Resource management in a small Maine town: monitoring, conserving, and managing clam flats in Bar Harbor

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Executive summary

Since Bar Harbor first enacted a shellfish ordinance in 1998, a number of groups and individuals, led by Jane Disney and the Bar Harbor Marine Resources Committee, have focused a great deal of effort on monitoring populations of the soft-shell clam (*Mya arenaria*) in Bar Harbor. Most attention has centered on the intertidal at Hadley Point, where the town has set in place a series of conservation closures. Clam populations have been monitored since 1999 using a survey technique modified from those used by the Maine Department of Marine Resources. These surveys, previously kept in different locations and formats, are combined here for the first time. Major trends include higher densities of clams at Hadley Point since a major recruitment event in 2005 compared with all previous surveys; and that densities have remained higher on the east side, the site of a conservation closure, than they have on the west side. However, densities of legal clams at Hadley Point remain lower than the initial surveys of 1999, though if growth of individual clams continues consistent with our observations, a large number of clams should be reaching legal size in the next several years. Our recommendations include ways to refine census methods and for the allocation of future effort. To optimally monitor trends in density at Hadley Point, we recommend the Committee sample at least once per year—twice per year for better estimates of growth rates—that each survey should collect a minimum of 30 clams, and that permanent areas should be established for sampling. We further recommend that the Committee should encourage continued monitoring by high school and college classes, that monitoring efforts should focus on Hadley Point, and that growth rates should be further studied by following marked individuals. Additional effort may encompass broader, less intense surveys of other flats in Bar Harbor, outplanting clams from areas closed for health reasons to the Hadley Point conservation closure, and natural enhancement experiments in the conservation closure. While there appear to be differences between the closed and open areas of Hadley Point, the areas need to be monitored for a reversal of population trends coinciding with a reversal in closure areas to establish the conservation closure as a cause of increased survivorship of clams.

Introduction

Management of living marine resources in the Maine waters of the Gulf of Maine involves a wide variety of organisms and an equally complex set of agencies and management groups. To understand the management of any single marine resource, there are layers of overlapping jurisdiction to negotiate; for any given species or industry, there can be federal, regional, state, local, and municipal regulations governing its management and use. Federal regulations extend to international boundaries (200 nautical miles), while inside three nautical miles, the state has authority to manage its resources. These are the source of the majority of regulation, though various regional and species councils operate across a large range of geographic scales. Endangered species and marine mammal legislation further fracture any overall management schemes by creating a strong federal management presence within state waters. Meanwhile, stocks for many species move among these management areas, and fishermen in one area can affect the stocks of another set of fisherman, either directly by catching individuals that move between management areas, or indirectly by the use of gear that damages habitat or by depleting resources necessary for another species.

The movement toward multi-species management has encouraged greater coordination between the many groups involved with umbrella-like oversight by regional councils. At the same time there has been an emerging call for both bottom-up and community-based management. Very few marine resources are managed at this level, but there are several examples of local management to inform the movement. Lobsters are most often touted as a resounding success of local management by users; Maine delegates certain parameters of management to seven geographic zone councils comprised of elected fishermen. However, lobsters are managed primarily by the state and user groups. There are a very few resources given to general town government to manage; river-run alewives and several species of intertidal shellfish, including surf clams (*Spisula solidissima*), razor clams (*Ensis directis*), and soft-shell clams (*Mya arenaria*) have town involvement in their management. Of these, soft-shell clams are by far the most economically important, and in comparison with the other species, municipalities have far more flexibility in their management.

Since municipal management of marine resources is so rare in Maine, many towns are not well equipped to manage their clam resources. The state provides substantial support for this function, training shellfish wardens and advising on matters of science and policy. However, for towns with shellfish ordinances, the burden of time and labor falls on the town, and effort needs to be efficient. In 1998 when Bar Harbor began creating a shellfish ordinance, the town established a shellfish committee to oversee clam management. The scope of the committee has increased with time, moving from clam management to a broader range of issues including water quality and habitat restoration, making it important to streamline operations. With just under a decade of town management of clams, Bar Harbor is at a point to examine past monitoring efforts for trends and to refine and focus future effort. Several citizen and school groups have assisted in population census efforts over the past two years, and as members have coordinated and gained familiarities with the census techniques, surveys have also become more efficient and consistent. In order to make the most of this organization and effort, it seems prudent to evaluate the current state of clam management in Bar Harbor in order to refine and direct future work. Given the high level of citizen involvement, synchronizing and standardizing surveys will ensure that they provide maximum information. Bar Harbor also provides a model for small-scale management; with the upcoming closure reversal at Hadley Point, censuses may increase our understanding of the effects of conservation closures on clam populations.

This senior project is an attempt to make available and consolidate resources, data, and monitoring methods in a single document to inform future monitoring and policy decisions. It includes a general natural history of soft-shell clams, a history of clam management in Maine and Bar Harbor, summary tables of data collected in Bar Harbor to date with a corresponding database, descriptive analysis of data gathered for Hadley Point, a summary of challenges for current monitoring protocols and suggestions for improvement, recommendations for future action and allocation of effort by the Bar Harbor Marine Resources Committee, and reference material. This document is also being packaged with a CD that contains all of the original clam data and two past public

presentations. It will be given to the chair of the Marine Resources Committee, Dr. Jane Disney, with additional copies kept by myself and Dr. Chris Petersen.

Biology and ecology of soft shell clams

Mya arenaria, the soft-shell clam, is common in the intertidal and shallow subtidal soft-bottom habitats over most of the northern Atlantic including Europe, Canada, and most of the United States eastern seaboard down to North Carolina (Ellis 1998). They are found in a wide range of sediment sizes, from fine silt and marine clay to coarse gravel. They predominately inhabit lower energy shores in shallow bays and inlets. In New England they are the dominant infaunal bivalve of intertidal gravel and mud habitats. The benthic invertebrates most commonly found associated with *M. arenaria* in Maine include the polychaetes *Neries virens, Glycera dibrachiata, Arenicola marina, Spiochaetopterus costarum*, the bivalves *Mercenaria mercenaria,* and *Mytilus edulis,* several species of gastropod including the predatory moonsnail, *Euspira heros,* other predatory species such as *Cerebratulus lacteus*, *Limulus polyphemus*. and the introduced green crab *Carcinus maenas*.

Soft-shell clams are active filter feeders, extending a long siphon to the substrate surface and pumping water across a ciliated gill that filters out particles. The siphon is located at the posterior end of the animal, and clams are always oriented in the substrate with this end of the shell up. Siphon length, along with season, directly correlate with burying depth of individuals (Zwarts and Wanick 1989). This creates a pattern of vertical distribution in the mud with larger individuals positioned lower in the sediment and smaller individuals closer to the surface. In New England clammers occasionally dig as deep as 12-14 inches to uncover larger individuals.

As with many marine invertebrates, *M. arenaria* have a life-cycle that includes a pelagic larval stage that undergoes metamorphosis into a relatively sedentary adult stage. Ropes and Stickney (1965) report that *M. arenaria* north of Cape Cod have a single annual reproductive cycle, as opposed to those south of the cape that are reported to have two

reproductive peaks per year. Almost all spawning in Maine occurs from late May through August (Ropes and Stickney 1965). With its larval stage of around 3-6 weeks, most recruitment of settling individuals occurs from mid-summer into the early fall.

Settlement can be highly variable and is influenced by a number of factors including abundance of larvae, pelagic environmental conditions that affect dispersal, and availability of substrate (Hunt *et al*. 2003). On smaller spatial scales, hydrodynamics and larval behavior also play a role. Once individuals settle to the substrate, mortality is high and variable (Goselin and Quinn 1997; Hunt and Scheibling 1997; Beukema 1982). Recently settled clams also have a much higher degree of mobility than their larger counterparts (Günther 1991, 1992; Palmer et al. 1996). Settlement densities are often high in the lower intertidal initially, but soon after settlement juveniles are found in greater concentrations higher in the intertidal. *Mya arenaria* less than 5mm in length are regularly redistributed by currents, and there is evidence that these post-settlement factors along with predation are more important in influencing populations than low settlement densities (Hunt et al. 2003). On a larger geographic scale, *The Maine Clam Handbook* (Ellis 1998) states that in a reversal of historical patterns, larval densities are now seven times higher in southwest Maine than downeast, and that this has correlated with a drop in landings in eastern Maine. This would suggest that for the eastern counties larval supply and initial settlement densities are of greater importance in establishing population densities.

Although the timing of reproduction is relatively similar between years, the level of recruitment varies tremendously not only between sites but also at a given site through time. This leads in many cases to a strong age structure at a site, with a single or several age-classes dominating the population. Given the relatively long lifespan of *M. arenaria*, with individuals having a maximum lifespan of 4-28 years (Maximovich and Guerissimova 2003), these hierarchies can persist for many years (Maximovich and Guerissimova 2003; Strasser et al. 1999).

Reports for Maine indicate a wide range of ages at which individuals mature, from 2-10 years (Ellis 1998), coinciding roughly with their attainment of legal size. This is most likely due to the differences in growth rates between sites, with faster growing individuals reaching reproductive maturity more quickly. Growth rates of *M. arenaria* appear to vary greatly with a variety of environmental conditions including temperature, food availability, salinity, sediment type, exposure time, water velocity, and population density. (Peterson and Black 1993 as cited in Beal *et al*. 2001). The greatest growth occurs during summer months when the clams' metabolic rates are high, though plankton levels are lower. Site-specific data are required to accurately estimate growth rate for a location, but even without site-specific data there do appear to be some general correlations of clam growth with habitat. Growth is slower in the higher intertidal, as well as in coarser sediment (Newell 1982; Ellis 1998), and is also influenced by sediment suspension (e.g. Swan 1952), and local rates of predation on juveniles (Günther 1992). Growth rate slows with age as conversion becomes less efficient and more energy is allocated to reproduction.

One reason for the range in estimates of time necessary to reach sexual maturity or legal minimum size may be the difficulty in measuring growth. There is not good evidence that external shell deposition lines are a good indicator of age. Strategies to evaluate growth include various mark and recapture techniques or surmising growth from size-frequency distributions through time, though for legal size clams this only works in areas that do not support harvesting effort. It is also possible to assess age of individuals from internal shell deposition, though this technique requires equipment and training (Jones 1980; MacDonald and Thomas 1980).

Several studies have examined causes and patterns of mortality in soft-shell clams in a variety of locations (e.g. Ambrose 1985; Goselin and Qian 1997; Hunt and Sheibling 1997), and several generalities have emerged. There is a complicated relationship between individual size and susceptibility to predation. Very early post-recruitment, individuals are not subject to high rates of predation, but predation risk increases as they grow and become an object of prey to a variety of predators, (including *C. lacteus*, *N.*

virens, *G. dibranchiata*, *L. heros*, *L polyphemus*, and the invasive green crab, *C. maenas*). After individuals reach a length of 1 inch, only a few predators can eat them. Smaller clams are also more susceptible to other sources of mortality such as weather, particularly cold, and smothering due to suspended sediments. Harvesting, on the other hand, targets those clams that are over 2 inches, but may also incur a toll on undersized clams through direct damage or indirect effects of disturbance. Density does not appear to be a factor in mortality or growth (Beal *et al.* 2001; Beal and Kraus 2002), unless there is the potential for density-dependent predation.

History of clamming and clam management

Human use of clams as food predates European colonization of the Gulf of Maine. Precolonial shell middens along the coast testify to their importance in the diet of Maine Indians (Ellis 1998). Clams continued to be an important source of nutrition, particularly in the absence of other resources, for early European fishing stations and later colonies. Clamming is now a multimillion dollar industry in Maine, with landings in 2004 at over 1,000 metric tons worth over $6.5 million. In the first half of the twentieth century, the majority of clams were processed by canneries until the industry moved south to process surf clams. Clams from New England were mostly sold for steamers and fried clams. In the late 1970s and 1980s there was a boom in the industry, with landings in 1976 topping 3,000 metric tons. Despite a decline in landings, clamming still remains an important industry in Maine, providing low-capital employment part-time for many residents.

Laws regulating marine resources, particularly clams, were initiated very early in the history of the State of Maine. After secession from Massachusetts in 1820, the Maine legislature in 1821 gave towns the authority to regulate their clam resources through local ordinances (Ellis 1998). This continued until 1895, when the legislature began passing what were called “special and private laws” on behalf of individual towns to regulate their resources. This appears to be a change in pathways to codify laws; what had been done through town ordinances now required approval of the state legislature, though

towns still created their own management systems. All aspects of clam management were set by these special and private laws.

In 1963 the legislature gave towns their current authority and responsibility over the clam resources within their boundaries; all special and private laws were repealed (Newell and Lignell 1983). Options available to towns fall within a broad range prescribed by the state. Currently, the statewide rules include a required state shellfish harvesting license for any commercial harvesting, a minimum individual clam length of 2 inches, all harvesters may only use hand implements, and the closure of flats for health reasons. The state defines commercial harvesting as any harvesting not for personal use or that exceeds two pecks per day. At one extreme, towns can choose not to enact any ordinances or management plan. In this case the towns have no responsibility for policing their flats for compliance with state laws. For towns that do choose to have management plans, their management tools include requiring licenses for harvesters, limiting the number of licenses issued, with a state-mandated portion of at least 10% available to non-residents, creating licensing fees and structures, including possible requirements of time toward flat management or enhancement, with non-resident fees not to exceed twice that of resident fees, making distinctions between recreational and commercial licenses, establishing harvest limits for license types, setting closed and open seasons, creating conservation closures, and using a variety of resource enhancement methods (see Ellis 1998 and www.maine.gov/dmr/ crd/smd/index.htm for details and statute). Although in this scheme towns have the authority to create ordinances, the state role remains important and includes providing guidance to towns and protecting public health. Maine waters have a history of warm-season closures due to red tide, which is caused by several species of dinoflagellate whose toxins can rise to dangerous levels in shellfish, and these conditions are closely monitored by the state. Towns that have an clam ordinance or clam management plan also accept responsibility for enforcing compliance of clam harvesting regulations within their boundaries.

In addition to generally limiting individuals and their harvests, towns have the option to lease out as much as 25% of their flats to individuals. The emphasis in these leases is to

promote management and enhancement of clam resources, providing an opportunity for individuals to experiment with and practice a variety of practices with the incentive of ensured harvest.

One of the first perceived threats to Maine clam populations was the introduction of green crab (*Carcinus maenus*) to the east coast of North America in the 1890s. Green crabs were known to be predators of shellfish, and there was concern over the potential for them to decimate local clam populations. The crab population expanded its range north from the Long Island region reaching Maine in the early 1900s, with first reports of green crabs in Casco Bay occurring in 1905, but not reaching population levels of concern throughout Maine until the 1940s (Scattergood 1952). No green crabs were reported in midcoast waters in 1945, but by 1951 they were coming up in lobster traps (Ellis 1998). For a possible exception, see Arnold (1901) for an observation.

There is substantial evidence that green crabs, once established, had a negative impact on the clam populations in Maine (e.g. Ropes 1968; Welch 1968). To counteract this influence, managers have tried a variety of methods to deter crab predation on clams. These deterrents include fencing off areas of flat, and covering flats with a kind of netting. Fencing is achieved with a flanged mesh developed in-state that creates a barrier to green crabs moving in at high tide. Although tried and used popularly in the 1960s and 1970s, this technique is mostly abandoned now, and no new fences have been constructed since 1979. The other common method used is to cover a flat with plastic mesh netting and bury the edges to a depth of 8 inches. Floats are positioned underneath the mesh and buoy it off the substrate surface. These predator deterrents have not been used to a great extent in a number of years, and fears of a large-scale decimation of clam populations have been largely unrealized. While there has been a decline in clam populations, it was not to the extent feared. There are still commercially viable populations of clams, and green crabs are not regarded as the largest current threat.

Enhancement strategies have focused on seeding flats with juvenile clams reared in hatcheries, transplanted, or wild set, and on enhancing recruitment to flats. Since small

currents and flow patterns influence settlement, these strategies focus on creating eddies and slowing flow across flats. People have dug over flats to increase texture and used snow fencing or brush placed in flats to change local water movement and induce greater settlement and retention of juveniles. Some towns are currently experimenting with old lobster gear and wire domes to create easily moveable structures across their flats (H. Annis, DMR, pers. comm.). Despite the prevalence of these methods, there is no documentation for their effectiveness in increasing recruitment.

Management of other marine species in Maine

Although clams are managed at a local level, most other species that occur with them are managed at larger scales, primarily through the state. This can lead to a disjunction between management schemes at a single location. In general, the successive levels of management can only be more restrictive than the levels above it, working within the rules handed down. The primary work to regulate the important fisheries in Maine is done by the state, and it is the state that steps in to manage emergent fisheries. There is a broad range of management schemes, from an absence of regulation to a complete moratorium. With lobsters as a notable exception, most fisheries in Maine, as in most places, only became subject to strict regulation with concern over depletion.

Clam management is better understood in the context of the management of similar fisheries. With this additional information it is easier to discern differences between the management of clams and other species and to speculate on possible interactions between industries that may result. The species of the intertidal are subject to a wide variety of management schemes, with no consistent pattern due to the differences in harvesting methods, size of the industry, and industry participants. Below are some examples of the regulation of several concurrent fisheries, including worms, seaweed, mussels, hen clams, and quahogs.

The most obvious fishery to compare to clamming is the baitworm industry since harvesters use similar equipment in similar areas to harvest organisms. Diggers target

primarily *Glycera dibranchiata*, and *Nereis virens* with methods similar to clammers. The first worm fishery regulations in Maine were enacted in 1980, and regulations have always existed exclusively at the state level and apply to the entire state. The regulations are for registration, with the only catch limits being a 125 worm limit on Sundays. Recreational diggers are limited to 125 worms per day. There have been no changes in these regulations over the last 25 years, although the fishery has expanded considerably over that time.

While towns have the authority to close areas to the harvest of clams, that flat is still open to state-regulated fisheries such as those for baitworms, *Glycera dibranchiata*, bloodworms, and *Nereis virens*, sand or clam worms. Beal *et al*. (2001) describe the history of these two fisheries that traditionally occurred in separate areas due to habitat differences, primarily substrate, that influenced both abundances of the target species and the ease of digging in a certain style. However, in the 1980s declines in abundance of both species with correlated increases in prices led both the clam and worm industries to expand from traditional areas that were fairly distinct and to overlap more frequently. While the industries are concurrent and similar, there are differences in manner of harvest. Clams are found across the range of sediment types, and clammers go specifically to sites with the readily visible siphon holes, turning a flat over with the long-tined rakes once, perhaps twice, in a season, with "no regular pattern of sediment excavation" (Beal *et al*. 2001). In contrast, worms, on which there is no significant regulation, are harvested with short-tined rakes, and harvesters dig more systematically over an entire area, turning over an area three or more times in a season.

The effects of worming on clams are debated. Many clammers have long believed that these fisheries have a direct negative impact particularly on small clams by damaging the shell, and that the excavation of sediments facilitates predation on the clams disturbed (as referenced in Beal and Vencile 2001). This belief is supported by Ambrose *et al*. (1998) who examined clams left exposed on the sediments excavated by commercial wormers, finding that at least 6% of clams greater than 2mm in length were exposed on the surface. Twenty percent of the exposed clams had at least one valve damaged, adding to their

susceptibility to death. Ambrose *et al*. (1998) also found that about 15% of undamaged clams were left with their siphons up, and the rest were either horizontal on the surface (44%) or oriented with their siphon down (41%). Those clams oriented with their siphon up reburied faster and to greater depth than the others, and those that were horizontal were faster to rebury than those with their siphons down. When they redug plots 10 days later, they recovered only 50% live, and shell damage indicated heavy predation.

Beal and Vencile (2001), while not refuting that worming has negative effects on populations of *M. arenaria*, concluded in a study on a seeded flat in Brunswick, ME, that natural mortality was high and variable and that the effects of worming were negligible compared to these impacts, unless predators are excluded. They also found that clamming had a greater negative impact on undersize *M. arenaria* than worming did, increasing overall losses by 15%. This study, focused on a flat closed for seeding, may or may not be applicable to closures with different goals. Another relevant difference in the Beal and Vencile (2001) study from Bar Harbor is a difference in the main predators; in Brunswick predation was primarily by *Limulus polyphemus*, which is not present in Bar Harbor, and by *Cerebratulus lacteus*, found in relatively low density at Hadley Point (pers. obs.). It is difficult to tell whether the conflicting results of these two studies are due to ecological or methodological differences.

Seaweed harvest is another intertidal industry managed by the state. In Maine, a variety of species are harvested for food, extracts, packing material, and mulch. Commercial harvesters are required to have a state permit, which distinguishes between residents and non-residents. No permit is required for anyone with a worm dealer's license or wholesale seafood license, anyone who harvests, possesses, ships or transports less than 50 lbs/day for noncommercial purposes, for charitable or municipal organizations for noncommercial use, or anyone collecting naturally detached or dead seaweed. Beyond permitting, harvesting regulation is limited to that harvesters must leave the lowest lateral branches and at least 16" of thallus above the holdfast. Seaweed harvesting has no apparent interaction with clam populations.

One of the more contentious fisheries thought to produce conflicts among user groups—especially with clamming—is mussel harvest. While some people harvest mussels by hand, mostly for personal consumption, most wild mussels are taken by dragging. A boat license is required for dragging, while handraking requires a separate license when taking more than two bushels. Licenses are only available to Maine residents. Limited permits are available on a first-come first-serve basis. Mussels are managed by the state across the entire state, with four special conservation areas established in 1988 for seed mussel harvest for aquaculture. Seed mussels are defined by number of individuals per volume, and are unlawful to possess, transport, etc. except for the purpose of collecting and transporting them to a aquaculture lease site. Restrictions on seed mussels are the only size limitations. Other regulations include drag widths and limitations on nighttime dragging. Because mussel draggers can drag in the intertidal at high tide, they have the potential to physically alter clam flats, and they are not currently restricted from town conservation closures.

Quahogs (*Mercenaria mercenaria*) and hen or surf clams (*Spisula solidissima*) within the intertidal can be included in municipal shellfish ordinances, while those found subtidally are subject to state regulation. Regulations are for the entire state, with a few sub-areas managed differently. Restrictions are primarily on drag width, with a minimum size of 1 inch hinge width for quahogs, except when being used for aquaculture, and several areas have quahog harvest restricted to hand implements.

History of clam management in Bar Harbor

Information for this timeline comes primarily from minutes of the Bar Harbor Marine Resource Committee and from conversations with the current chair, Dr. Jane Disney, who is also a charter member of the committee. For full details, including dates for

specific actions and a copy of the current Bar Harbor Shellfish Management Ordinance, please see Appendix A.

In 1998, Bar Harbor founded a Shellfish Conservation Committee (later becoming the Marine Resources Committee), so that greater focus could be given to clam management in Bar Harbor than was possible through the Harbor Committee with the goal of implementing a town ordinance under state-granted authority to regulate shellfish harvesting in the town. The ordinance was subsequently adopted by the town council and approved by the state in 1998. Bar Harbor's Shellfish Management Ordinance reflects the competing goals of public access and a concern about over-utilization and for the conservation of flats in its mission "to establish a shellfish conservation program for the town of Bar Harbor that will ensure the protection and optimum utilization of shellfish resources within its limits." The ordinance includes the following tools to be used in Bar Harbor towards its goals: licensing; limiting the number of shellfish harvesters; restricting the time and area where digging is permitted; limiting the minimum size of clams to be taken; and limiting the amount of clams taken daily by a harvester.

Following a survey from the east side of Hadley Point to Salisbury Cove, the committee recommended and the town council approved a conservation closure of this area for one year effective 1 January 2000. A conservation closure is defined as an area closed for the purpose of protecting or enhancing the resource rather than for reasons of public health. A 2000 survey by Dr. Jane Disney with students from MDIHS found that the proportion of legal clams in the closure was not high enough to warrant opening the flat as scheduled, and the Shellfish Conservation Committee and town council decided to extend the closure for an additional year through December 2001. The committee, after examining results from their survey in the fall of 2001, found that there were enough legal clams to open the flat, but recommended extension of the closure for six months until 30 June 2002 to allow clams to achieve maximum harvest value. The town council implemented this recommendation, and the area opened in the summer of 2002. The town further implemented restrictions on harvesting in the former conservation area to one peck per day per recreational license, and one bushel per day per commercial license

compared with state limits of two pecks per day for a recreational digger and no harvest limit for commercial diggers. In the spring of 2002, the committee experimented with spat recruitment enhancement, setting out cages in two locations, with limited success. Later that year, the committee recommended and the town council approved an annual closure for the east side of Hadley Point to Salisbury Cove for the first half of every year, from 1 January to 30 June to allow individuals to spawn before harvest. This continued until in late 2004 the committee recommended to switch to a rotational closure scheme, with the east side closed until July 2007, and the west side closed from 1 January 2008 to 1 July 2010. The town council adopted this recommendation, effective for the beginning of 2005.

To better understand the resources they are managing and the results of management actions, the town's Marine Resources Committee and others have sporadically surveyed various flats within town jurisdiction since 1999. Most surveys have used state protocols outlined in the *Maine Clam Handbook* (Ellis 1998), with some modifications to adjust for the relatively small size of Bar Harbor's flats, reducing grid size to 50 foot intervals (current practice in Appendix B).

In 2003 Nina Therkildsen and I collected and analyzed all available past surveys of clam populations in Bar Harbor, compiling recommendations for monitoring methods to make data collection more efficient and the results more generally useful. This study focused on a power analysis to determine minimum sample sizes required to detect differences of size distribution and density in populations (recommendations from that report are included in Appendix C, the complete report is on the CD associated with this report). Since then the Bar Harbor Marine Resource Committee, the MDI Water Quality Coalition, College of the Atlantic, and the MDI High School, through individual and group efforts, have worked to coordinate and standardize clam censuses and have particularly focused on Hadley Point (Table 1; selections in Fig. 1). The surveys have been aligned with many of the recommendations made in our 2003 report and the town Marine Resources Committee has used the results to evaluate and justify the continuation of their use of conservation closures to the town council. The data we have collected has

greatly increased our site-specific information and improved our capacity for analysis. Also, sample sizes have been more consistently high as participants have grown familiar and proficient with sampling methods. Assuming that the variation in size frequency distributions remains similar to previous samples, the replication in recent surveys of Hadley Point is more than sufficient to detect a 0.5 inch difference in average size of clams. Classes from COA and the MDIHS have established a regular sampling schedule, ensuring to a greater degree that both sides of Hadley Point are surveyed semi-annually.

Analysis of clam flat censuses

Reasonably reliable data from the east side of Hadley Point dates back seven years. Over this time it is evident from the surveys that average size, density, and density of harvestable clams have varied tremendously (Tables 1-3).

From 1999 to 2006, two major trends are apparent in the data. The 1999 survey of the east side found close to 10 clams per plot with a predominance of larger, legally harvestable clams (Table 2). By 2003 densities had dropped dramatically. By fall 2005 there had been a very obvious recruitment event, contributing to the highest densities ever recorded at either site. Although the abundances have decreased since then, they remain higher than pre-2005 levels. These more recent numbers reflect the survival and growth of the 2005 year-class and probably include more recent recruits.

Table 1. Summary table of all clam-census data considered in this document. Site = locations of collection. Collected by indicates the group and supervisor for a given survey. Capital letters represent groups or student classes involved. COA- College of the Atlantic, MDIHS – Mount Desert Island High School, MDIWQC – Mount Desert Island Water Quality Coalition, BHMRC – Bar Harbor Marine Resource Committee. FEDA, ENH, and MB refer to COA classes Field Ecology and Data Analysis, Ecology and Natural History, and Marine Biology, respectively. Status – whether the census area was open or closed to clam harvesting at the time of the census.

Site	Date	Collected by:	Status	# Quadrats	Total # soft-shells
Hadley Point East	10/6/2006	COA-Chris Petersen-FEDA	closed	40	1192
Hadley Point West	9/28/2006	MDIHS-MDIWQC-COA	open	38	153
Hadley Point West	10/3/2006	COA-Steve Ressell-ENH	open	17	330
Hadley Point East	4/26/2006	COA-Chris Petersen-MB	closed	33	631
Hadley Point West	5/2/2006	MDIHS-MDIWQC-COA	open	64	665
Hadley Point East	9/17/2005	COA-Chris Petersen-MB	closed	31	1293
Hadley Point West	9/17/2005	COA-Chris Petersen-MB	open	20	584
Hadley Point West	10/24/2003	COA-Chris Petersen-FEDA	seasonally closed	33	24
Hadley Point East	10/24/2003	COA-Chris Petersen-FEDA	seasonally closed	37	34
Hadley Point East--line from past first flat to Salisbury Cove, plots every 100ft.	2001	BHMRC-Jane Disney	closed	30	268
Hadley Point East--line from past first flat to Salisbury Cove, plots every 100ft.	2000	MDIHS-Jane Disney	closed	58	154
Hadley Point East--line from past first flat to Salisbury Cove, plots every 100ft.	10/1/1999	MDIHS-Jane Disney	open	71	510
Hadley Point East	7/8/1999	Jane Disney	open	45	416
Hadley Point East	prob. 1999	BHMRC-Jane Disney	prob. open	71	497
Salisbury Cove	9/26/2000	MDIHS-Jane Disney	closed	11	174
Clark's Cove	5/10/2001	COA-Chris Petersen	open	95	4
Bar Harbor Bar	5/1/2003	MDIHS-Jane Disney	closed	41	57

The first comprehensive surveys for the west side are from 2003, but the patterns since are similar to those of the east side. Low densities in the fall of 2003 were followed by the highest densities ever observed in the fall of 2005 (Table 2). Spring of 2006 showed a marked decrease in density while maintaining levels higher than in 2003, with a further decrease in the fall of 2006. However, a more selective sampling in fall of 2006 showed much higher density than the previous spring (Table 2, Fig. 3)

Although it can be difficult to compare densities at a site through time due to the difference in sampling locations, number of replications, and method used to decide where to collect samples, some patterns appear to emerge between the west and east sites. Relative to the east side, the west side did not appear to experience as massive a recruitment event in 2005, with 29.2 clams/plot found on the west side compared with 41.7 clams/plot for the east side. In addition, the west side appeared to have a more precipitous drop-off in density after the major recruitment event of fall 2005 and did not seem to rebound as much after the 2006 summer recruitment season.

There can be several different reasons for the differences between sites. Not only do the sites differ in terms of their physical environments, but also the west side has been open to clamming, which could affect differences either through removal of legal size clams, or through disturbance directly or indirectly causing mortality of undersize clams. While these are obvious possible causes for the different clam density patterns found on either side of the point, we cannot yet determine the relative importance of any of these factors.

The estimate of density for a site during a season appears to be highly dependent on how the sampling is done. In the fall of 2006, two samples were taken on the east side, one large sample and a much smaller sample that focused on known clam habitat (Table 1). These samples showed a large difference in the estimated density of clams (Fig. 3), and using the surveys would result in very different conclusions about the survivorship of clams at this site.

Table 2. Clam density from selected censuses at Hadley Point. All densities are reported as number of clams per sampling unit (1 by 2 foot rectangle). East and West refer to the two census areas at Hadley Point. SD = standard deviation. Legal/plot = Number of clams ≥ 2 inches per plot. n = number of plots. For additional details on each census, see Table 1

Hadley Point	West					East				
Season	Density/plot	SD	Legal/plot	SD	*n*	Density/plot	SD	Legal/plot	SD	*n*
Fall 2006	**4.03**	7.95	**0.55**	1.20	*38*	**29.8**	41.81	**1.53**	2.91	*40*
	17.81	20.64	**2.25**	6.66	*16*					
Spring 2006	**10.39**	21.28	**0.95**	1.49	*64*	**17**	27.39	**0.31**	0.59	*32*
Fall 2005	**29.2**	52.37	**0.35**	0.75	*20*	**41.71**	82.44	**0.45**	0.96	*31*
Fall 2003	**0.73**	1.23	**0.48**	1.00	*33*	**0.92**	1.59	**0.65**	1.42	*37*
Summer 1999						**9.24**	13.57	**4.31**	6.46	*45*

Size distribution of clams at Hadley point

The early censuses from 1999 and 2003 showed an average clam size of approximately 2 inches (Table 3). By the fall of 2005 this pattern had changed; there were a large number of very small clams on both the east and west sides of Hadley Point. This apparent recruitment event from the summer of 2005 led to a very large number of clams in the smallest size classes, with the average clam size for both sides falling below 1 inch.

Since the 2005 recruitment event, the average size of clams on both the west and east side has increased steadily. To estimate growth, we have used size frequency distributions as a proxy, following peaks of distinct size classes as they grow to larger size categories. Samples taken from fall to spring indicated significant growth during the winter on both sides, contrary to results from other locations where virtually all clam growth occurs during the summer months (B. Beal pers. comm.; Beal *et al*. 2001, others reviewed in same). On the west side of Hadley Point the length of clams increased similarly over the 2005-06 winter compared with the 2006 summer season. On the east side, there actually appeared to be greater growth over winter compared to summer. All of these growth estimates assume that the 2005 cohort was being followed, and that changes in the peak size distribution were caused by the growth of this cohort. These growth estimates also assume that the mortality to undersized clams does not disproportionately affect larger individuals, an assumption supported by the literature as previously discussed. Although the average size of clams has continued to increase over the last two censuses, it is still much smaller than the average size from 2003 census data.

Table 3. Average clam size (length in inches) for selected surveys from Hadley Point. SD = Standard deviation. n = number of clams. For additional details on each census, see Table 1.

Hadley Point	West side			East Side		
Season	Ave.size	SD	*n*	Ave. size	SD	*n*
Fall 2006	**1.32**	0.45	*153*	**1.25**	0.40	*1191*
	1.20	0.37	*330*			
Spring 2006	**1.08**	0.53	*665*	**1.16**	0.31	*631*
Fall 2005	**0.80**	0.30	*584*	**0.89**	0.34	*1293*
Fall 2003	**2.10**	0.52	*24*	**2.14**	0.61	*34*
Summer 1999				**1.76**	0.46	*416*

Density of legal size clams

There are several patterns in the density of legal-sized clams ($\geq$ 2 inches) both over time and between the east and west sides of Hadley Point. On the east side, there was a huge decline between 1999 and 2003 that mirrors the decrease in overall density during this time. These legal-size densities remained low after 2003, and even after the recruitment event in 2005, the pattern did not change until the fall of 2006, when it appears that some of the recruits from 2005 attained 2 inches in length (Fig. 2). The fall 2006 census on the east side showed clam sizes distributed around a peak of approximately 1-1.5 inches, with some clams from this distribution beginning to reach 2 inches. At the rate that clams appear to be growing, we expect a large number of clams to attain legal size within the next 1-3 years on the east side of Hadley Point.

On the west side of Hadley Point, the pattern of legal-sized clams over time shows a relatively constant and low density of legal sized clams for all censuses. Without a census pre-2003 it is impossible to know if the high density of harvestable clams in 1999 on the east side was mirrored on the west side, but in 2003 the number of legal-sized clams was approximately only 0.5 per census plot (2 square feet). The west side has not shown the net increase in legal-sized clams found on the east side. One possibility is that clams are being harvested from this side at approximately the same rate that smaller individuals achieve legal size.

There has been some concern that a recent mussel aquaculture lease off the west side of Hadley Point may affect clam recruitment, growth, and mortality. If the lease is having an adverse effect on the clam populations of nearby flats, we would expect to find reduced or no recruitment when compared to past patterns or unaffected flats, and individuals exhibiting anything from decreased growth across all size classes to increased mortality rates due to limited food or increased sedimentation. While we do not yet have a history of growth to compare current rates against, no change in trends of other factors has been apparent since the lease site was established.

The potential effect of the east side closure

The east side closure appears to have helped protect legal and undersize clams, with higher densities and lower mortality than seen on the west side (Fig. 1). The increase in legal-sized clams on the east side compared to the west while the closure has been in place is the most obvious difference that could be attributed to the closure. However, the sites do differ, and until these results are reversed with a reversal of closures, we cannot rule out other causes that are currently not controlled for with this single closed-site methodology. The results are suggestive, but not conclusive.

Other resource extraction activities such as mussel, seaweed, and worm harvesting have not been affected by the closure. Worming continues actively, and there was extensive worming on the east side during the surveys in the fall of 2005 and of 2006, therefore any differences between sites is not due to changes in the harvest of other species. In addition, the harvesting that does occur at Hadley Point for other species does not appear to have the potential for a large impact. At the east side of Hadley Point worming occurs lower in the intertidal than does clamming in areas of low clam density where sediment sizes are smaller and the habitat less conducive to clams.

Recommendations

Current management plans for Hadley Point

The current management plan for Hadley Point is to open the east side as of 1 July 2007, and to close the west side 1 January 2008. This schedule was set with the idea of maintaining an open area of Hadley Point for harvest while keeping part protected for the conservation of the resource and allowing populations to rebound in the absence of harvesting.

Two likely options exist for closure patterns at Hadley Point. These options include having both sides open and close independently based on current population sizes and abundances meeting the recommended benchmarks for opening a flat, or a timed rotation

of closure between the two sides, the current strategy. The current strategy is supported by success in other fisheries. Pfister and Bradbury (1996) describe a system of rotated geographic harvesting areas for the red urchin, *Strongylocentrotus franciscanus* in the northeast Pacific (Washington State). Their simulations predict that a rotational model is less likely to decrease populations to unsustainable levels than a "yearly fishery," though the yearly fishery would have higher yields.

The recommended condition to open a closed area is when the proportion of legal-sized clams reaches at least 50% of the total clam population at a site (H. Annis, DMR, pers. comm.). Given this criterion, the east-side closure should continue for at least one additional year, contingent on the current pattern of growth and survival continuing into the future.

However, there are several reasons to consider maintaining the current schedule of conservation closures and reopening the east side in July of 2007. The west side has a relatively high density of undersized clams, so closing this area on schedule may allow densities and average size of clams to rebound more quickly in this area. With continued monitoring, this reversal will also help us to better understand the effects of closure. Currently it appears that clams within the conservation area are surviving better than clams on the east side. By reversing conservation closures, it should be possible to decouple the effect of geographic area and conservation status.

Second, the east side is a larger area, so when it is opened it is likely to be able to maintain a given harvesting level for longer than the west side. Given the desire of the town to keep at least one side open, we believe that the east side should be open at least as long if not longer than the west side, due to its greater area and potentially better clam habitat. Another consideration is that the site may be able to be maintained as a public use area with harvesting for a longer period if it is opened when densities of legal-sized clams are still relatively low. If the east side is only opened after half of the clams there reach legal size, the predicted densities of legal clams will be extremely high and the potential exists for a boom and bust exploitation cycle, with large numbers of individuals

or a few individuals with consistent effort removing most of the clams quickly. If opened at lower levels, harvesting effort will likely persist as recreational. Given these considerations, I would recommend synchronizing the opening and closing of the two sides of Hadley Point in the future.

Allocation of future effort:

1. Continued surveying at Hadley Point

I recommend that the first priority of effort be to maintain a census presence and effort at Hadley Point. There are a number of options for censusing clams, each decision with trade-offs in the information attained, which is summarized below.

The first question concerning censusing is their spatial and temporal extent. Concentrating surveys on known clam habitat can give a more accurate estimate of how the population is changing through time in areas most likely to be dug but does less to show how clams are distributed across a flat. Similarly, surveying a defined area allows effort to be focused for greater insight into the population at that location, while surveying several areas in a flat provides a broader picture with less detail. Other options include surveying the same site every time or moving around; and whether to focus on a particular habitat or sediment type. Since the focus of conservation effort by the Bar Harbor Marine Resources Committee and the majority of surveys have been at Hadley Point, continuing to survey this area has great potential to yield understanding of growth rates and the effects of the current system of conservation closures. It may be possible to fine-tune the current system to best fit the populations at Hadley Point.

Estimates of density and size-distribution require different levels of replication to achieve strong support for differences between populations (2003 recommendations in Appendix C, full report attached on CD) Size-distribution requires as few as 30 clams to show the relatively small difference in average size of 0.5 inches, while to see a difference in density of 1 clam per 2 square feet (1 plot) takes close to 100 plots given the variation found in the surveys of 2003. Therefore, to see differences in density we must either

increase our sample sizes or decrease the variation we find. Since 100 plots would hardly fit on most flats in Bar Harbor and would require a huge investment of effort, the second option, of focusing on changes in smaller areas with less variation in density is preferable. Based on these tradeoffs, **we recommend that areas to be surveyed at Hadley Point for density should be permanent and clearly defined** and efforts should concentrate first on areas with known harvestable clam populations to reduce variation,. This reduces the need to split surveys in future analyses, giving higher and more meaningful replication on which to base density estimates.

To ensure adequate replication on which to base size-distribution estimates, surveys should collect no fewer than 30 clams, preferably more. If these clams are not collected in standard plots, additional digging should be done to gather a minimum number of clams and this should be clearly indicated on the data sheets to make sure that these data are not included in density analyses. Although these measurements are used for different aspects of population biology, to compare areas' average size and distribution of sizes appears to give much more information than density alone.

Future surveys should use a standard datasheet (included on attached CD) to give best comparative capabilities and provide more consistent information.

At Hadley Point, surveys can focus on answering several questions that will aid in management of the clam resource, including the effects of conservation closures and a site-specific growth rate estimate.

Closures to clamming may have a number of effects on the resource, or may have no discernable effect at all. One primary reason for enacting a closure is to allow densities of legal sized clams to increase to populations that provide opportunities for subsistence, recreational, or commercial digging. By eliminating all clam harvesting, a closure can reduce the direct damage to all legal and undersize clams. A closure can also reduce or eliminate indirect mortality of legal and undersized clams due to increased exposure to weather, exposure to predators, or sedimentation caused by the disturbance of individuals

or the substrate. Given these effects, a closure can help maintain adult population densities for successful reproduction and provide young for recruitment, even possible self-recruitment. Another effect from a closure may also be to simply allow a less disturbed, more natural soft-bottom assemblage of organisms to exist.

Right now, we do not have a clear understanding of or evidence for the effects of the conservation closure at Hadley Point. In order to achieve these, it is necessary to continue to survey both sides after the reversal of current closures. Besides providing information on Hadley Point, the results will be more generally useful; although the effects of closures have been examined in other communities, there has not been much done in soft-bottom areas, and this will contribute to our understanding of the role of closures in this kind of system. **The Marine Resources Committee should make it a priority to maintain surveying at both sides of Hadley Point at least once a year for the best insight into the effects of closures.**

2. Studies of clam population biology

Growth rates of individuals are valuable information for managing a resource, particularly the length of time it takes individuals to reach a harvestable size. This information can help managers determine the periodicity of closures and the effects of closures on growth rates. As previously discussed, growth is a site-specific parameter that can be difficult to assess in clams. From previous surveys, we can achieve an indirect measure of growth rate through changes in size distributions of clams at a site through time, but there is still a need to verify these estimates by following individual growth rates through time. Options are available to more accurately measure growth rate at a site which include to measure and mark individuals and recapture them at a later date, either by labeling individuals and recording measurements or coloring the existing shell edge of clams to ascertain later shell deposition. Another strategy is to introduce hatchery-reared clams, which have distinct growth patterns, and to measure new growth. **To continue using size distributions as a proxy measure of growth, the Marine Resources Committee should survey the areas of interest twice a year.**

3. Extending effort to other town clam flats

There has been substantial effort devoted in the last several years to the clam censuses, and if this continues, there is likely to be enough effort to survey other sites in Bar Harbor in addition to Hadley Point. Several possibilities head this list in their potential to assist the Marine Resources Committee in comprehensive management, such as a broader, less intense survey to identify all potential sites in Bar Harbor, a new survey of Salisbury Cove, and surveying the area from Hadley Point to the narrows by the bridge. Any of these locations would benefit clam management at the town level.

4. Experimental enhancement of clam populations

Although past efforts at improving clam populations with netting did not appear to be successful, this and other options for enhancing clam flats still exist. Other options for the town to experiment with are to close an area and reseed it, to practice a method of enhancing wild seed set such as brushing a flat, or to use areas closed for health reasons like the Bar Harbor Bar as an experimental source for outplanting clams. The west side of Hadley point starting in January 2008 will be an excellent site for such experimental planting since it will be maintained as a closed area for over two years.

5. Increased public education

It may also be worth effort by the committee to find ways to increase awareness of the resource, either through the literature provided by the town office to licensees, or through more general education. A key concept is that of replanting clams from overturned sediments oriented with their siphons up. Particularly when placed in fine sediment, this makes it easier for small clams to rebury, making them less susceptible to other sources of mortality (Pfitzenmeyer and Drobeck 1963).

Summary

The Marine Resource Committee of Bar Harbor, currently headed by Dr. Jane Disney, has assembled a group of concerned citizens, scientists, and students that have put hundreds of hours of effort per year into monitoring and conserving clam flats in Bar Harbor. By putting all of the information they have gathered in one place and in one accessible form, we hope to make this effort more useful to resource managers and interested citizens. We hope that our recommendations will increase both the efficiency of data collection and the value of information gained from future efforts by the Marine Resource Committee and its citizen partners.

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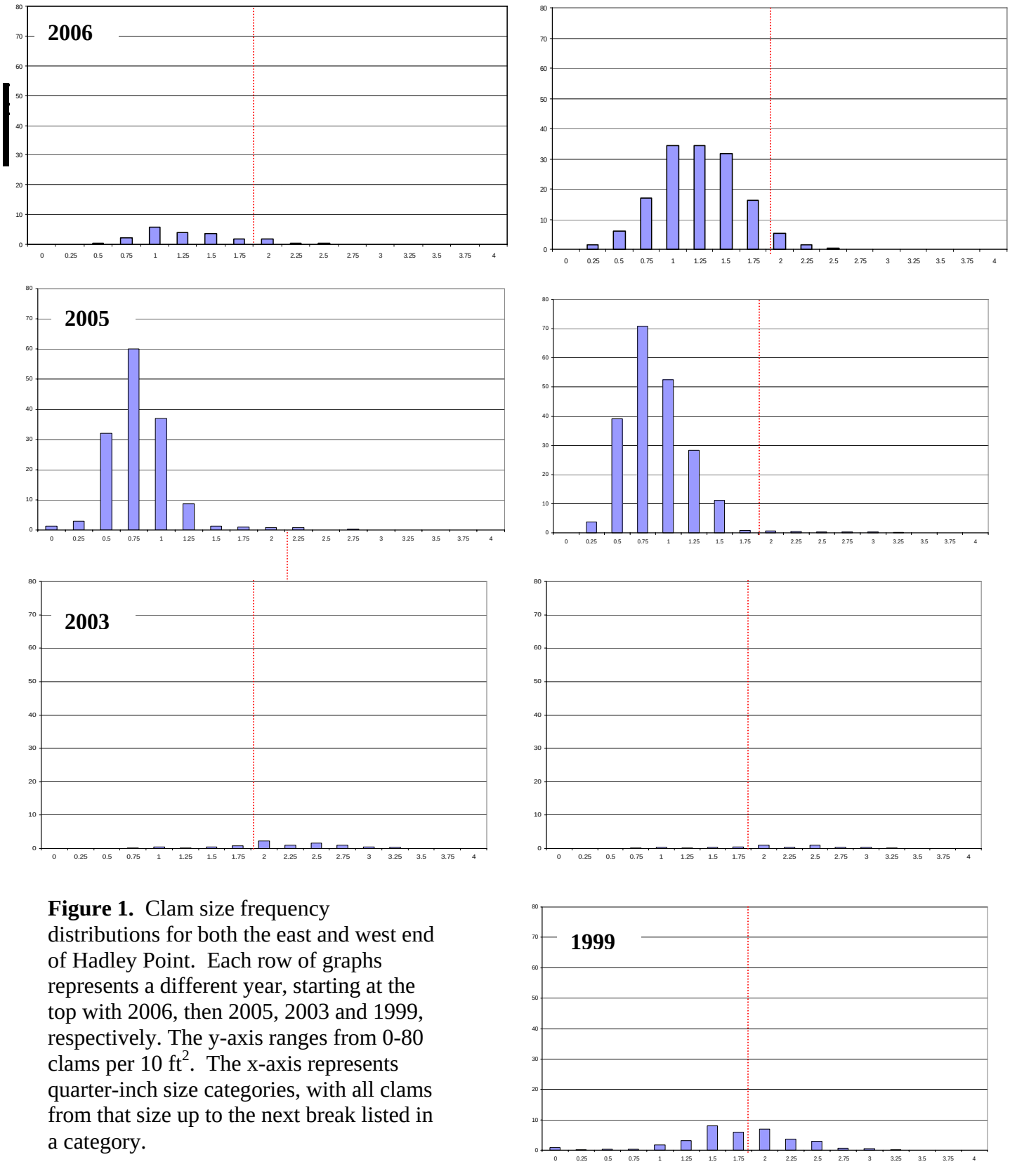


Figure 1. Clam size frequency distributions for both the east and west end of Hadley Point. Each row of graphs represents a different year, starting at the top with 2006, then 2005, 2003 and 1999, respectively. The y-axis ranges from 0-80 clams per 10 ft^2. The x-axis represents quarter-inch size categories, with all clams from that size up to the next break listed in a category.

Hadley Point East

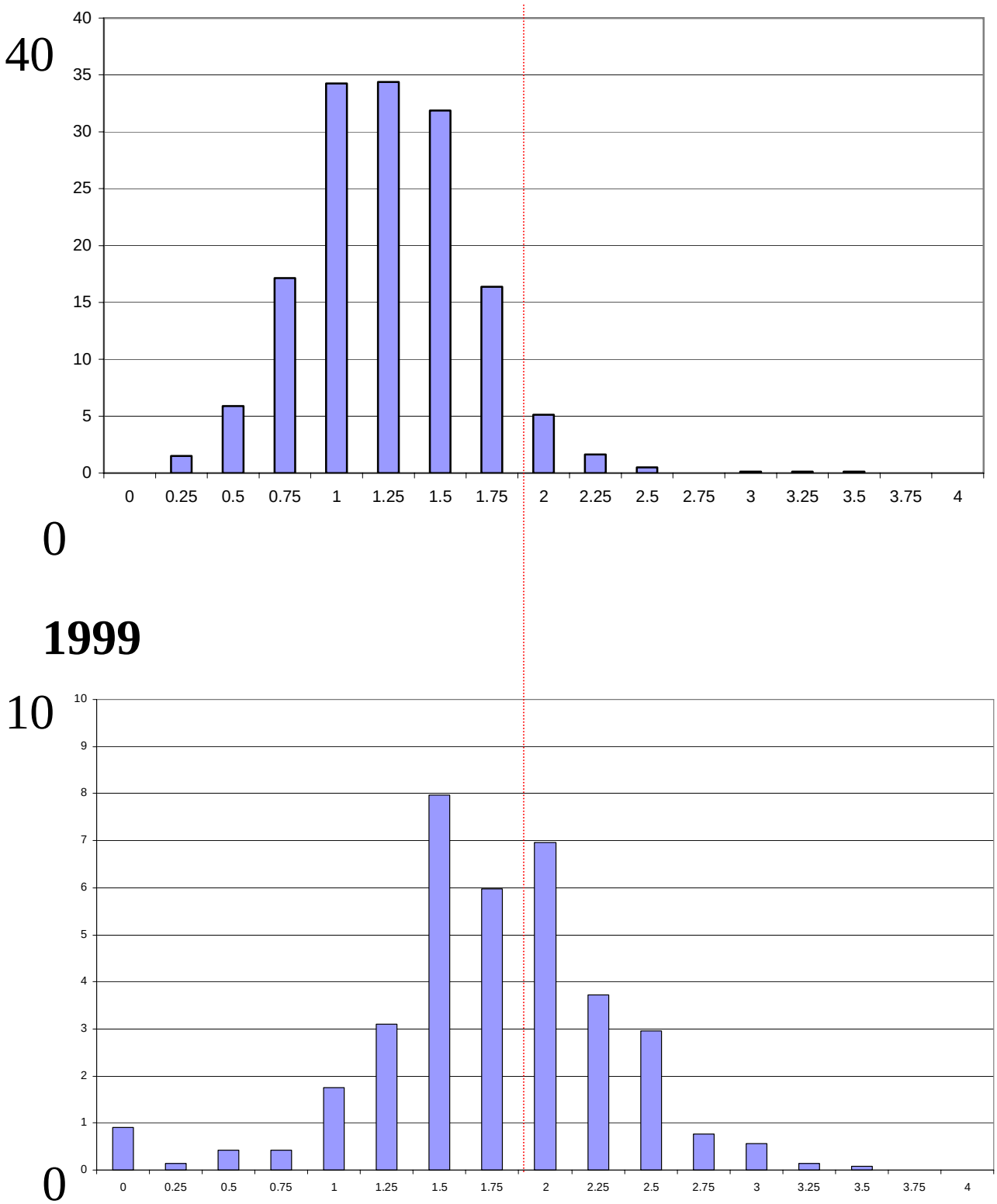
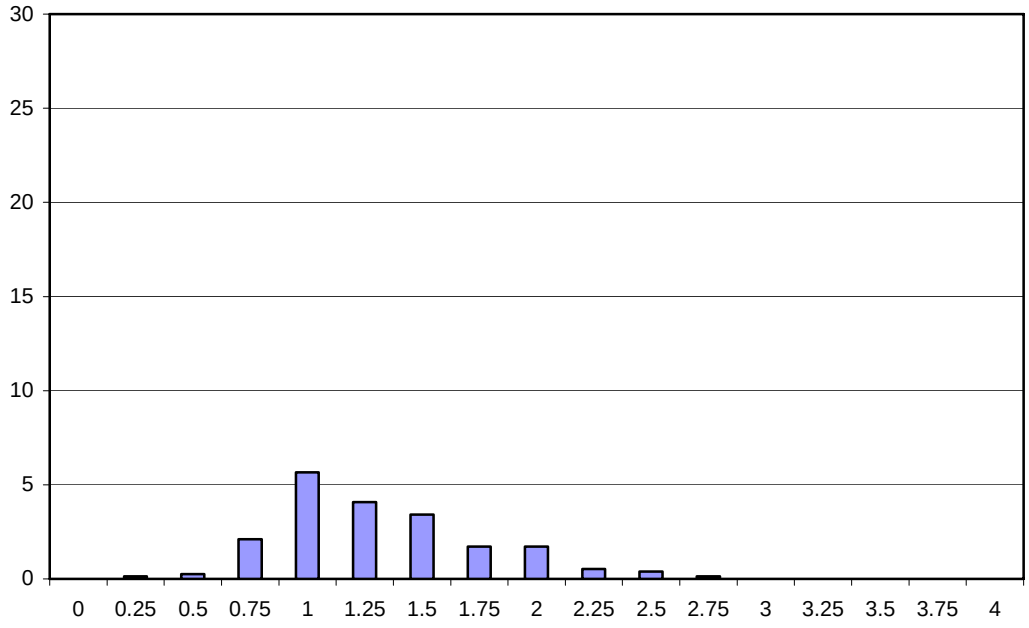
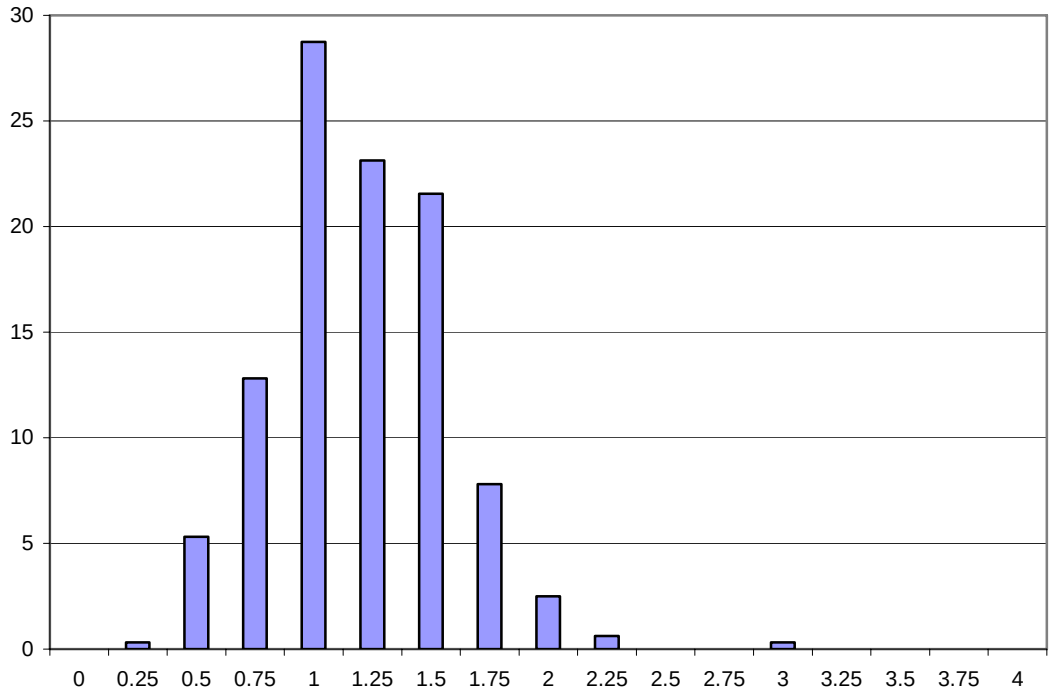


Figure 2. Clam size frequency distributions in 1999 and 2006 at Hadley Point. Note that the y-axis of the two graphs are not to scale, the upper graph has significantly greater density. The dotted line represents the size that clams are legal to harvest (2incles). All other details are identical to Figure 1**.**



Random sample



Selective sample

Figure 3. Size-frequency distribution from two sampling dates in 2006 from Hadley Point West. The upper sample was collected over a wide area within the census area, the lower sample was restricted to an area where clams have historically been at higher densities. Note that although size frequencies are similar, the density estimates were very different. Other axis information is identical to Figure 1.

Appendix A: Current shellfish ordinance; referenced minutes of the Bar Harbor Marine Resources Committee

Adopted: November 16, 1999 Effective: December 16, 1999

Shellfish Ordinance Amendment

To expand the mission of the Shellfish Committee

Town of Bar Harbor

Ordinance•# 7-9906

The Town of Bar Harbor hereby ordains that Chapter 7 - Licenses and Business Regulation, Section 07.02 Shellfish Conservation Ordinance - of the Town of Bar Harbor Code is amended as follows:

SECTION 07.02 Shellfish Conservation

07.02.01 Authority

This Ordinance is enacted in accordance with 12 M.R.S.A. Section 6671.

07.02.02 Purpose

To establish a shellfish conservation program for the Town of Bar Harbor that will insure the protection and optimum utilization of shellfish resources within its limits. These goals will be achieved by means including:

- licensing;
- limiting the number of shellfish harvesters;
- restricting the time and area where digging is permitted;
- limiting the minimum size of clams taken;
- limiting the amount of clams taken daily by a harvester.

07.02.03 Marine Resources Committee

The Shellfish Conservation Program for the Town of Bar Harbor will be administered by the Marine Resources Committee, consisting of seven(7) members to be appointed by the Town Council for terms of three(3) years.

07.02.03.01 Committee's Responsibilities

The Committee's responsibilities include:

07.02.03.01.01

Establishing annually, in conjunction with the Maine Department of Marine Resources, the number of shellfish digging licenses to be issued:

07.02.03.01.02

Surveying each clam producing area at least once each three (3) years to establish size distribution and density and annually to estimate the status of the Town's shellfish resources;

07.02.03.01.03
Submitting to the Town Council proposals for the expenditures of funds for the purpose of shellfish conservation;

07.02.03.01.04
Keeping this ordinance under review and making recommendations for its amendments;

07.02.03.01.05
Securing and maintaining records of shellfish harvest from the Town's managed shellfish areas and closed areas that are conditionally opened by the Department of Marine Resources;

07.02.03.01.06
Recommending conservation closures and openings to the Town Council in conjunction with the area biologists of the Department of Marine Resources;

07.02.03.01.07
Submitting an annual report to the municipality and the Department of Marine Resources covering the above topics and all other Committee activities.

07.02.03.01.08
Submitting to the town Council proposals for ordinances that affect land use in areas where shellfish beds will be impacted.

07.02.03.01.09
Submitting to the town Council proposals for ordinances that affect water use in areas where shellfish beds will be impacted.

07.02.03.01.10
Supporting water quality monitoring efforts by local citizen and school groups that are working with the Maine Department of Marine Resources in areas where shellfish beds are located. This includes but is not restricted:

- Assisting with selection of monitoring sites,
- Attending training sessions,
- Participating in water sample collection,
- Assisting with watershed surveys,
    - Submitting to the Town Council proposals for the expenditures of funds for the purpose of
      addressing water quality related issues,
- Working with the Conservation Committee to evaluate water quality data, and

- Making recommendations to the Town Council for changes in land or water use practices
  that are impacting shellfish beds.

07.02.04 Definitions

Resident: a person who has been domiciled in this municipality for at least three (3) months immediately prior to the time his/her claim of such residence is made.

Nonresident: anyone not qualified as a resident under this ordinance.

Shellfish, Clams and Intertidal Shellfish Resources: softshell clams, *Mya arenaria.*

07.02.05 Licensing

07.02.05.01 Generally

07.02.05.01.01 License Required

It is unlawful for any person to dig or take shellfish from this municipality without having a current license issued by this municipality as provided by this ordinance.

07.02.05.01.02 License Fees Waived

Resident recreational shellfish license fees will be waived for residents over sixty-five (65) and under sixteen (16) years of age.

07.02.05.01.03 State Commercial License

A commercial shellfish harvester must have a valid Commercial Shellfish License issued by the Maine Department of Marine Resources. This license does not need to be purchased prior to purchase of the Town license.

07.02.05.02 Designation, Scope and Qualifications

07.02.05.02.01 Resident Commercial Shellfish License

The license is available to residents of the Town of Bar Harbor, and it entitles the holder to dig, take or possess any amount of shellfish from the shores and flats of this municipality.

07.02.05.02.02 Nonresident Commercial Shellfish License

The license is available to nonresidents of this municipality. It entitles the holder to dig, take, or possess any amount of shellfish from the shores and flats of this municipality.

07.02.05.02.03 Resident Recreational Shellfish License

The license is available to residents and real estate taxpayers of this municipality and reciprocating municipalities. It entitles the holder to dig, take or possess no more than one (1) peck of shellfish in any one (1) day for personal use. This license is not available nor valid, to holders of a Maine Commercial Shellfish License.

07.02.05.02.04 Nonresident Recreational Shellfish License

The license is available to any person not a resident of this municipality. It entitles the holder to dig, take or possess not more than one (1) peck of shellfish in any one (1) day for personal use. This license is not available, nor valid, to holders of a Maine Commercial Shellfish License.

07.02.05.02.05 License Must be Signed
The licensee must sign the license to make it valid.

07.02.05.03 Application Procedure
Any person may apply to the Town Clerk, on a form provided by the municipality, for the licenses required by this ordinance.

07.02.05.03.01 Contents of the Application
The application must be in the form of an affidavit and must contain the applicant's name, current address, birth date, height, weight, signature and any other information the municipality may require.

07.02.05.03.02 Misrepresentation
Any person who gives false information on a license application will cause said license to become invalid.

07.02.05.04 Fees
Fees for the various classifications of licenses shall be established by the Town Council from time to time. License fees must accompany in full an application for any license. The Town Clerk shall transfer all fees received to the Town Treasurer. Fees received for shellfish licensing shall be used by the Town for shellfish management, conservation and enforcement. Fifty cents ($.50) may be retained by the Town Clerk's office, or a designated agent, at point of purchase.

07.02.05.05 Limitation of Diggers
Because the shellfish resources are limited and a commercial or recreational digger can be expected to harvest a certain volume of clams per year, the number of diggers must be controlled. This number will vary from year to year depending upon estimates of the resource capabilities and management requirements consistent with good resource utilization. The following procedures will be followed to exercise the control:

07.02.05.05.01 Number of Licenses Established
Prior to May first, the Town Shellfish Conservation Committee, with the approval of the Maine Commissioner of Marine Resources, will establish the number of commercial and recreational licenses to be permitted following the requirements of 12 M.R.S.A. Section 6671(3-A).

07.02.05.05.02 Notice to Town Clerk
Prior to June first the Town Shellfish Conservation Committee will notify the Town Clerk in writing of the number of licenses to be issued.

07.02.05.05.03 Public Notice

Not less than ten (10) days prior to the period of issuance, notice of the number of licenses to be issued and the procedure for application shall be published in a trade or industry publication, or in a newspaper or combination of newspapers with general circulation, effective in reaching persons affected. Notice shall also be posted in the municipal offices until the period of issuance concludes.

07.02.05.05.04 Dates of Issuance

The Town Clerk shall issue licenses to residents and nonresidents as allocated from the first day of July until the twenty-eighth day of September, after which licenses shall be issued to residents and nonresidents on a first come, first served basis.

07.02.05.06 License Expiration Date

Each license issued under the authority of this ordinance expires at midnight on the thirtieth day of June following the date of issue.

07.02.05.07 Suspension

Any shellfish licensee having three (3) convictions for a violation of this ordinance shall have his/her shellfish license automatically suspended for a period of thirty (30) days.

07.02.05.07.01 **Reapplication**

A licensee whose shellfish license has been suspended pursuant to this ordinance may reapply for a license only after the suspension period has expired.

07.02.05.07.02 **Effective Date of Suspension**

The suspension shall be effective from the date of mailing of a notice of suspension by the Town Clerk to the licensee.

07.02.06 Opening and Closing of Flats

The Town Council, upon the approval of the Maine Commissioner of Marine Resources, may open and close areas for shellfish harvest. Upon recommendation of the Shellfish Conservation Committee and concurrence by the Maine Department of Marine Resources area biologist that the status of the shellfish resource and other factors bearing on sound management indicate that an area should be opened or closed, the Town Council may call a public hearing on ten (10) day's notice published in a newspaper having general circulation in the Town, stating the time, place and subject matter of the hearing, and shall send a copy of the notice to the Department of Marine Resources. The decision of the Town Council made after the hearing shall be based on findings of fact.

07.02.07 Limitation on Clams to be Taken

07.02.07.01 Definitions

Lot: the total number of softshell clams in any bulk pile. Where softshell clams are in a box,

barrel or other container, the contents of each box, barrel or other container constitutes a separate
lot.

Possess: dig, take, harvest, ship, transport, hold, buy and sell, retail or wholesale, softshell clam shellstock.

07.02.07.02 **Tolerance**

Any person may possess softshell clams that are less than two inches (2") if they comprise less than ten percent (10%) of any lot. The tolerance shall be determined by numerical count of not less than one (1) peck nor more than four (4) pecks taken at random from various parts of the lot or by a count of the entire lot if it contains less than one (1) peck.

07.02.08 Penalty

A person who violates this ordinance shall be punished as provided by 12 M.R.S.A. Section 6671(6-AandlO).

07.02.09 Effective Date

This ordinance, which has been approved by the Maine Commissioner of Marine Resources, shall become effective after its adoption by the municipality, provided a certified copy of this ordinance is filed with the Commissioner within 20 days of its adoption.

07.02.10 Separability

If any section, subsection, sentence or part of this ordinance is for any reason held to be invalid or unconstitutional, such decision shall not affect the validity of the remaining portions of this ordinance.

07.02.11 Repeal

Any ordinance regulating the harvesting or conservation of shellfish in the Town and any provisions of any other Town ordinance which are inconsistent with this ordinance are hereby repealed.

Legislative History:

Amended:	February 3, 1998
Effective:	March 4, 1998
Changes Proposed:	September 7, 1999
Adopted by Council:	November 16, 1999
Sent to MOMR:	October 11, 1999

Minutes of the Bar Harbor Marine Resources Committee referred to in text.

3 February 1998. Bar Harbor Shellfish Ordinance adopted. Effective 4 March 1998.
15 September 1999. There was a general discussion of how far to close the Hadley Point area [east side]…a planned survey by Jane [Disney]'s students will provide information.

17 November 1999. Dave Clifford shared with us a letter from Paul Anderson, Director of Shellfish Sanitation, permitting the clamflat closure at Hadley Point.

15 December 1999. There was a general discussion of the passage of the Hadley Point closure by the Town Council.

18 October 2000. Ecstension of conservation closure by one year at Hadleys Point…was prepared for town council's approval. Survey of Hadleys Point to state closed area [Salisbury Cove due to overboard discharges] was completed.

20 December 2000. Update of closure recommendation: Council approved closure…on the last survey the quantity of clams found decreased. The hypothesis being that the survey plot location may have differed.

10 October 2001. [Letter to Dana Reed] On September 26, 2001, the Marine Resources Committee conducted a clam survey at Hadley Point to determine if the clams in the closed area had reached legal market size in sufficient quantities to allow the area to be opened for digging. The survey conclusions indicate that there was a sufficient increase in the size of the clams in the area to justify reopening the flats. The Marine Resources Committee has unanimously decided to recommend that the area from Hadley Point ot Salisbury Cove be reopened to soft shell clam harvesting on July1, 2002, which will necessitate a six month extension on the current closure. The reason for the extension is to allow the clams in the closure to attain maximum market value.

17 October 2001. Continued discussion on spate collection: …It was agreed to put mesh in…Northeast Creek, Hadleys Point, the Bar, and Clarks Cove. …the extension was approved with no problems.

20 February 2002. Number of clams that may be harvested from the now closed area when it opens July 1, 02: Recreational diggers: 1 peck. Resident commercial diggers: 1 bushel. Vote 6/0.

20 November 2002. It was moved…and seconded…to close the clam flats from Hadleys Point to Salisbury Cove. Said closure to be in force from January 1st to June 30th annually, for conservation purposes. Vote 7/0.

15 December 2004. It was moved…and seconded…to close the right [east] side of Hadleys Point until July 2007, the left [west] side form January 1, 2008 until July 1, 2010, and limit commercial diggers to one bushel per day in the conservation areas. Vote 6/0.

Appendix B: Current practice for clam population censuses, adapted from *The Maine Clam Handbook* (Ellis 1998).

Samples are located on a staked grid at 50 foot intervals. Each plot is assigned an identification number, and included on a site map for future reference. GPS coordinates are taken for each plot. Each plot is 1 x 2 feet in area, and dug as deeply as practical. If the area at the stake is impossible to dig (rock, standing water, etc.), then the nearest available location is selected, and the GPS coordinates are recorded for this location. All live clams are removed from the plot area, and are measured across the longest part of the shell. The length is recorded as a hash mark in the appropriate size category on the data sheet. Size is rounded down to the nearest quarter inch; thus, a clam that is almost but not quite 2 ¼ inches is recorded as a 2 inch clam. If a clam is killed, its length is still recorded as a live clam. Dead shells found with both valves intact are measured and recorded as dead clams. Other species such as *Mercenaria mercenaria* (quahogs) are recorded separately. After all individuals have been removed, digging depth is estimated and the hole is filled in with the excavated sediments. All clams should be replanted with the siphon oriented up. Separate data sheets are used for each plot. In addition to these data, the date, time, general location, and names of individuals collecting the data are included on every data sheet. A standard data sheet is included on the attached CD.

Appendix C: Complete 2003 report by Therkildsen and Quinby included on attached CD

2003 Recommendations

We recommend the following to the Bar Harbor Clam Committee:

- The Committee should clearly define regular survey sites, preferably with GPS. This should help eliminate uncertainty over the consistency of survey areas for a given site and remove effects of different areas surveyed on data.

- The Committee should ensure/require that anyone who surveys uses the methods prescribed in The Maine Clam Handbook to make data collection more consistent.

- The Committee should use a standard data sheet (that we will provide) for all surveys to make data collection more consistent. There were many analyses we could not perform when surveys recorded different information.

- The Committee should consider whether management decisions could be based on size frequency data exclusively, because a much smaller sample size is needed for powerful tests for this parameter compared to density data (that has a higher variance)

- The Committee should decide on the effect sizes they consider important, and use the power analyses to set minimum sample sizes for surveys.

- The Committee should always survey an area before they open or close it to digging. Surveys should also be taken no less frequently than one per year following the action, until a time when any effects have leveled out. This is the only way to see if closing flats affects the abundance or relative size distribution of clams, and how long effects last. An example would be surveying the right side of Hadley Point biannually, once towards the end of the seasonal closure (June) and again towards the end of the main digging season in late fall.

- While community outreach is not an express mission of the committee, it has served a valuable function. We do not feel that our recommendations in any way exclude the involvement of community members, but rather will make the data they collect more consistent and valuable to the committee. Our recommendations are to encourage a commitment to consistent minimum effort on the part of the committee, but should not discourage additional effort.