited entry, harvesting can be controlled by the imposition of restrictions on the number of days and/or times during which harvesting can take place or on the amount taken during any specific period of time. For example, several communities have limited harvesting to daylight hours only while others have prohibited harvesting on Sundays.

It Is Interesting to Know



The first reference to size limitation as applied to soft-shell clams in Maine came in 1917 when laws regarding "reservations", essentially private leases, restricted the harvesting of clams to 2 1/2 inches or greater. In 1935, a law was passed which, for the first time, set a statewide minimum size of 2 inches and allowed a 15% tolerance level, the level being reduced to 10% in 1943. The statewide "2-inch clam law" was repealed in 1963 to increase resource availability due to the devastating effects of green crab, *Carcinus maenas*, predation during the 1950's and early 1960's. Also, in 1963, the Private and Special

laws were repealed and the Legislature authorized the establishment of Municipal Shellfish Conservation Programs which, upon State approval of a Shellfish Ordinance, allowed individual towns to set size limits, among other things. However, the statewide "2-inch clam law", with a 10% tolerance, was reenacted in 1984.

Interestingly, support for reinstatement of the 2-inch size limit came from industry, not so much as a conservation measure, but as a result of economic concerns that small clams were considered lower in quality and thus depressed market price, both in and out of state. Indeed, following re-enactment of the 2-inch law, prices rose and Maine regained its reputation for a premium product.

Resource protection and enhancement

The best-known and most extensively used resource protection measure is *size limitation*. Size restrictions are commonly used in fisheries management and are currently being applied to numerous species. *Conservation closures* are routinely imposed on flats where clam density is low due to over-harvesting, lack of recruitment, or a combination of the two. Such closures have proven successful in improving productivity, particularly when combined with resource enhancement measures. Another is to alternately close and open several flats simultaneously, thus spreading the digging effort, a technique referred to as *flat rotation*. While this latter approach may appear to be sensible in theory, the fact that clams grow at different rates on different flats makes coordination difficult. As a consequence, many towns feel it is better to simply leave all areas open at all times, thus ensuring a more even distribution of the harvesting pressure.

The resource enhancement measure most widely used today to increase production is the seeding of flats. Two techniques currently receiving considerable attention in Maine are the *transplanting of naturally occurring seed* from high-density areas to low-density areas and the *planting of hatchery-raised seed*. The transplantation of naturally occurring seed has the advantage of requiring little monetary outlay, but is very labor-intensive. Planting is usually accomplished by broadcasting harvested seed directly over the target area during high water, preferably in the late afternoon, thus ensuring that the next low water will occur during darkness to reduce avian predation. Hatchery production of soft-shell clam seed offers great promise, particularly for private-sector aquaculture, but the current production capacity in Maine falls far short of the needs. Furthermore, once spread, hatchery-produced seed is subject to the same risks of predation as naturally produced seed. In view of the substantial cost of the seed, these risks are often considered undesirable. Many communities have begun programs to revitalize the industry by seeding flats with both wild and hatchery-grown seed (from the Beals Island Regional Shellfish Hatchery and Spinney Creek Shellfish Hatchery) and are also conducting recruitment, growth and survivability studies.

History of Shellfish Management

Shellfish have played an important role in the coastal economy of Casco Bay throughout Maine's history as evidenced by the shell mounds around the shoreline and on the many islands of the Bay left by the native people hundreds of years ago. Active management of this resource is first documented in 1821, the year of the 151 Legislature of the then newly formed State of Maine, when laws were established to protect the rights of citizens to the taking of clams. Delegation of authority to individual towns for management of the resource began in 1895 when the Towns of North Yarmouth, Yarmouth, and Cumberland began managing their shellfish resources under the Private and Special Laws. These laws were amended and expanded until no less than 68 laws applied to shellfish management. By 1957 these laws had become sufficiently complicated and burdensome that a special Research Study Committee created by the Legislature recommended that the State, through the then Department of Sea and Shore Fisheries, assume cooperative management responsibility for shellfish resources. In practicality, however, control remained with the towns. In 1959 responsibility for enforcement of town boundaries by the State was withdrawn, leaving the towns to rely entirely on themselves. This situation soon became unsustainable and in 1963 the legislature enacted enabling legislation that laid the groundwork for the management system that exists today.

Today, towns across Maine manage the intertidal shellfish resources within their municipal boundaries through authority conferred by their respective Town Shellfish ordinances. These ordinances must be approved by the Maine Department of Marine Resources before enactment and are administered through local shellfish committees or commissions. Individual town ordinances are developed based on a Model Ordinance developed by the Maine Department of Marine Resources and specifically describe how management will be carried out in the town.

Heavy clam sets appear to occur adjacent to structures protruding from the sediment surface, i.e. stones, branches, tires, etc. Based on these observations, it seems reasonable to assume that structures intentionally placed as vertical projections from the sediment surface also act to encourage settlement in the surrounding area. Use of recruitment *enhancement structures* may serve as an attractive alternative to both transplanting naturally occurring seed and the planting of hatchery-produced seed since their use is much less labor-intensive than the former and less costly than the latter.

All of these resource enhancement measures are very labor-intensive and are consequently nearly always done as a volunteer effort. In order to ensure that sufficient labor is available to carry out their respective shellfish conservation programs, several municipalities now require commercial harvesters to perform a certain number of "conservation hours" in order to assure re-issuance of their harvesting licenses.

Predator control

Clam predators are many and varied and include the green crab, *Carcinus maenas*, their principal predator, the moon snails, *Euspira heros*, and *E. triseriata*, sand worms, *Nereis virens*, mud shrimp, *Crangon septemspinosus*, and the milky ribbon worm, *Cerebratulus lacteus*, to name but a few. The green crab is by far, aside from man, the clam's most significant predator. The most dramatic example of the effects of green crab predation is the impact of the crab population explosion that occurred in the 1950's that led to the precipitous decline of the resource that followed the late 1940's boom. The mild winter temperatures during the 1950's allowed the green crab to survive in unprecedented numbers. The green crabs devour small clams shortly after settlement as well as larger juveniles and are such effective 'green predators' that by the late 50's and early 60's the soft-shell clam resource up and down the entire Maine coast had been reduced to historically low levels.

The Department of Sea and Shore Fisheries responded to the green crab emergency by implementing a predator exclusion program, more commonly referred to as the "crab fencing" program. Crab fences were erected along the

mouths of selected coves known for their productivity to prevent green crabs from moving up the flats on the incoming tide. Crab traps were set and fished inside of the fenced-in area to remove existing crabs. These measures were very labor-intensive, but proved effective in protecting at least a small portion of the population. However, green crabs do exist in efficiently large numbers in certain areas to pose a risk to seeding efforts. Consequently, in certain areas where seed is applied to the flats, the seeded area is covered with plastic mesh to exclude crabs.

Soft-shell farming techniques

As overexploitation of marine resources caused the clam population decline, new farming techniques must try to control, protect, and enhance the resource. Soft-shell farming represents an important link between easing fishing pressure on exploited species and allowing clambers to continue this Maine tradition and life style and to provide us with soft-shell resources. Most soft-shell farming techniques require extensive labor and capital investment, therefore, the need for developing low-cost and low maintenance methods is significant.

In order to test the value of soft-shell farming options, in October of 2001 the CBEP, together



Author of this fact sheet, Natalia Kassatova, establishing the boundary of the test site.

with Normandeau Associates, has conducted experimental clam seeding in saltwater "farms" in three different locations: Yarmouth (between Cousins and Little John Island), Freeport (north of Indian Island off Flying Point Neck), and



Local clammers helping Normandeau Associates staff, Marcia Bowen, furrow one of the test plots. Furrowing is a technique used to drag the mud with clam rakes to create holes and lines where broadcasted baby clams will be protected from predators.

Phippsburg (off Small Point Harbor). Clams were planted employing several preplanned techniques and at appropriate density. These techniques include: different timing (fall and spring), different seed size (small up to 10 mm and large 18-20 mm), furrowing the substrate prior to broadcasting juveniles, covering the beds with predator netting.

Three plots measuring 28 X 25 feet were established in each town. One was for small clam seeding, one was for larger clams, and one was with no seeding at all. Half of each plot was covered with predator netting and the other half was left uncovered. Half of the plot was furrowed with a clam rake, with furrowing done perpendicular to the net, so that half of the netted area and half of the uncovered area were furrowed. Results will be based on the control plots with no seeding and natural conditions.



Covering the half of the plots with and without furrowing with net. The net protects small juveniles from predators.

Implementation of the Management Techniques

Management techniques vary significantly between municipalities within Casco Bay and between regions within the state. Most communities with defined shellfish resources to protect do have ordinances that define the responsibilities and goals of the shellfish committee, requirements of license holders, license fees and applicable state regulations. Most towns within Casco Bay do not restrict the amounts of clams that can be harvested per tide by Commercial License holders; all towns do have limits on Recreational diggers. Few municipalities allow nighttime digging, as this is especially difficult to enforce. Conservation time,



The size of the seeding clams ranges from small (8-10 mm) to large (18-20 mm). In the spring and fall 2002 the surviving clams will be counted and measured to

required of most harvesters to obtain a town license, can involve assisting with resource surveys, re-seeding events, collecting water samples or other tasks deemed necessary by the shellfish committee. Provisions are set forth in all ordinances to allow for the revocation of licenses for any violation of that ordinance. Shellfish management plans rely upon resource surveys, which vary in extent and complexity depending on budgetary and volunteer resources.

Regional Shellfish Management

The concept of a regional shellfish management program is not new in Casco Bay. From the late 1940s through the 1950s a Casco Bay regional shellfish management council was established to coordinate efforts to enhance and manage the clams, *Mercenaria mercenaria*, and fishery. Among

other accomplishments, the council was instrumental in coordinating the transplanting of 38,000 bushels of small juvenile hard clams from heavily concentrated areas to less densely populated areas around the Bay over a period of several years. A more recent attempt at regional management which began in 1978, specifically the Brunswick- Harpswell- West Bath Region Council, was not as successful.

The success of any future attempt at regional management will rest on the acceptance of and

parties, the Council should seek representation from all aspects of the shellfish industries, (including harvesters, dealers, processors, and shippers), resource management, the marine scientific community, and all municipalities bordering on Casco Bay, and State and local law enforcement personnel.

Comprehensive Shellfish Management Plan for Casco Bay

If a comprehensive plan were to be developed, these are some possible components of the plan:

- Develop an educational outreach program to publicize the economic and community benefits of protecting Casco Bay. Provide periodic updates on the efforts of communities to protect their shellfish resources.
- Develop a plan for the coordinated and regional management of soft shell clams in Casco Bay.
- Explore the feasibility of new management tools, such as coordinated shellfish management, privatizing shellfish-growing areas with aquaculture leases, and regional marketing.
- Municipalities with clam management programs under State regulations are required to survey their clam producing flats at least once every three years.

What You Can Do



The next time you wash dishes, take a shower, do the laundry or flush the toilet, consider this: the average family contaminates from 120 to over 500 gallons of water per day. This water contains: fecal matter, fat and grease, nitrates, phosphorus, pathogenic bacteria, infections viruses, toxic chemicals, and organic compounds. Needless to say, if you are concerned about keeping the water clean, it is in your interest to limit your use of household chemicals, detergents and cleansers. By conserving water, you can cut down on the amount of waste water you discharge.

respect for the sense of ownership. Accordingly, the focus of a regional council should be on issues of broader rather than specific concern. These issues include resource assessment, research and development of new management techniques, including transplanting and assessment techniques, compliance with water quality monitoring requirements, and law enforcement. And finally, to ensure participation by all interested

Copies of the reports, *Expanding and Sustaining the Shellfisheries of Casco Bay: Phase 1*, by Normandeau Associates and MER Assessment Corporation; *Portland Area Wastewater Treatment Impact*, by Jody Hibbard; *Casco Bay Plan*; by Casco Bay Estuary Project; and *Treat It Right: Alternative Wastewater Systems That Protect Water Quality*, by Maine Department of Environmental Protection and Maine Department of Community and Economic Development, are available from the Casco Bay Estuary Project.

Want to know more?

The mission of the Casco Bay Estuary Project is to preserve the ecological integrity of Casco Bay and ensure the compatible human uses of the bay's resources through public stewardship and effective management. For more information,



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