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An Examination of the Georges River Clam Management Program

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AN EXAMINATION OF THE GEORGES RIVER CLAM MANAGEMENT PROGRAM

By

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This thesis examines the Georges River Clam Management Program, a multi-town interlocal harvesting and management plan in mid-coast Maine. It discusses relevant economic and communal action theory, and examines their application to the development of the program.

Chapter 1 reviews the purposes and methods of the study.

Chapter 2 reviews the relevant clam biology necessary to understand the principles of soft-shell clam management.

Chapters 3 and 4 provide the history and background of clam harvesting and management in Maine.

Chapter 5 discusses the Georges River Program, including the factors that led to its development and the details of its organization and scope.

Chapter 6 provides a review of the pertinent literature pertaining to fisheries economics, rational choice theory, externality theory, collective action theory and co-management.

Chapter 7 provides state of Maine landings data obtained from the Department of Marine Resources. It compares catch per unit of effort figures between the Georges River estuary and the state as a whole both prior to and post management.

Chapter 8 discusses how the theories and facts discussed in the previous chapters are relevant to the Georges River Program. In particular, it examines the relevance of co-management theory versus economic theory. It also discusses the program's potential for long-term success, and what lessons can be learned from the program and applied to fisheries management theory in general.

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Chapter 1

INTRODUCTION

The state of Maine allows municipalities to develop soft-shell clam management programs giving preferential harvesting rights to locals. This allows towns to develop management that excludes people from the resource and potentially increases yields for those harvesters with access to the flats.

In 1996, five towns along the Georges River Estuary in mid-coast Maine entered into a multi-town cooperative soft-shell clam harvesting agreement and management program. A two-tiered management regime was established, with a shellfish committee comprised of local harvesters, and a joint board with selectmen from each of the towns. Harvesters must perform conservation activities each year to be eligible for a license. Although surveys are not regularly completed, anecdotal evidence suggests that the management program has been a success by establishing higher than average CPUE and maintaining rather than depleting the resource.

The Georges River program is an example of co-management, which has gained popularity in recent years as an alternative to traditional top-down control. Several co-management authors have developed theories examining the factors that facilitate the development of successful self-governance and co-management. This study examines these theories, and discusses their application to the Georges River program. In particular, the theories of Schlager and Ostrom (1993) are examined, and their concept of property rights in fisheries is discussed.

This study also uses common property and co-management theory to discuss the possible future of the Georges River program, and the lessons it has to offer fisheries management in general.

Chapter 2

CLAM BIOLOGY

Habitat

Mya arenaria, known in Maine as the soft-shell clam or steamer clam, occurs naturally along the coasts of North America, Europe, and Asia. In the United States, it is most common from Maine to Maryland.

Within this range, soft-shell clams live within tidal flats, in water of approximate ocean salinity (30-32 parts per thousand), although they are able to survive great ranges in salinity for short periods of time. They are bottom-dwelling (benthic) bivalves that live within the bottom sediment.

Feeding and Anatomy

The soft-shell clam feeds by projecting a siphon into the water column, where it filters microscopic particles (primarily phytoplankton, but also zooplankton, bacteria, and detritus) out of suspension. Cilia on the gills generate a feeding current, carrying seawater through the inhalant siphon and inhalant chambers. As the water passes by, branched cilia strain out suspended particles as small as 5 microns. The particles are then swept into food grooves and carried toward the mouth by cilia. Food is ground up and partially digested by the action of the crystalline style (a clear, flexible rod within the stomach). Further digestion takes place in the digestive gland, and feces are released at the anus and carried out the exhalant siphon.

Clams are capable of pumping and filtering a large amount of seawater. Clams approximately 25-32 mm long can filter as much as 2.5 liters per hour in the summer (Ellis, 1998). Their ability to filter and digest food varies throughout the year, with the greatest rate of food digestion occurring in summer.

The clam's two elongated valves are joined at the hinge by an interlocking projection and ligament. A live clam regulates the opening and closing of the shell with two adductor muscles. When these muscles are relaxed, the shell is forced open by an elastic pad beneath the hinge. The death of the clam will produce the same result.

Each shell is made up of two calcium carbonate layers and a protective covering. This covering varies in thickness, color, and shape according to the growth rate and the sediment type in which the clam lives. With each period of growth, new material is added to the shell. In winter, the growth period ends, and a thickening of the shell edge occurs. This process results in observable growth lines on the shell. The width of these lines can be used to approximate growth rate, but is not an exact indicator.

Spawning and Setting

Clams are male or female, and spawning is accomplished by releasing sperm or eggs into the water column. A 6.25 cm (2 inch) female may spawn about 3 million eggs a year, and a male of the same size produces billions of sperm (Dow and Wallace, 1961).

Fertilized eggs develop into veliger larvae (named for the velum, which is the swimming appendage). The veliger larva stays suspended in the water for three to six weeks. During this time its movement is controlled primarily by tidal currents and winds.

During its free-swimming period, the larva develops a foot (becoming a pediveliger) with which it is able to crawl about after settling out of the water column. It also develops a shell and most of the organs characteristic of the adult. Even as a pediveliger, the larva is able to swim if the substrate type encountered is unsuitable. Once settled, a clam probes the new substrate with its foot. If the bottom is hard and impenetrable, the clam will retract its foot and swim away. This "swim and crawl" stage allows the pediveliger to delay settlement for up to a week while choosing its eventual home. During this time it is subject to unfavorable winds, storms, and changes to salinity, temperature, currents, and food availability. It is also subject to predation. Because of these factors, and the fact that eventual placement of the clam is largely dependent on currents and winds, only a small percentage of pediveliger larvae survive to settle out within reach of a suitable substrate.

Eventually, the swimming organ degenerates completely, and the clam larva attaches itself to some object (sand grains, seaweed, rocks, etc.) by means of a byssal thread. The thread is similar to that found in the adult mussel, and the clam can now move over the flats, swinging by the byssus and detaching at any time to crawl along the bottom with its foot. When it reaches a suitable location, the young clam burrows into the sediment. If it is dislodged or washed out, it can dig in again. It can also dig its way out of the sediment if conditions become unfavorable and migrate short distances by crawling with its foot. However, the clam is permanently established in its burrow before it is an inch long (Dow and Wallace, 1957). The clam retains its ability to dig into sediment through adulthood, although this ability diminishes with increasing size. The ability to move about while still young can make it difficult to predict future

concentrations of clams in a flat. Samples taken may show high concentrations of spat, while later testing may show a total absence of clams (Stubbs, 1982).

Current patterns and other environmental factors can be very important in larval settlement. Certain flats, or specific areas within them, may exhibit a higher affinity for settlement than others. In Casco Bay, for instance, soft-shell clams generally settle more heavily in northeastern sections of coves and in south-facing flats (Ellis, 1998).

Clam recruitment can vary greatly from year to year, due to numerous factors including low spawning effort, poor current patterns, or high predation. When conditions are favorable and good spawning success leads to numerous larvae that are able to settle out successfully, a dominant year class develops. This dominant year class may be able to sustain the fishery for several seasons despite subsequent years of unsuccessful settlement if managed properly (Ellis, 1998).

Clam Growth

Clam growth depends on a number of factors such as water temperature, food availability, degree of crowding, and time of submergence. If all other factors are equal, differences in growth rate have been shown to depend on water temperature alone (Dow and Wallace, 1961). Warm water tends to favor rapid growth, and the greatest percentage of annual shell growth occurs between early June to mid-August. Only 1% of yearly shell growth occurs from October to the following spring (Ellis, 1998). Although warm waters enhance growth rate, excessively high temperatures can be detrimental (Dow and Wallace, 1961).

Clams found lower in the intertidal zone grow at a greater rate than those higher in the zone, presumably due to the length of time they are submerged and able to feed. In southern portions of Maine, clams may reach two inches in one-and-a-half growing seasons near the low water mark. It may take eight to ten years or more for clams located higher in the intertidal zone to reach this size.

Type of sediment can also affect growth rate. The hydrographic and geological conditions that create a sandy bottom are also favorable to clam growth. Sand bottom occurs in well-washed areas with rapid water movement. It provides good drainage, water percolation, and water exchange. The rapid growth of clams in these favorable conditions results in a thin white shell, which brings a higher price in the steamer market. Although the quickly-moving water that creates a sandy bottom creates favorable growing conditions, it also has its drawbacks. Quick tidal currents can make it difficult for larva to establish a bottom attachment, and can also erode bottom sediments (Dow and Wallace, 1961).

Violent storms can also cause erosion, especially when moving in the same direction as the tidal current. Occasionally, enough sediment is displaced to expose the shellfish beneath. If this occurs during cold winter months, a large percentage of the clam population will die (Dow and Wallace, 1961). During cold weather, clams exposed on the surface make very little effort to dig themselves in again. Repeated thawing and freezing on the surface of the flats results in their death because the pallial (mantle) muscle of the clam breaks away from the shell. Although the clam may still be alive, it is unable to burrow into the flats.

The converse situation can also result in clam death, when storms move sandbars shoreward, burying and smothering clams in the tidal flats. Erosion occurring above mean high water can also have serious consequences. A thin layer of clay, deposited on the surface of the flats, can kill the clams. Commercial diggers refer to these areas as "dead flats" (Dow and Wallace, 1961). Upstream or adjacent dredging, land movement, or high runoff can cause mass mortalities. Since clams must keep their siphons clear of sediment in order to feed and breathe, increased sediment loads from human activity can result in suffocation or starvation.

Predators

Soft-shell clams are a food source for many organisms other than humans, and the numbers and types of predators change with the size of the clam. Planktonic clam veligers experience high predation from zooplankton, larval fish, and planktivorous adult fish. Upon reaching approximately 1mm, they are subject to predation by worms, amphipods, snails, and crabs. As the clams grow, their list of predators decreases.

The northern moon snail (*Euspira heros*) and the banded moon snail (*Euspira triserata*) both prey on Maine's soft-shell clam population. Snails attack clams that are similar to their own size by drilling a hole in the shell with their radula and secreting digestive enzymes to kill the clam. They then insert their mouth-like proboscis through the hole and consume the clam. According to a study in Whiting Bay near the town of Edmunds, moon snails can consume up to 60 percent of clams less than 20mm during a summer (Ellis, 1998). Moon snail predation is particularly important in eastern Maine.

Humans are an obvious predator to the soft-shell clam, and even those clams left behind can perish due to harvesting activity. Shell breakage and burial occur each time a flat is turned over for harvest. Commercial digging operations leave undersized clams buried at depths of 1 to 9 inches (Dow and Wallace, 1961). The deeper the clam is buried, the poorer their chances are for survival. Each time a flat is dug, about half of the small clams are buried too deep to survive. Survival is proportional to clam size (larger clams are more likely to survive re-burial), and better in winter than in summer (Glude, 1954).

The Green Crab Problem

Green crabs (*Carcinus maenas*) can be an extremely significant predator for soft-shell clams. Although not native to the Americas, green crabs were introduced to the Atlantic coast from Europe in the late 1800s, and established themselves on the coast of Maine in the early 1900s. They are particularly important predators on smaller clams. Smaller clams have thinner shells and are burrowed less deeply in the sediment. Clams less than 12mm in length can usually be eaten whole, while larger ones are chipped apart and the meats picked out. Clams over 60mm become resistant to green crab predation, due partly to a heavier and thicker shell, as well as their ability to burrow more deeply into the sediment (Ellis, 1998).

Green crabs seem to suffer from colder than average winters, and their predatory effect on clams has not been constant throughout the past decades. Green crab predation was particularly great in eastern Maine in the 1950s and 1960s. For example, the Washington County softshell clam harvest fell from 294,000 bushels in 1950 to 42,000

bushels in 1962. Green crab predation is thought to be a major reason for this decline (Ellis, 1998).

Anecdotal evidence suggests that green crab levels are on the rise, and a "green crab task force" has been formed by the Maine Softshell Clam Advisory Council to address the problems they pose to Maine's clam harvest. Various attempts have been made to reduce their impact on clams, with varying success. Poison bait, trapping, and fencing have all worked to varying degrees on a local basis, although none are as effective as natural temperature cycles. Currently there are no state-wide measures in effect to control the green crab population. A fencing program administered by the Department of Marine Resources has currently been inactive for more than 15 years (Ellis, 1998).

Green crabs are harvested for profit in Maine, although only on a very small scale. Researchers at the University of Maine at Machias are currently working to develop this fishery, and the green crab task force is working to develop a program to sell licenses for their harvest. Currently, only those holding a lobster/crab license are able to harvest green crabs. A separate license would allow more people to harvest the crabs, and fees for the licenses could be used to further address the green crab problem (author's notes from Clam Symposium at the Maine Fishermen's Forum, March 2002).

Chapter 3

SOCIAL HISTORY OF CLAMMING

The soft-shell clam has long been an important resource for coastal New Englanders. The clam resource has played a significant role in the social and economic history of the area, and its importance dates back to well before the arrival of the first European settlers. Fragments of shells found on the Glidden Farm in Newcastle show a carbon 14 age of some 1700 years (Dow and Wallace, 1961). Their prevalence in kitchen middens (also known as "clam heaps") attests to their historic importance to Native Americans.

Although clams were an important food source for Native Americans, European settlers did not take to them with equal fondness. Although they made use of the resource, they initially did so only in times of dire need. Clams were eaten only as a last resort to prevent starvation. Period writings convey the low esteem in which clams were held. In one document, Elder Brewster of the Plymouth Colony wrote that in the winter of 1620-21 he often had "only clams to eat"(Dow and Wallace, 1961).

In years of poor harvest, people often traveled great distances to dig clams. This usually took place in late winter and spring, when the goods they had stored from the harvest were gone, and no alternative food source was available. In his Journal of Maine History, Sprague wrote "In 1781 food was scarce with many at the Kennebec..., many even twenty miles inland sought the clam banks."(Dow and Wallace, 1961)

The clam resource was indeed available to all who wanted it. Laws governing Maine's soft-shell clam resource, which are derived from English Common Law, allow

all citizens to make use of lands below the high-tide line for fishing, fowling, or navigation. Clams were thought of as common property and a last-resort food. The low esteem in which clams were held would certainly have played a role in their initial lack of commercial development. The fact that clams were available to all who wanted them, and the apparent limitlessness of the resource probably contributed also to the lack of management of the resource.

Soft-shell clams were used for food and bait since colonial times, and were dug without regulation. The supply seemed so limitless, and the demand so moderate, that a shortage of the resource seemed implausible. As the economies of the New England states grew, the importance of the soft-shell clam as a food resource decreased as a wider variety of foods became more accessible and affordable. However, its importance was boosted in the early 1800s with the increase of hand line trawl fisheries. Soft-shell clams opened easily, stayed on the hook well, and provided a plump and enticing bait. Great numbers of clams were salted in barrels for use by Grand Bank fishermen. They were dug and barreled from October through March, a process that provided welcome winter employment to many coastal Mainers.

The salt-bait industry declined after 1875 as Bank fishermen began using fresh bait. However, a consumer market had developed both for steamed clams in the shell and canned clams. By the late 1800's, clams were being canned in significant quantities, and canned clam production in Maine amounted to roughly 60,000 cases per year (Dow and Wallace, 1961). From 1900 to 1940, the canneries took the major portion of all clams produced in Maine. Canning was confined to the winter months when there was little competition from other activities, so the canning season continued the tradition of winter

clam digging. As a conservation measure, the state established a canning season in 1901, which limited the harvest of soft-shell clams from September 15 to June 1. Parallel legislation prohibited the transporting of clams beyond state limits unless the clams had been canned, packed, or barreled during the legislated winter season. This season allowed for maximum utilization of canning factories, with soft-shell canning occurring in winter and spring, and sardines in the summer. However, at the same time that the canned clam market was booming, soft-shell clambakes were becoming increasingly popular. Those engaged in the steamer clam trade were eventually able to obtain waivers of the seasonal digging laws during the summer to allow for steamed clam consumption within the State.

Although fresh clams were popular in the state of Maine during the summer months, the restrictions on their transport limited the development of a fresh market outside the state. In the early part of the twentieth century, the vast majority of Maine soft-shell clams were destined for the canned market. However several factors would contribute to a greater importance for the fresh clam market, which would grow to surpass that of canned clams.

Maryland's soft-shell clam and surf clam industries developed in the early twentieth century, and these less-expensive clams quickly replaced Maine clams as the favorite of the canning industry. Also, just prior to World War II, a large restaurant chain introduced fried clams made from fresh-shucked clam meats. Their new specialty, cooked in the newly invented fryolator, became very popular. This innovation is credited with the increase in demand for shucked clams from Maine as well as from other growing areas in New England and Canada (Dow and Wallace, 1961).

With the increased demand for clam meats and steamers, the fresh clam industry would fight to repeal the summer digging restrictions altogether. They argued that winter digging led to the freezing death of the clams unearthed from their protective cover of mud on the flats. The canning industry would counter that summer heat would kill exposed clams. Eventually, summer digging restrictions were lifted on a county-by-county basis beginning in 1937. Interestingly, a perceived economic dependence on winter canning prevented the ban from being lifted in Maine's four northeastern counties until much later.

During World War II, many clam diggers went off to fight, and clam stocks increased in number. At the close of the war, discharged military personnel began looking for work, and many went to the flats. For many, clam digging was merely interim employment while they looked for other more permanent work. This perception of clam digging being an interim employment while the digger "looks for something better" persisted throughout much of the last century. Clams have been Maine's second or third most valuable fishery in over half of the last fifty years, and have always been an important supplemental income for many of Maine's coastal families. However, respect for the profession of clam digging has not always been on par with the resource's monetary value.

Unlike many other fisheries, a person wishing to dig clams professionally has very low start-up costs. The cost of the license itself, which rarely exceeds $200, is undoubtedly the greatest necessary expense (although many diggers use boats to travel between flats, a boat is not always a necessary component of clam harvesting). In 1957 the Maine Legislature passed a law that limited clam digging to hand harvesting only.

This ensured that clam digging would remain an easily accessible fishery. Although fishermen in other industries are often unable to compete effectively without costly equipment, no such equipment is required to dig clams or to process them for sale. The traditional tool of the trade is a multi-tined hoe used to turn over the sediments in which the clams live. In some areas of the state, primarily Downeast, they are "pulled" from soft sediments without the aid of a hoe or other implement.

Prior to World War II, clammers measured their daily production in barrels, equal to roughly three bushels. A harvest of two or three barrels per tide per clam digger was common. At that time, clams were plentiful and were relatively low in value compared to other Maine seafood. Fewer than 1500 licensed diggers worked professionally in Maine, and each could expect to harvest more than 1000 bushels per year. In contrast, full-time clammers today, which number roughly 2030 (personal communication with Hal Winters), can expect to harvest approximately 300 to 500 bushels of clams per year.

Following World War II, both the number of diggers and the annual landings increased dramatically. The increased landings were due to the increase in diggers, the respite the flats received during the war that allowed the clams to accumulate, and an increase in market demand for protein foods (Dow and Wallace, 1961).

Landings began to decline in 1950, and reached record lows in the mid-1950s. The drop in landings is generally attributed to increased harvesting after the war, greater predation from green crabs, and more closures due to increased water quality assessments. A slow recovery followed, and the prices paid for soft-shell clams grew dramatically between 1973 and 1992.

Both landings and the number of harvesters again declined rapidly beginning in 1985. By 1996, the harvest was the third lowest since 1941, with just more than 1.5 million pounds collected by 1700 harvesters. This represents a 75 percent decrease from the production highs of the 1970s and early 80s. The dramatic decrease in wild clam populations has resulted in annual declines of nearly $3.5 million to Maine clam diggers, despite the continued increase in price paid per bushel. Although the reasons for these historic low landings levels are not entirely understood, it is generally accepted that environmental factors as well as over-exploitation have played a role. Currently, roughly 20 percent of Maine's commercially licensed clammers work full-time in the industry (Ellis, 1998, confirmed for 2001 by personal communication with Hal Winters).

It is not uncommon for full-time clam harvesters to display animosity toward "part-timers". Full-time fishermen consider themselves dependent on clam digging, and resent the part-timers, who take away "their" clams merely to supplement their incomes. This animosity can become an important factor when full-timers and part-timers come face-to-face on shellfish management committees.

When a town decides to develop an ordinance, it must decide whether it wants to support commercial harvesting, recreational harvesting, or both. Some towns prohibit any commercial digging, which leaves the resource available on an exclusively recreational basis to residents. There is a long-standing tradition in Maine of locals being able to dig a "mess" of clams for themselves and their families. Recreational harvesting is usually limited to one peck per day in order to prevent the commercial sale of recreationally-dug clams. Recreational diggers are often avid supporters of clam management plans.

Despite the recent decline in clam stocks, or perhaps even because of it, many towns have begun to change the way they manage their flats. As mentioned above, the tradition in Maine has always been to allow open access to clam flats. There has also been a strongly town-based, territorial tradition that allows for preferential harvesting of clam flats by town residents. In the past, locals discouraged non-residents from working the flats they looked at as "their own". They often did so without the legal sanction of a town law or municipal ordinance. Without a town ordinance, a community's clams are available to anyone holding a state commercial harvesting license. Today, the main goal of many community management plans is to preserve the resource for local residents.

The following chapter will discuss the history of Maine's clam management in detail.

Chapter 4

CLAM CONSERVATION AND MANAGEMENT

Conservation Measures

The first clam conservation efforts in Maine were a direct result of the seasonal commercialization of the resource (Dow and Wallace, 1949). Clams were first dug commercially for use in the salt bait and canning industries, both of which were winter activities. With no summer market for their product, clam diggers did not operate from April to October. This resulted in a voluntary closed season that would set the precedent for future laws.

The first law restricting the taking of clams was passed in 1890. It prohibited the digging of some flats in June, July, August, and part of September (Dow and Wallace, 1949). It remained in place until 1937, when it was repealed in three southwestern counties with growing markets for fresh clams.

As detailed in the previous chapter, in the early 1900's the Maine legislature prohibited out of state shipment of clams during the summer months. The ban was accepted at first without protest. However, in the 1940's the market for fresh shucked and whole clams increased considerably. Maine harvesters and processors convinced the legislature to lift the ban on a county-by-county basis beginning with Lincoln County in 1941. By 1949, summer digging and out-of-state transport of clams were permitted in all Maine counties.

When harvesters began working year-round, it became apparent that some sort of seasonal closure should be established. Divided interest groups argued for different

seasonal closures. Those involved in the canning industry claimed that summer heat killed unearthed clams. They also claimed that the closed season should correspond with the spawning period, which takes place in the spring. Those involved in the fresh market claimed that winter freezing was detrimental to clams, and argued for a winter closure.

State-wide consensus was never achieved. Instead, the state established minimum conservation requirements and allowed towns the option of developing more specific management programs. A two-inch minimum size was established in 1935, and state commercial harvesting licenses were first required in 1947. The first closure of flats due to pollution occurred in the 1930s in southern Maine (Ellis, 1998). To this day, the state retains the responsibility of monitoring clam flats for potential health risks.

State licensing was initiated in 1947 to satisfy federal public health requirements for interstate trade in shellfish and to gather more reliable statistics on the fishery. The state requires commercial clam harvesters to purchase a state shellfish license and to harvest only clams over two inches in length (with a 10 percent tolerance of undersized clams per bushel). The Department of Marine Resources also sets the standards that local ordinances must meet in order to be approved. State Marine Patrol officers of the DMR enforce the two-inch minimum law and prevent the harvesting of clams from closed areas. They do not enforce local ordinances. The DMR tests shellfish species for the presence of paralytic shellfish poisoning (known as "red tide"). DMR area biologists and local water quality monitoring groups test water quality and identify pollution sources. Based on the results of these tests, the DMR classifies shellfish-growing areas as open to harvesting, open to restricted harvesting, or closed to all harvesting. Flats can also be

closed on a seasonal basis, as when spring runoff or increased (human) summer populations result in an increase of water-born bacteria.

DMR uses standards created by the Interstate Shellfish Sanitation Conference under the National Shellfish Sanitation Program. In the late 1980s, these standards were changed (personal communication with Hal Winters). Earlier in the century, flats remained open unless testing showed a need to close them. The new ISSC standards shifted the "burden of proof". A flat would remain closed until it was tested as safe. The criteria for keeping areas open became more stringent, and the required testing frequency was increased. These changes occurred at the same time that Maine state budget cuts decreased funding to the DMR. In 1988, the ISSC released a report that listed Maine as one of a number of states not in compliance with the new standards. In order to continue interstate trade in shellfish, these states had to close areas that were not properly classified. As a result, Maine DMR closed roughly 30% of its productive flats, which amounted to approximately 83,000 acres (Hal Winters, personal communication). Even if water quality were dramatically improved, a flat would sometimes remain closed simply because DMR lacked the resources to perform the necessary tests.

A History of Local-Level Management

There is a long tradition of local shellfish management in Maine. In 1821, the Maine Legislature granted coastal municipalities the authority to issue permits for taking shellfish and imposed a standard penalty for the violation of the permit conditions (Ellis, 1998). The State Legislature passed "Private and Special Laws" for particular towns

from 1895 until 1963. In 1963, they passed legislation that permitted towns to establish local ordinances regulating the harvest of soft-shell clams under DMR supervision.

This legislation is unique in Maine's fisheries management. Although town plans must be approved by the DMR, municipalities have a great deal of freedom in designing their own programs. This freedom is due at least in part to the strongly town-based territorial attitudes toward the resource. It is also due to the characteristics of the clam itself. Unlike many other managed marine fisheries, clams are sedentary. One town's management is less likely to affect the resources of a neighboring community. Since adult clams within town boundaries remain there until harvested, local control is more feasible than in other fisheries.

Individual towns have the option of enacting their own ordinance for the protection of their resource, or relying solely on the limited state regulations. In 1985, Ralph Townsend concluded that managed flats typically have a 15 percent higher catch per unit effort than unmanaged flats. In 2001, 53 coastal communities had ordinances for the protection of their soft-shell clams.

Once a town has enacted a management plan, it is responsible for the enforcement of its ordinance. Town ordinances usually require a town license, with residents paying substantially less than out-of -towners. The state requires that towns make at least 10% of commercial licenses available to non-residents, and the fee for these licenses may not exceed twice the resident fee (or one and a half times the resident fee if the resident license is $200 or more). Many towns require the fulfillment of "conservation hours" in order to be eligible for a commercial license. These hours can be fulfilled by participating in shoreline clean-ups, reseeding events, and other events intended to

enhance the resource. The towns also have the ability to manage their resource as they see fit subject to the approval of the DMR. Area biologists are available to assist municipalities with their management plans.

Towns can manage their softshell clam resource in several ways. The primary reason most local programs exist is to allow preferential harvesting to local residents. Prior to 1963, most local management programs limited commercial digging to town residents or land owners. Legal challenges within Maine and elsewhere argued that these restrictions violate federal constitutional protections (Clime and Townsend, 1993). The DMR then discouraged outright bans on non-resident licenses. Today, state statute requires all towns that issue commercial licenses to make at least 10 percent of the licenses available to non-residents. They also encourage towns to adopt more comprehensive management strategies that include flat closures and rotations, stock assessment, and reseeding.

The DMR published a handbook for community management in 1999. The book is intended to clarify management program options and town responsibilities. In the book, they specify the following approved activities and tools towns can use to manage their clam resources:

Clam Management Activities

- *Setting the number and types of licenses* – towns can restrict entry into the fishery by limiting the number of licenses available. A number of towns rely solely on this activity to manage their resource.
- *Establishing conservation areas* – This is done for a number of reasons: to protect areas that have been seeded from harvest activity until the seed has reached legal

size, to set aside an area that doesn't freeze up in the winter for digging; and to rotate with other conservation areas to even out harvest effort, particularly for areas prone to overharvesting.

- *Restricting the amount, time, or season of harvest* – Most towns do not limit the amount of clams a commercial harvester can take, but do limit recreational digging to one peck to discourage the selling of recreationally harvested clams. Time restrictions usually involve night digging, which is prohibited by some towns. Harvest seasons are generally imposed due to water quality considerations, although some towns also restrict digging to weekends and holidays.
- *Seeding with hatchery stock* – A number of towns have worked with both public and private hatcheries in an effort to augment natural recruitment through seeding. Several studies are underway or planned to determine the best procedures for seeding flats with hatchery stock.
- *Reseeding from closed or high density areas* – For towns with areas containing a high density of clams, reseeding or transplanting juvenile (sub legal) clams is the preferred method to enhance natural recruitment. Several Maine towns reseed each year.
- *Protection from predation with fences, traps or nets* –Fencing used to be common, but has fallen out of favor due to its cost and labor. Nets placed over the sediment are often used in seeding/reseeding projects, as the seed clams are particularly vulnerable to predation.

- *Enhancing spatfall with brush, fences or nets* – The placement of partial barriers (such as pieces of brush, fences or nets) on the flat works to slow currents and form eddies which encourage spat to drop out of the water. This activity is only effective when spat are present in the water column.

Clam Management Tools

- *Clam flat surveys* – Surveys were once required by the DMR, but many towns did not have the ability to comply with the requirement. Surveys consist of counting and measuring clams taken from two square-foot plots. The plots are situated every 100 feet along a series of transects forming a grid over the flat. They provide information on size distribution, average density and standing crop. Surveys are the only way to make a direct assessment of standing crop.
- *Production data* – The two main sources for landings information are shellfish dealer reports and warden reports. Towns with only recreational harvesting will have only warden reports available. Shellfish dealers are required to submit monthly reports to the Department of Marine Resources (DMR), including information on where clams were harvested and by how many harvesters. These data can vary in accuracy, as harvesters are sometimes reluctant to reveal the exact location of their harvest, and are not always diligent in their reports. Landings data from 1997 onward are available at the DMR. Landings data by town prior to 1997 are not always reliable, as they are available only through original dealer reports that are difficult or impossible to obtain.
- *Committee meetings* – The most successful management programs have regularly scheduled monthly meetings. Towns that encourage harvester participation in the

meetings gain a valuable source of information and feedback. Harvesters are also more likely to abide by the rules if they feel they had a hand in their creation.

- *Conservation Credits* – Conservation credits are often given to diggers in exchange for labor in reseedings, surveys, committee membership, or clean-up efforts. The credits are often required to obtain a license for the following year.
- *Enforcement* – Enforcement is a vital component of any management program. A shellfish warden must be present to monitor and patrol flats in all towns with ordinances. State wardens will patrol flats to enforce the two-inch minimum law and closures, but all towns with ordinances must hire a shellfish warden to enforce local regulations.

As mentioned above, the most successful town programs are supported by community volunteers. These groups consist of selectmen, harvesters, or members of the general public who are willing to volunteer their time and efforts in the interest of clam management. Their roles vary from town to town. Possible activities include conservation projects such as reseeding and shoreline clean-ups, organizing fundraising activities, writing newsletters, or distributing information to licensed diggers. In some communities, these groups may take part in management itself, either as advisors or as the actual decision makers. The success of any program depends in large part on the dedication of these community volunteers. Often, one individual or several individuals will "carry" a town program. If this individual decides to limit his or her involvement, the program will often suffer. Volunteers regularly complain of "burnout" from many

hours of unpaid work. Their dedication levels vary, and program success and community responsiveness often fluctuate from year to year.

Although some communities hold fundraising events, many town management efforts are funded exclusively by license sales. When landings decline, fewer harvesters purchase licenses. As a result, money for management and enhancement activities often decrease at the time when they are most needed. Some programs, such as the Georges River Program, receive money from local taxpayers. Although this supplies financial assistance, it can also be problematic. Harvesters can resent feeling obliged to "answer" to town management and justify their actions and expenditures to local taxpayers.

Depuration Digging

The DMR classifies areas as either open to harvesting, closed, or open to restricted digging (also known as open conditionally). If a flat is open conditionally, the clams there can be harvested only by depuration companies. They are then taken back to a plant where they are treated with ultraviolet light and filtered seawater to kill any harmful bacteria that may be present. They can then be sold safely to consumers.

Areas are often open to depuration digging after having been closed for some time. The lack of digging during closure will often result in a "goldmine" of clams to be harvested by the depuration companies. These flats also produce above-average yields per digger simply because they are closed to all other digging (Townsend, 1986). Higher yields per digger are offset by lower prices paid to diggers per pound. Lower prices are necessary to offset processing costs. Local harvesters often express resentment that people from outside the area are able to harvest what should be their clams. Depuration

companies are required by law to hire local diggers preferentially. However, local diggers sometimes argue that this does not take place. They complain that they receive no benefits from the operation, while the depuration companies are able to go in and "pillage" their flats. This has been an especially vexing issue in the Georges River area, which will be discussed in the next chapter. Currently there is only one depuration plant operating in the state of Maine.

Cooperative Efforts

In 1997, the Maine Soft-shell Clam Advisory Council was formed as a collaborative effort between clam harvesters, state agencies, and non-profit organizations. The Council is intended to provide a forum where issues and policies relating to soft-shell clam management can be discussed among all stakeholders. The objectives of the MSSCAC are to collect information at the local level, recommend policy, and redistribute information back to the local level (Ellis, 1998).

It has proven difficult to get stakeholders from all parts of the coast together for regular meetings. As a result, the MSSCAC created three regional (downeast, mid-coast and Casco Bay) councils to discuss local issues of clam management. These issues could be dealt with at the area council, or brought to the state-wide meetings if necessary. The councils of the mid coast and downeast never took hold, and neither council exists today. The Casco Bay Regional Clam Management Council currently meets once each month.

Although towns manage their soft-shell clams individually, many communities are beginning to realize that cooperation with neighboring communities can benefit the resource. Although clams are perceived as a sedentary species, they are mobile in their

early developmental stages (see clam biology section), and cooperative management is seen as one way to encourage a "good set" for a community. It is also more efficient to manage flats on their entirety rather than on the basis of town boundaries, both in terms of the effectiveness of management and the costs of enforcement. The single greatest management expense for most towns is the cost of the shellfish warden's salary. It makes sense for neighboring towns to combine numerous part-time positions into one full-time position and split the cost.

In January of 1996, the towns around the Georges River Clam Project introduced an act to the Maine legislature that would allow towns to form regional shellfish commissions. Prior to this, local management was only recognized at the town level. This legislation allowed towns to cooperate on their shellfish management without having to form individual town shellfish committees as had been required by existing laws. The Georges River Program is currently the only example of a multi-town ordinance in the state of Maine.

Numerous towns have attempted to cooperate on their management plans, in varying degrees of formality. The towns of Arrowsic, West Bath, Phippsburg, Georgetown and Woolwich have independent ordinances, but share one warden. Other towns have tried to arrange more formal cooperation, such as those listed below.

Cobscook Bay Clam Restoration Project

Between 1995 and 2001, Lubec, Trescott, Whiting, Edmunds, Dennysville, Pembroke, Perry, Pleasant Point, and Eastport managed their clam resources jointly. The Cobscook Bay Clam Restoration Project facilitates and coordinates the management,

with the goals of improving the health of the bay, increasing productivity of the flats, creating a regional approach to clam management, and increasing access to education in resource management. Although the towns cooperated on area management, they did not have a joint ordinance to cover the entire area. Each town was responsible for the management of its own resource, and chose how they would cooperate with the other towns to enhance these efforts.

Damariscotta River Regional Management Program

Boothbay, Boothbay Harbor, Damariscota, Edgecomb and Newcastle share their clam resources through reciprocal harvesting agreements included in each town's management ordinance. This arrangement began in 1991, when it was adopted independently by each town.

Clam management is administered solely by the lead town, which alternates between the five communities. Each town determines and issues its own number of commercial licenses. A commercial license from any of the five towns allows its holder to dig in any of the communities' flats.

Georges River Clam Project

The Georges River Program is unique in the state in that five towns work together under a single interlocal agreement and ordinance. Management is carried out by two groups – the Joint Board of Selectmen and the Shellfish Committee. Chapter 4 describes the program in detail.

The cooperation between towns, fishermen, and management officials that takes place in these cooperative plans helps to overcome one of the greatest problems confronting fisheries management. That problem is an inherent mistrust between people who harvest a resource, the people who study it, and the people who regulate it. When researchers attempt to gain information from fishermen, they are confronted with the mistrust. A harvester is unlikely to give accurate reports of his landings if he believes the information may come back to haunt him. This negative impact could be in the form of higher taxes if the IRS realizes his true landings, other fishermen discovering the good areas he's found to dig, or increased regulations if someone believes he is harvesting either too many or too few clams.

A cooperative approach to management is essential if this mistrust is to be overcome. Historically, most fisheries have been managed on a "top-down" command and control basis. Government officials consult with scientists to create regulations that are imposed upon fishermen. There is a trend now in fisheries management to create new types of "bottom-up" management, with the fishermen themselves taking part in policy formation. The Maine soft-shell clam industry is one of the first areas where this type of management has taken place, and the area around the St. George River is the first formal multi-town ordinance in the state. The following chapter will detail its development and implementation.

Chapter 5

THE GEORGES RIVER PROGRAM

The Historic Fishery

The St. George River is located in mid-coast Maine and flows through Knox and Waldo counties. The head of the tide is located in Warren. From here the river flows through the towns of Cushing, Thomaston, South Thomaston, and Saint George. The river's drainage area covers 182 square miles at Warren and 258 square miles at its mouth. The tidal portion of the river houses 3800 acres of clam flats.

Exact landings figures by town for any part of the state of Maine are difficult to obtain prior to 1997, although statewide landings are available. Any estimate of landings specific to the Georges River area prior to 1997 is subject to a certain degree of inaccuracy. However, it is possible to make a good estimate by combining what landings data are available with anecdotal evidence from local diggers and residents. Using this method, Sherman Hoyt of The Georges River Clam Restoration Project estimates that annual commercial soft-shell clam production for the towns of Cushing, St. George, Thomaston, and South Thomaston approached 30,000 bushels from 1975-1985. By 1994, less than 7,000 bushels of clams were being harvested from these towns (Sherman Hoyt, personal communication)

Water Quality Improvements

Much of the following section comes from a personal interview with Larry Pritchett, a member of the Georges River Tidewater Association. This interview took place on August 16, 2001.

Soft-shell clams are filter feeders, and are not safe for human consumption if taken from an area with high levels of bacteria. The state DMR tests water quality along the Maine coast and classifies flats as safe or unsafe for shellfish harvesting. The harvesting status of flats is linked to local water quality.

A group of Georges River area stakeholders formed the Georges River Tidewater Association in 1988. Their mission statement includes a goal to "help protect and restore marine resources and water quality in the estuary through advocacy, public education, and environmental monitoring." (1991 winter Tidewater Association Newsletter). The Tidewater Association was responsible for initiating changes in the Georges River estuary that made commercial softshell clam harvesting possible.

In the late eighties, the town of Thomaston's sewage treatment plant was unable to meet the wastewater treatment needs of the area. The Tidewater Association documented more than 230 apparent violations of federal water pollution control laws related to the system. In February of 1990, the Tidewater Association filed notice of a citizen's suit against the town of Thomaston for these violations.

In April of 1990, the Thomaston Board of Selectmen signed a consent agreement that legally bound the town to a two-and-a-half-year schedule to correct chronic problems in the treatment system.

The Tidewater Association also addressed other pollution sources within the estuary. These problems included sewage overflows at the Maine State Prison in Thomaston and hundreds of houses with failing septic systems or "straight pipes" in the five towns bordering the estuary.

In their 1992 summer newsletter, the Tidewater Association included a cover story on "Clamming, Water Quality, and the Economy". In it, they stated that poor water quality was preventing the establishment of a commercial clam fishery in the area. They also stated that estimated landings for such a fishery would be $1.5 million (in 1991 dollars), and that total economic impact to the area could exceed $7 million (these figures were based on early eighties landings data). The Tidewater Association suggested six ways in which water quality could be improved and the clam fishery restored. The first five dealt with code enforcement, local water quality testing, and improving and inspecting local septic systems. The sixth suggestion was to "Consider Multi-Town Shellfish Commission." Because clam flats in one town can easily be contaminated from pollution sources in a neighboring town, they favored a multi-town approach to management for the Georges River estuary.

Georges River Clam Project/Steering Committee

The Tidewater Association kept working to improve water quality. By 1994, the major pollution sources had been dealt with. DMR tests would soon document the improved water quality and re-open the flats to commercial digging. These tests were scheduled to be completed for the entire Georges River by late May of 1996.

Sherman Hoyt, a resident of St. George, knew that the flats that were about to be

opened. He saw that the flats had the potential to support a long-term sustainable fishery, and worried that the clams would be depleted unless the towns acted quickly. Anyone with a valid Maine commercial shellfish harvesting license can harvest clams from any town's open flats unless the town has an approved ordinance prohibiting them from doing so. By the mid 1990's, many communities had enacted ordinances limiting harvesting to residents. A group of St. George residents had attempted to establish a clam management plan for their town in 1983 (St. George town records). However, their efforts were unsuccessful, and none of the towns along the estuary had town ordinances.

The flats along the estuary had been closed for years, and were full of mature clams. This bounty of clams would entice many commercial diggers to the area. Hoyt doubted the fishery would last long under the pressure of unmanaged harvesting.

Hoyt began attending local selectmen's meetings to discuss the possibility of a multi-town management program. At these meetings, he would bring up the concept, and discuss what each town could bring to the program. Although Warren was in the fresh water portion of the estuary and had no clam flats, its residents impacted water quality for the entire area. St. George had the largest acreage of flats, but very few harvesters. Hoyt emphasized each town's importance, using the tidal portion of the river as the unifying ecological system they all shared. Some residents expressed concerns about how all the details would be worked out. Some of the towns were already cooperating on municipal issues. Cushing, Thomaston and South George had a joint K-12 school district (SAD 50). Thomaston and South Thomaston worked together with Owl's Head to administer a joint solid waste transfer station. A resident at one meeting commented "If we can't get 3 towns together on a school budget, how will we get 5 towns together to manage

clamming?" Selectmen were already busy with other municipal duties. However, they realized their residents were losing potential income as a result of the closed fishery. Selectmen in each of the towns said they were willing to support the program if Hoyt was willing to do the work.

He also discussed the concept with area residents and clam harvesters, and found them receptive to the idea. When the river was closed, many local harvesters began digging for depuration companies. A number of harvesters felt they had been treated unfairly, and resented so much profit from area clams going to an out-of-town company (Spinney Creek located in Eliot). They were anxious to get the river open to commercial harvesting so they could dig for themselves again. When commercial clam harvesting had taken place in the area, harvesters had traditionally worked the entire estuary rather than staying within one town. Developing a plan for the entire estuary made sense to harvesters.

In July of 1995, Hoyt created the Georges River Clam Fishery Restoration Project. University of Maine Cooperative Extension allowed him to use space at their office, and helped him form a steering committee of local residents. He worked out of the county extension office and used their computers to write grant proposals to support the project.

All grants had to go to a legal non-profit entity, and the Island Institute performed this role. The first grant came from the Maine Community Foundation to purchase a computer. The first big grant was from the Betterment Foundation for $30,000 over two years. Support was also received from local businesses, the towns of St. George and Thomaston, and other philanthropic organizations. By October of 1995, the Project had

generated $38,000 in support. These funds would allow the Project to hire Sherman Hoyt as a full-time facilitator in 1996 (personal communication with Sherman Hoyt).

The first meeting of the Georges River Clam Fishery Restoration Project took place on April 5, 1995. A 10-person steering committee was present, including Hoyt, Ron Aho (DMR's area biologist), county extension agents, and local residents. The first item discussed was the decision making process. Several members described the benefits of a "consensus approach" to decision making, where all stakeholders are allowed to present their opinions and concerns. This method was adopted by the group, although it was decided that only members of the steering committee would be allowed to vote on issues (April 5, 1995 Restoration Project meeting minutes).

The restoration program was created according to the extension model, where the goal is to provide guidance and support and eventually to phase out involvement. The steering committee's goal was to restore the clam fishery in the Georges River, and to help to establish a local management system to sustain the resource over time. From the very beginning, the steering committee's goal was to help establish a management regime that would eventually be self-supporting.

The next step was to decide what sort of management program would best suit the area. Roger Gagne was present at the first meeting. He was a commercial harvester, and worked for Spinney Creek as a depuration crew supervisor. He advocated working with Spinney Creek to continue depuration digging on a larger scale in the river. Gagne discussed the efficiency of depuration digging, where all harvest is strictly controlled to allow for maximum productivity of the flats. Although Aho pointed out the increased safety of depuration digging, the group decided against this option. Locals were not

generally in favor of depuration digging, and the group wanted to develop a more traditional program (April 5, 1995 Restoration Project meeting minutes).

In 1996, Tom Howell of Spinney Creek sent a letter to the St. George town manager suggesting that the town reject the proposed multi-town ordinance in favor of an exclusive arrangement with Spinney Creek. St. George has the largest acreage of productive flats within the estuary. In return for this arrangement, Spinney Creek would pay a per-bushel surcharge of $5.00 per bushel. The proposal was rejected (personal communication with Bob Dennison, July 25, 2001).

The project initiated and provided leadership in organizing a statewide conference "Improving Municipal Clam Management in Maine" in December of 1995. This was the largest Maine shellfish conference to take place since 1946. It produced eight working groups that met statewide during January and February to define problems and recommend solutions. A second industry work session occurred as part of the Maine Fishermen's Forum in February of 1996. While at these sessions, steering committee members were able to brainstorm with people involved in shellfish management from all over the state. These discussions influenced the development of the Georges River Program.

Hoyt spoke with Alan Houston, who was in charge of Brunswick's management program. Brunswick had been involved in a multi-town reciprocal harvesting agreement. At the time Hoyt and Houston spoke, it had recently been dissolved due to differences of opinion between the towns. Hoyt realized that having a reciprocal harvesting agreement without one unified management plan could create problems, and proposed a program in which one ordinance governed the entire estuary. He spoke with the Maine Municipal

Association about the structure of interlocal agreements. These agreements are governed by a joint board with selectmen from each of the towns involved. Hoyt proposed combining a joint board with a shellfish committee. He knew that the selectmen on the joint board were not knowledgeable about clam harvesting, and would benefit from the input of a shellfish committee. Being familiar with fisheries management theory, he also knew that the harvesters would be more likely to adhere to a program in which they played an active role.

The Project helped to form the Joint Board, with a selectman from each of the five towns, and the Shellfish Committee comprised of local harvesters. These two groups began to meet in the spring of 1996. Their first task was to draft the interlocal agreement and ordinance. Bob Dennison, the selectman from St. George, was adamant that decision-making power be shared by the two bodies. He included language in the ordinance that stated that a unanimous vote of the Shellfish Committee could only be overruled by a unanimous vote of the Joint Board. He stressed that the harvesters would have no incentive to participate in management if they did not have a say in it (personal communication with Bob Dennison and Sherman Hoyt).

Dennison drafted the original interlocal agreement, which detailed the towns' responsibilities. Its stated intent was to preserve the clam resource for present and future diggers, both commercial and recreational. It included sections on administration, finance, property, personnel, arbitration, and amendments.

The original agreement authorized the Joint board to "set the number of shellfish licenses to be issued, establish license fees, open and close the flats, set times when digging is allowed, set permitted quantities that may be harvested." However, it also

stated that recommendations of the Shellfish Management Committee should be approved by the Joint board unless a unanimous vote of the Joint Board decides otherwise. In practice, the SMC would make the above decisions with few exceptions.

The Joint Board would be composed of one selectman from each of the 5 towns. At least 3 of these selectmen were needed to create a quorum so that a vote could occur.

A governing municipality would have administrative responsibilities. This town would receive 10% of total license sales to offset administrative costs. All other funds (remaining license fees, fines, fundraising moneys and donations) are held in a joint shellfish ordinance account by the treasurer of the administrative municipality. The original governing municipality was Thomaston, which was later changed to St. George.

The shellfish warden was to be employed by the administrative municipality. (However, in practice it was the SMC that would write the job description for and hire the warden, who would report to the Thomaston Chief of Police) The Shellfish Committee and Joint Board began regular meetings in May of 1996.

The Shellfish Committee was responsible for the management ordinance. Sherman Hoyt brought a copy of Darmariscotta's ordinance to the committee to use as a guide. There were similarities between the two programs, as Damariscotta has reciprocal harvesting agreements with neighboring towns. The management ordinance was written by Butch Taylor (chairman of the SMC), Cliff Weaver and Ron Stone (SMC members) with advice from Ron Aho and Sherman Hoyt. The ordinance limits the commercial harvest per digger to 4 bushels per tide, prohibits Monday and night digging, and sets licensing procedures. It also sets standard penalties and fines for violation of the rules of the ordinance. It outlines the structure and duties of the SMC, which is to be composed

of three residents from each of the communities, "at least two of whom shall be commercial diggers appointed by the selectmen of the municipalities."

The Interlocal Agreement was approved by each of the towns in mid April, 1996. Harold Winters, watershed manager for the DMR, approved The Georges River Regional Shellfish Management Ordinance as written on April 22, 1996.

Water testing continued, and a large area was deemed safe for harvesting in late spring of 1996. At the request of the Joint Board, DMR temporarily delayed opening the area to digging while details were hammered out between the towns.

The SMC had to decide how many licenses would be issued. Ron Aho supplied them with landings data from 1995, which suggested that somewhere between 13 and 78 licenses be issued, depending on how many bushels harvesters would be allowed, and how many days they would be allowed to work.

Bob Dennison of the Joint Board advocated unlimited licenses with a restricted season. He said all residents have a right to the resource, and that basic economics would ensure that the resource would not be overharvested. Once landings began to fall, people would decrease their harvesting effort, and stocks would rebound. Cliff Weaver of the Shellfish Committee advocated limiting the number of licenses with a small reduction in the number of fishing days (personal communications with Bob Dennison and Cliff Weaver). The SMC favored this proposal.

Eventually, the SMC used a combination of 1996 survey data, historical landings data, "gut instincts", and the number of people in the community interested in a license to arrive at a figure of 128 commercial licenses. Because this figure was substantially higher than the figure Aho recommended, they prohibited digging on Mondays. They

also required that "conservation time" be completed in order to be eligible for a license. Recreational licenses were not limited.

128 commercial licenses were issued on July 8 via a lottery. Per state law, 10% of these were sold to non-residents. On July 10, over 500 acres of flats were approved for open digging by the DMR.

The SMC organized numerous fundraisers to support the program and pay the warden's salary and expenses. They hired a warden in August, and purchased a boat, motor, and a used police cruiser for his use.

In September of 1996, the SMC reported that the diggers and warden were getting along well. Only one license was revoked, due to failure to show proof of residency. Enforcement issues did not seem to be a problem at this time (SMC meeting minutes, September 5, 1996).

Harvesters and residents seemed enthusiastic about the program. The SMC kept up weekly meetings to discuss the program and keep it going. On September 4, the Committee recommended to the Joint Board that Maple Juice Cove be closed due to an abundance of juvenile seed clams. This recommendation was accepted and went into effect on September 23.

The SMC joined with the Tidewater Association at a fundraiser in July, and held a public supper and a raffle in October. They also put on a hunter's breakfast in November. Spinney Creek paid a per-bushel surcharge to Thomaston (the administrative municipality for the program) for all depuration digging conducted in any of the five towns. These monies supplemented those received from license sales. The SMC seemed

committed to raising the necessary funds to keep the program going. These fundraisers continued over the coming year.

Scott Tilton, a member of the SMC as well as the Restoration Project Steering Committee, developed a conservation time policy manual. In it, he outlined the types of activities that would qualify as conservation time. In April of 1997, the first reseeding event took place. Five bushels of seed were taken from Broad Cove and placed in Maple Juice Cove, which remained closed.

In their April 7, 1997 meeting, the SMC noted that communication with the Joint Board had deteriorated. They decided that they would discuss this issue and how it could be improved with the Joint Board, and present the results at a future meeting. The warden was also discussed. Having the warden report to the Thomaston Chief of Police seemed to be creating some problems. The police department did not share the same vision of the warden's responsibilities as the SMC. This issue would become more important in the months to come.

Butch Taylor, the original chairman of the SMC, resigned in October of 1997. He did not give a specific reason for his resignation, and continued to serve on the committee (October 20, 1997 SMC meeting minutes).

In late 1997 and early 1998, the SMC dealt with their first major conflict: "The Wormer Issue". Soft-shell clams often occur in the same areas as marine worms. Worm harvesters turn the mud in the same way as do clam harvesters. Clam harvesters claimed that this practice "turned the mud to soup", left seed clams exposed to the elements, and often made it impossible for them to conduct their business. They also complained that the fishery was largely unregulated, and wondered why they were subject to conservation

restrictions while wormers were not. Clammers found it particularly vexing that wormers were able to harvest in areas closed to clam harvesting for conservation reasons (personal communication with Sherman Hoyt).

With both types of harvesting taking place in the same area, problems were bound to occur, and they did. On August 22, 1997, the chairman of the SMC sent a letter to Robin Alden, Commissioner of the Department of Marine Resources. In it he said that the SMC "is facing a serious problem that if not dealt with in a timely manner has the potential of erupting into a violent situation." He stressed the need "to respond quickly to address these concerns in order to head off the growing threat of violence." He stated a strong belief that both fisheries could coexist, and made several recommendations to the commissioner that would help this to happen. She responded in early October by asking the Maine Soft-shell Clam Council to establish a subcommittee to deal with the issue. The subcommittee would include a small group of stakeholders including both the worm and clam industries, selected members of the Council, DMR staff and local legislative representatives.

In November of 1997, the SMC's monthly newsletter included a section "Working with Wormers". The article was written by Scott Tilton, the newly-appointed committee chair. He discussed the recommendations Taylor had made to the commissioner, and the resulting subcommittee. Cliff Weaver, a member of the SMC, had been attending the subcommittee's meetings, as had Sherman Hoyt. Hoyt was quoted as saying "Cliff has really expressed the clammer's position very well. And the wormers are responding in an incredibly positive way. There is a mutual understanding that yes, there are problems, but an agreement can be reached."

Another problem was developing at the same time. Neil Pollis, the warden originally hired by the SMC, suffered from health problems, and had been unable to work over the summer. A temporary part-time warden had been hired, but he resigned in November. This left the towns without an enforcement officer. The warden issue had always been somewhat of a problem, as the Thomaston Police Department did not supervise the warden in the way the SMC would have liked (personal communication with Shellfish Committee Members, September 10, 2001).

Clam harvesting slows down in the winter months, and the issue was not addressed officially until February, 1998. In a February 5 letter to the Joint Board, the Restoration Project expressed concern over the lack of an enforcement officer. They suggested "If this issue cannot be resolved by the current administrative municipality, we would suggest considering changing the administrative responsibility from Thomaston to another town in the five-town region, perhaps St. George. It is ultimately the responsibility of the Joint Board to assure that the resource is appropriately managed, and at this point, the resource is at risk"

The administrative municipality was changed to St. George, and the Joint Board assumed the responsibility of hiring the shellfish warden. Neil Pollis, who had recovered from his health problems, was rehired. He would report to St. George town manager John Falla, who was also a member of the Joint Board. At the same time, the Joint Board assumed control of other issues that had been traditionally left to the SMC. Although the interlocal agreement stated that budgeting and fiscal issues were the responsibility of the Joint Board, the SMC had been handling these issues. The warden's salary was the

largest expense, and with the SMC handling this expense, it seemed natural that they would handle other money issues as well.

John Falla would regularly sit in on Joint Board meetings. The Joint Board and the administrative municipality (St. George) became a much more cohesive unit. The Joint Board became more involved in warden issues. When the issue of benefits was raised, it was the Joint Board, not the administrative municipality, that decided he would not receive benefits due to budget shortfalls. The Joint Board gradually became more involved in fiscal issues. In early 1998, the SMC asked the Joint Board to request $2000 from each town to support the program (SMC meeting minutes, March 16, 1998). A stipulation was made that this money would be returned the following year if it was not needed. The request was made. With the programs receiving money from the towns, the Joint Board reasoned it was their responsibility to monitor where these moneys went (personal communication with Bob Dennison, July 25, 2001). The SMC voted on March 23 to rescind the request for money, but the money had already been received from St. George, and would soon be received from the other towns.

By March, absences were becoming a problem at SMC meetings. The committee needed 8 members present in order to have a quorum to vote on issues, so with low attendance, the SMC could not make recommendations to the Joint Board. Committee members were also disappointed that no Joint Board members attended their meetings (SMC meeting minutes, March 16, 1998).

In their March 30 meeting, the committee expressed their grave disappointment that the Joint Board had overturned a recommendation that the SMC had presented them with unanimous support. (This recommendation was that the SMC be involved with the

evaluation of the warden's job performance. This motion had passed 11-0.) The SMC expressed a desire for the warden to increase his presence on the flats, and check diggers more frequently to look for undersized clams and enforce the four-bushel limit. In their June 29 meeting, a number of committee members expressed disappointment with the job performance of the warden. The disappointment centered on the fact that people were digging in conservation areas, the four-bushel limit was not being enforced, and unlicensed digging was taking place. They forwarded a letter to the St. George town manager, who responded that they would consider hiring another part-time warden. The SMC was not pleased with this solution, as they saw the problem not as a lack of manpower, but as a lack of desire to enforce the rules.

In August, the situation improved when Pollis took "brave and decisive action" (SMC meeting minutes, August 17, 1998) against several individuals who were violating the ordinance. The SMC wrote a letter of commendation to Pollis for his recent law enforcement activities.

In April of 1999, Scott Tilton resigned as chair of the SMC. He was working long hours at two other jobs, and said he was no longer able to commit to the 10 – 15 hours each week necessary to chair the SMC. He was replaced by Peter Hope.

In the spring of 1999, the Georges River Clam Fishery Restoration Project ceased to meet. They deemed that they had completed their responsibilities, and the Joint Board and SMC were functioning well on their own. Sherman Hoyt began a full-time position with the county extension office, and continued to operate as an advisor to the SMC and Joint Board.

There were no major conflicts to resolve at this time, and the SMC began to meet less frequently. With no control over the finances, they did not plan as many fundraisers, although they did take part once again in the July 4th river festival. Reseeding and shoreline cleanup events continued.

The next major conflict occurred in the spring of 2001. A clam harvester who was also a member of the SMC was arrested and charged with aiding and abetting. He claimed to have dug clams that were allegedly dug by his son in excess of the four-bushel limit. The shellfish warden witnessed the event, and claimed the father was lying. He brought the father before municipal court, where he was fined (author's notes from Joint Board meeting, February 8, 2001).

Language in the management ordinance stated that anyone who used his license to deliberately aid and abet another to violate the laws of the ordinance would lose their license for a period of 12 months in addition to paying a $1000 fine upon conviction. However, the father claimed that when he pled guilty in municipal court, the judge assured him that the fine was his only penalty (author's notes from Joint Board meeting February 8, 2001). The SMC was adamant that he should lose his license, since this penalty was clearly stated in the ordinance. The father claimed that he did not know this, which the SMC did not believe since he was present when the ordinance was written and approved on an annual basis.

The Joint Board originally revoked the father's license. However, he appealed the decision on the basis of what he had been told in municipal court. He claimed he would not have pled guilty had he known he would lose his license. The Joint Board decided to reinstate his licenses despite the objections of the SMC.

Another contentious issue has been the money that the program receives from the towns. The SMC wanted to return to a self-supporting structure, and wanted to regain control over financial expenditures. The Joint Board insisted that the town money was a necessary part of the program, and that they were most qualified to handle money manners. Peter Hope resigned his chairmanship in the spring of 2001 as a result of the money issue and the "aiding and abetting" incident. He was replaced by Dwayne Hunt.

The SMC originally met infrequently throughout the spring and summer of 2001, but increased the frequency of their meetings late in the year. Bob Dennison resigned his chairmanship of the Joint Board in 2001, and was replaced by Steve Miller, an area fisherman. He seems to be firm in his administering of the ordinance. Several diggers had not fulfilled their conservation time requirement in time for the 2001-2002 season, and were not entered into the lottery to receive licenses. They appealed this decision, and Miller denied the appeal, arguing "they knew the rules as well as anyone else." The SMC seems pleased so far with his management. There have been no major conflicts so far under his management of the Joint Board.

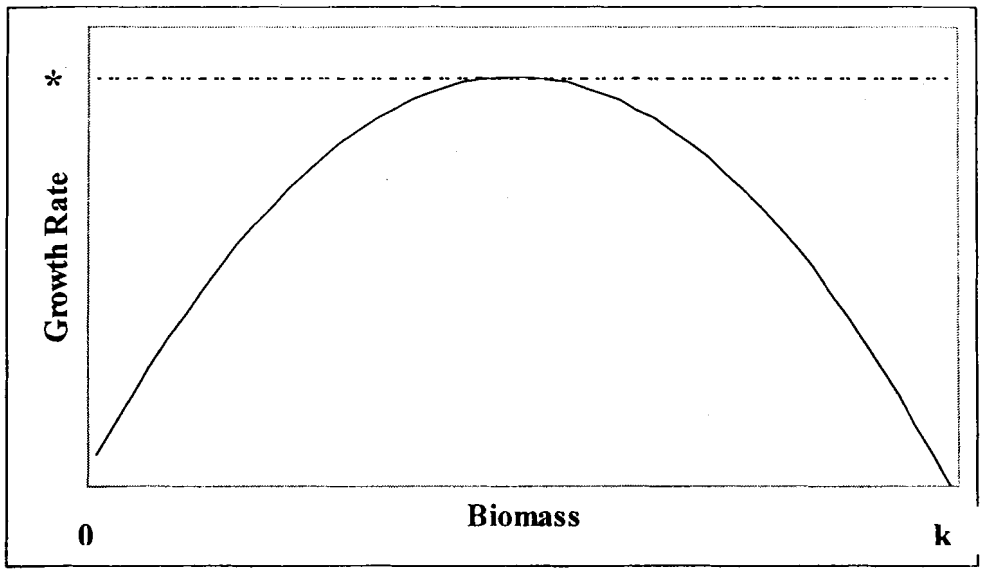
Chapter 6

LITERATURE REVIEW AND THEORETICAL DEVELOPMENT

Fisheries Management and Fisheries Economics Tradition

Modern economic analysis of fisheries began with Gordon (1954) and Schaeffer (1957). Prior (and often subsequent) to these authors, the goal of fisheries management was to harvest the greatest biomass possible without impacting the long-term sustainability of the resource. However, Gordon pointed out that focusing on maximizing catch without accounting for the costs of fishing results in inefficiency. Schaeffer showed this graphically with the "Schaeffer Curve". He assumed total cost is a linear function of fishing effort, and showed that fishing effort should not continue to the point of the largest sustainable catch. As fishing effort increases, catch increases at a decreasing rate, so more resources are used to catch each successive fish than the one before it. Fishing effort should stop at the point of the maximum distance between total cost and total benefits. This point, the optimum economic yield, will occur before maximum sustainable yield is reached (Schaeffer, 1957). *See Figures 1 – 3.*

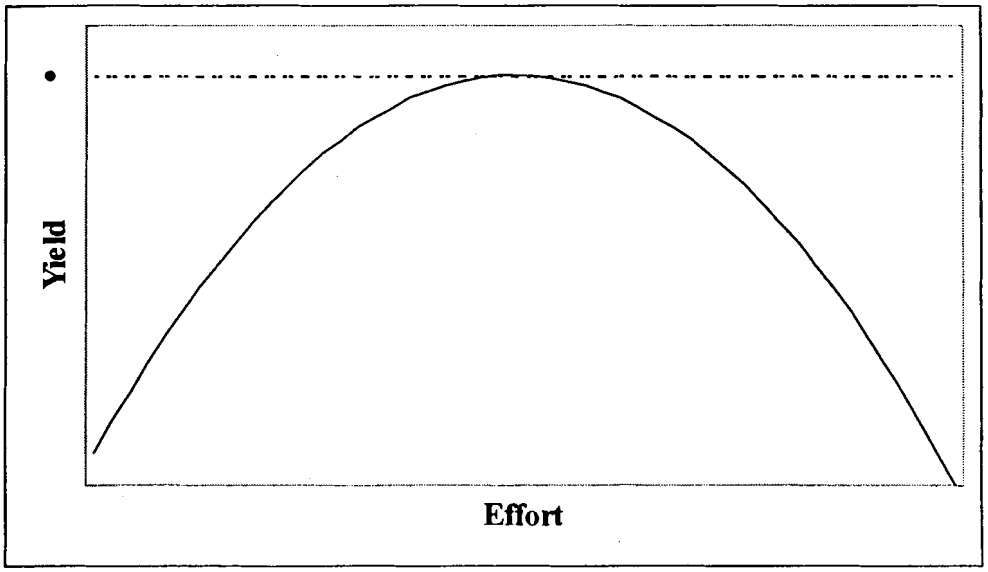
Biomass vs. Change in Biomass (growth rate)



* represents the maximum growth rate of the stock

Figure 1

Effort vs. Catch

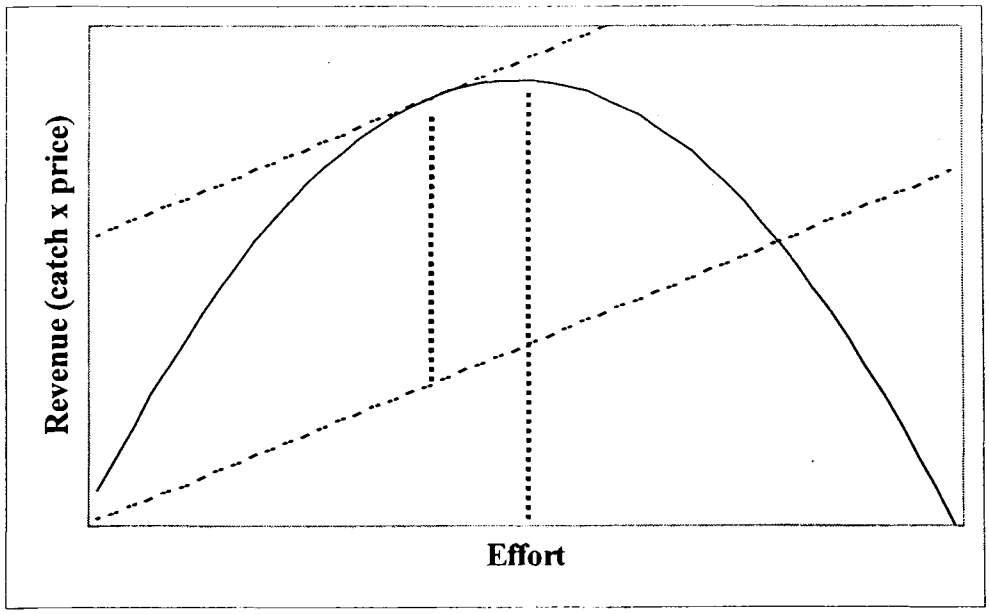


- Represents MSY. The axis on this graph has been flipped. Zero effort occurs at K, maximum effort will drive the population to zero.

Figure 2

Figure 3

Total Revenue vs. Effort



Dashed line to the left shows the maximum distance between total revenue and total costs, which occurs before MSY, the dashed line to the right.

Gordon argued that fisheries are inefficient because fish stocks are common property. If the stocks were owned or controlled by someone, fishing effort would stop where marginal costs are equal to marginal revenue. However, fishermen have no incentive to stop at this point. They know that others will continue to harvest, and are therefore driven to do the same. As a result, they keep fishing until average cost equals average benefit, and no rents are realized.

Schaeffer (1957) showed a dynamic relationship between a stock's biomass and its rate of growth. Over time, a stock's reduction (death and catch) is matched by its growth (recruitment and individual growth) so that total biomass reaches an equilibrium. When biomass is small, growth rate is high, and when biomass is high, growth rate is small.

Schaeffer then showed a relationship between fishing effort and harvest level (production). Initially, as effort increases, catch increases. The growth rate will increase to compensate for lost biomass. However if effort increases beyond a certain point, it will reduce the biomass of the stock so that growth rate is not able to keep up with harvest. Biomass and landings will decrease.

A "Schaeffer curve" can be drawn by plotting fishing effort on the x axis versus catch on the y axis. The top of the "Schaeffer curve" represents the maximum sustainable yield (MSY) for a stock. If the goal of a fishery is to remove as much biomass as possible, then this is the point for which management should aim. It represents the largest catch that can be perpetually sustained. If fishing effort increases beyond this point, the steady state growth will decrease. The smaller biomass will generate

inefficiency in the form of increased fishing costs - increasing effort will yield decreasing catch.

Economic efficiency requires that we consider costs as well as revenues. (See Figure 3.) Assuming revenue is a constant function of catch (price x catch = revenue), we can create a revenue/effort graph by multiplying catch figures on the y axis by price. Assuming cost is a constant function of effort, we can plot a total cost ray on this graph. The greatest distance between costs and revenues is found by drawing a line tangent to the effort curve that is parallel to the cost curve. The tangent point is the point of maximum economic yield (MEY). If the goal is to maximize net benefit, it is MEY we should aim for.

Scott (1955) advocated sole ownership of the fishery as a solution to its inefficiency problems. He showed that in the short-term, there is little difference in efficiency between common and private property. Each fishing boat (whether owned by individual fishermen or all operating under a sole owner) will experience increasing costs as it attempts to increase landings. Given a fixed number of boats and equipment, fishermen will increase their efforts until the price they receive for fish landed is equal to the costs they incur in fishing. However, inputs can be adjusted in the long-run. A sole owner can determine the optimum number of boats needed to catch fish most efficiently, and sell the remaining boats or put them to other use. However, the owner must have long-term property rights over the fishery in order to make this possible.

Beverton and Holt (1957) showed a relationship between fishing effort, mesh size, and equilibrium catch. Mesh size determines the size at which individual fish will be recruited to the fishery. Anything small enough to pass through the mesh will escape;

individuals larger than the mesh will be captured. Establishing a mesh size will change the age composition of the catch and hence the stock. Older fish larger than the mesh will be removed from the fishery as fishing continues, which will decrease the average size of individual fish.

Beverton and Holt (1957) showed that each mesh size gives a unique relationship between effort and catch. For any stock, all mesh sizes can be plotted, and a "eumetric envelope" can be drawn to connect them all. The point on each curve that is tangent to the eumetric envelope represents the most efficient level of fishing effort for that mesh size.

For any given mesh size, increased fishing effort will initially result in increased catch. However, as fishing continues, there are fewer large fish to catch. Also, some small fish are caught with every tow. For each mesh size, there is an optimum level of fishing effort. If effort increases beyond a certain point, biomass will be reduced and landings will fall. At this point, there are only two policy options to increase landings, both of which require time before landings increase: 1.) Stop fishing to allow the stock to recover, then resume fishing; or 2.) Establish a larger mesh size and continue to fish. This will allow more fish to grow to a size at which they can reproduce. However, it will mean fishermen will catch less fish in the short-term.

Turvey (1964) showed that rents cannot be generated in a fishery unless effort is restricted. For any given mesh size, unrestricted effort will increase until total revenue equals total cost. Restricting effort alone may generate rents if mesh size remains constant. The greatest rents can be realized by choosing the mesh and effort size that generate the largest distance between total costs and total revenue.

Externalities and Government Failure

An externality occurs when a person making a decision does not bear the full economic consequences of his action. External costs or benefits are borne by members of society. These costs are not correctly accounted for when deciding how much to produce or consume. If the externality is not corrected, the result will be an inefficient allocation of resources.

Lack of secure property rights can cause externalities. Consider for example a river that houses both a paper mill and a health spa. The paper mill uses the river as a receptacle for toxins produced in its production process. The health spa uses the river to attract customers. The mill's toxins lower water quality, which reduces the spa's business. However, the mill does not bear the cost of this reduced business, nor does it reap the benefits of the increased business a cleaner river would create. As a result, it will dump too much waste into the river, and an efficient allocation of river "benefits" will not be attained.

Externalities are present in many natural resources, including fisheries. Because no one owns the entire resource, no one bears the full costs of removing from it or weakening it, and no one gains the full benefits of protecting it.

In the early part of the twentieth century, prevailing economic theory suggested legislation and taxes as the best way to solve externalities. Taxes were used to stand in for the societal cost not accounted for by the individual. A "polluter pays" standard was the norm. Companies were made to pay for the costs they imposed on society. If a company produced pollution, they would be made to pay a tax equal to the (unaccounted

for) cost that pollution caused to society. However, Coase (1960) suggested another solution. Assuming all resource users have complete information and are capable of bargaining, they can solve the problem among themselves, often at lower costs. Coase demonstrated this concept with the example of a candy maker and a doctor's office. The doctor's practice is negatively impacted by the noise the candy maker produces. Traditional theory held that the person making the noise was responsible for the problem, and should therefore pay to rectify it. Coase showed that the candy maker can pay the doctor to compensate him for his losses, or the doctor can pay the candy maker not to make the noise. Either way, the costs that had previously been external to the noise-making decision are accounted for.

Transaction costs are the costs associated with gathering information necessary to make a deal, to bargain, and to enforce the terms of the agreement. Calabresi (1968) and Dahlman (1979) expand and clarified Coase's argument to show that it is transaction costs that prevent externalities from being solved. Dahlman concludes that our "sad state of affairs" is due to positive transaction costs and imperfect information. In fisheries, the lack of ownership rights is the primary cause of these externalities. A large part of the bargaining that must take place concerns who has rights to the resource. Because these rights are unclear, new entrants may emerge at any point and claim that they, too, have rights to the resource, and must therefore be allowed to bargain as well. Bargaining resources are used up determining ownership rights. These rights can then be challenged at any time, resulting in new rounds of bargaining.

Externalities create market failure. These externalities persist due to transaction costs. Much of the government's role is to reduce externalities and restore an efficient

allocation of resources. However, the government is not immune from, and often has very high transaction costs. Inefficiency can persist or even be augmented by government attempts to correct it.

Buchanan (1988) examined the inefficiencies in government solutions to market failure. He determined that "government failure" also occurs. Our government is based on the concept of public choice. Individuals are free to make choices based on their own cost-benefit calculus. Policy decisions have varying distributional affects. When a group of citizens stands to gain by a certain policy, they face an incentive to spend time and money to get the policy implemented. The potential losers also face an incentive to prevent the policy from being enacted. Potential gains are dissipated in distributional tug-of-wars. These battles employ numerous people who then stand to gain by ensuring that the tug-of-wars continue. Government inefficiency may dissipate rents, but it also keeps many people employed. These people stand to gain by preserving inefficiency.

Externalities create inefficiency in fishing. Government may be unable to solve these inefficiencies. If it is transaction costs that prevent inefficiencies from being solved by bargaining, then fishermen and non-governmental entities may be able to create institutions to reduce these costs, and therefore reduce the externalities.

Collective Action and Rational Choice Theory

Rational individuals make choices by analyzing the potential costs and benefits of possible actions. When a group of people must choose how to act, each faces individual incentives that may or may not align with collective incentives. A collective action problem exists where rational individual action can lead to an inefficient or Pareto-

inferior outcome (Taylor and Singleton, 1993). The basic question collection action theorists try to answer is "Under what circumstances will individuals create rules to constrain their behavior for the greater good?" This question was addressed by Mancur Olson (1965). Olson presents an equation of costs and benefits to determine the likelihood of successful collective action for any group. The net benefits to the individual *Ai* are equal to the gross benefits *Vi* minus the costs *Ci* of organizing the collective action to that individual. For any group, If $Ai > 0$ for some individuals, the group is privileged and will likely succeed. Those individuals for whom $Ai > 0$ will take the steps necessary to initiate collective action. If $Ai < 0$ for all individuals, the group is latent. Individual incentives are not present to induce group cooperation. Collective action will not occur unless other incentives are available to induce contributions.

Olson uses game theory (the Prisoner's Dilemma) to show that it is rational for individuals not to cooperate. The payoff for society and each individual would be greater if everyone cooperated. However, each individual has no way of making certain that others will also cooperate. If some cooperate and others do not, those who choose to cooperate will suffer a loss, while those who defect will gain. This logic applies to collective action – why should individuals join together and face the risk of abandoning a purely self-interested path? Olson also likens collective action to a public good. Public goods are characterized by the impossibility of exclusion and the jointness of supply. Olson's analysis of collective action depends not on jointness, but only on the impossibility of exclusion (R. Hardin, 1982). Once the good is provided, it is available to all. Individuals may look at the "good" of collective action as something that will be

provided regardless of their participation. They may therefore see it in their own best interest to "free-ride" off the work of others.

Olson suggests that the group size greatly impacts the likelihood of successful collective action. The smaller the group, the more likely they are to succeed. In a small group, each person's contribution is more obvious; individuals see the necessity of their cooperation in order for the group to succeed. In a larger group, individuals may feel their contribution is but a "drop in the pan". They are more likely to free-ride, assuming enough others will contribute to accomplish the task. Smaller groups are better able to monitor and sanction free-riders more effectively.

Olson identifies three possible "incentives" that make collective action more likely: irrational behavior, selective incentives of the by-product theory, and political entrepreneurship. Selective incentives such as membership benefits make collective action attractive enough to warrant the risks associated with it. These are linked to a by-product theory because many of the incentives come about only *after* the group is organized. Russell Hardin points out that because of this, many selective incentives do not explain what prompts groups to cooperate in the first place. Hardin places more emphasis on the importance of the political entrepreneur. Political entrepreneurs are people who, for their own career reasons, find it in their private interest to work to provide collective benefits to relevant groups. Political entrepreneurs work in one of two ways. They may be candidates for elective office who organize a group for political support. They may also found or expand an organization because their own careers will be enhanced by the size and prosperity of their organization.

Institutional Economics

The question "Under what circumstances will individuals agree to restrain their behavior in the best interest of society" is also addressed by institutional economists. Their work ties in with collective action theory because CAPs are often solved by the development of an institution. In both institutional development and CAP solution, individuals are trying to lower transaction costs.

There is a consensus among institutional economists that institutions and norms emerge as a way to coordinate behavior. Whether transacting with an ally, a competitor, or a trading partner, the process will work better if both parties have an idea of how the other will behave. Norms and institutions provide this sort of information.

In a two-person "game" or transaction, each party has a range of actions they can take. Each player's payoff is affected by their own choice as well as that of their opponent. The game is said to be in Nash equilibrium if each player's strategy is a best reply to his opponent's strategy. The question is: How do two players coordinate their play when they don't know what to expect from their opponent?

Sugden argues that players are somehow able, through experience and imagination, to signal each other what "type" of player they are. Over repeated plays, players note patterns in their opponents' strategy, and respond accordingly. Many games have several different equilibria. Because all players prefer to be at one of the stable equilibria, some of them will eventually focus on one of these equilibria, and the others will follow suit, which establishes a convention on how to play the game.

Sugden points out that there may be any number of equilibria in a game, with varying distributions of payoff, and that conventions could develop to attain any one of them. Any one of these conventions establishes an equilibrium, but no single one is prescribed as the solution. When people follow a particular convention, "they are guided by something more than the axioms of rational choice, as economists normally understand them."

Sugden suggests this "something more" is prominence. "Some ways of coordinating behavior seem to strike people as more obvious than others: this is the property of prominence. If people can coordinate their behavior without communicating with one another, they must be drawing – consciously or unconsciously – on some fund of ideas that they have in common." He goes on to suggest that the most important of such ideas is common experience. Common experience allows individuals to predict how others will act, and to choose their own action accordingly. People will follow conventions based on common experience in order to coordinate their behavior. Sugden's argument meshes nicely with that of Singleton and Taylor – individuals with common norms and experiences are more likely to coordinate their behavior to form an institution and to overcome a CAP.

Knight's (1992) theory is somewhat different. Although Sugden does mention that equilibrium points will often result in distributional inequities, Knight focuses on these inequities. Knight argues that social norms and institutions are developed as a result of people trying to maximize their individual gains. Any situation may have multiple solutions, and each of these solutions will benefit certain individuals more than others. People want to acquire as many assets as they can. People struggle to get rules

that help them to do this, and they do this by bargaining. When one person has more power (in the form of assets) than another, he has a leg-up in bargaining. Therefore, once a situation exists where one person has more power than another, he is in a strong position to keep this power.

According to Knight, rules emerge as a by-product of the conflict over distribution. Individuals want to increase their assets. Since everyone recognizes that *everyone else* is also trying to increase assets, the best way to acquire a bigger share of the available assets is by constraining the choices of others. People who are in power at the outset are obviously in a better position to do so. Those with minimal assets are apt to go along with these constraints, since they realize they lack the assets to make a better bargain. They will therefore abide by the rules imposed upon them, even though they're not obviously to their advantage. Rules are rarely completely fair – they almost always benefit some more than others.

Enforcing these rules can be costly, and can drain the resources of those in power to varying degrees. If a rule is very "unfair", those who suffer from it are more likely to rebel, raising enforcement costs. The constant interplay of benefits gained from inequitable rules and their enforcement costs can cause shifts in relative power. Knight says that norms are established from these shifts in power.

Communal Action Dilemmas and Natural Resources:

The rational choice and institutional economics discussions above examine two questions pertinent to this thesis: 1.) What circumstances will facilitate group cooperation; and 2.) How will rules come about to constrain individual behavior. A number of scholars have examined the former question as it pertains to natural resources.

Garrett Hardin (1968) made the "Tragedy of the Commons" a catch phrase by discussing collective action problems in natural resources. Hardin argued that any resource held in common will inevitably be overexploited. Hardin suggested two possible solutions to the "tragedy": open access resources should be privatized, or they should be regulated by the state. These two solutions were thought of as the only way to manage fisheries for much of the twentieth century.

The concept of access to common resources is not as simple as Hardin suggests. Schlager and Ostrom (1992) point out that it is important to define the types of property rights and access rights associated with a marine resource. Property rights can be divided into four basic types: *private property*, where an individual or corporation can exclude others from using the resource and can regulate its use; *state property*, where government holds and controls the rights to manage and use the resource; *open access*, where there are no well-defined property rights; and *communal property*, where the resource is held by an identifiable number of users who can exclude others and regulate use. (Berkes *et al.* 1989).

Hardin (1968) didn't acknowledge the presence of communal property. In fact, he used an example of communal property in his discussion of open access. He assumes

any resource not owned by private individuals or the state is open access by default. However, situations in which local user groups have turned open-access resources into communal property are not uncommon (Berkes *et al.* 1989; Ostrom, 1990; Acheson, 1998, among others). Communal property is not a recent phenomenon (see Eggertsson, 1992), although recognition of it as a solution to the problem of open access is.

Schlager and Ostrom (1992) define four types of rights that can be held over coastal fishery resources: access and withdrawal, management, exclusion, and alienation.

Table 1
Property Rights and Resource Users
Taken from Schlager and Ostrom (1992)

	Owner	Proprietor	Claimant	Authorized User
Access and Withdrawal	√	√	√	√
Management	√	√	√	
Exclusion	√	√		
Alienation	√			

They determine the likelihood of efficient harvesting rules increases as resource users gain more rights. However, they dispute the traditional economic argument that private ownership is the only way to ensure efficient resource utilization. People are more likely to invest in a resource if they know they will capture the benefits of their investment. The right of exclusion offers an important incentive for both owners and proprietors to make *current* investments in a resource. Owners and proprietors can decide who can and cannot access a resource, and are therefore reasonably assured that they and their offspring will benefit from their investments. Owners have the additional benefit of being able to sell their rights to the resource, which allows them to capture the benefits of long-term investments.

Individuals' discount rate will also influence how much they are willing to invest in a resource. Someone who values the future is more likely to invest in it. Conservation laws are, in a way, investments in the future of a resource. Clark (1973) showed that a high discount rate can provide justification for harvesting animal species to the point of extinction. In general, low discount rates provide incentives for conservation.

It wasn't until the late eighties that academics began to acknowledge that many small user groups had developed institutions to manage resources and to determine their allocation (Acheson, 1997; Wade, 1988; Baland and Plateau, 1996). Many of these institutions had gone completely unrecognized by the communities' government despite their success.

Taylor and Singleton (1993) address the importance of transaction costs in collective action problems (CAP). They note that unresolved collective action problems, or unrealized gains from cooperation, exist because of transaction costs. If it were not for these costs, rational actors would find ways to secure all the gains to be had from cooperation. They examine the factors that must exist for a group to solve a CAP endogenously (without outside assistance), and suggest this can only be done in groups with sufficient endogenous transaction resources to overcome the transaction costs.

The authors identify three phases to CAP solution. First, the parties must identify the possibilities for cooperation. Second, the parties must agree on one scheme of cooperation, which will involve bargaining. Third, the agreement will have to be monitored and enforced. Each of these phases has costs in the form of search costs, bargaining costs, and monitoring and enforcement costs. These are the transaction costs of solving a CAP.

They suggest that a strong sense of community makes overcoming a CAP more likely by reducing transaction costs and by increasing a group's endogenous transaction resources. They define community as a group of people having stability of relations, multiplex relations, direct relations, and shared beliefs and preferences. These conditions lower the uncertainty from which transaction costs are derived. Search costs are lower because identifying the possibilities for cooperation is easier when the group's members know each other and have multiplex relations. Bargaining costs are lower because shared beliefs and preferences reduce the range over which bargaining must take place, because stability makes it easier to conclude agreements and reduces the need for renegotiation, and because multiplex relations provide possibilities for trade-offs that compensate for differences in cooperative gains between the parties. Third, and most importantly according to the authors, monitoring and enforcement costs are reduced by shared beliefs and preferences, the stability of group membership, the expectation of continued interaction, and the directness and multiplexity of relations. "The more relations between the members of a group resemble those characteristics of a community, the lower are the transaction costs they must face – and hence the fewer the transaction resources they must expend – in order to solve a given CAP." Taylor and Singleton also point out that economic inequality and cultural heterogeneity tend to weaken community and therefore increase transaction costs.

One aspect of community that they consider very important is a shared system of norms. They define social norms as shared standards, and suggest that people conform to norms due to both the threat of sanctions as well as the belief that it is *right* to conform to

them. Because of this latter aspect, having a shared sense of norms may actually prevent having to enact sanctions, thereby preventing expenditure of transaction resources.

Taylor and Singleton bring up Olson's concept of a political entrepreneur. They state that a political entrepreneur must strengthen a group's sense of community in order to bring about collective action. The entrepreneur's role is to facilitate coordination and negotiation of an agreement and perhaps to monitor compliance with it. However, a political entrepreneur cannot *enforce* the agreement. Enforcement must come from within the community or from the state.

The amount of "community" present in a group will impact how much outside assistance is necessary in order to overcome a CAP. The authors describe various possibilities, from wholly-endogenous solutions to those that are imposed upon the group by an outside force. However, they believe that unless some of the characteristics of community are present in a group, the CAP will not be solved. A community has characteristics that reduce transaction costs enough so that they can be met from resources within the community. As the degree of community within a group weakens, more steps will be required to overcome a CAP. The authors state the first step will be internal division of political labor in arbitrating, monitoring, and enforcing an agreement; then the assistance of a political entrepreneur, and eventually recourse to the resources of the state.

Ostrom (1990) describes the basic conditions that should be met for communal action dilemmas to be solved. She distills these conditions down to a set of 8 design principles:

1. Clearly defined boundaries: Individuals or households with rights to withdraw resource units from the common-pool resource and the boundaries of the common-pool resource itself are clearly defined.
2. Congruence between appropriation and provision rules and local conditions: Appropriation rules restricting time, place, technology, and/or quantity of resource units are related to local conditions and to provision rules requiring labor, material, and/or money.
3. Collective-choice arrangements: Most individuals affected by the operational rules can participate in modifying the operational rules.
4. Monitoring: Monitors, who actively audit CPR conditions and appropriator behavior, are accountable to the appropriators or are the appropriators.
5. Graduated sanctions: Appropriators who violate operational rules are likely to be assessed graduated sanctions (depending on the seriousness and context of the offense) by other appropriators, by officials accountable to these appropriators, or by both.
6. Conflict-resolution mechanisms: Appropriators and their officials have rapid access to low-cost local arenas to resolve conflicts among appropriators or between appropriators and officials.
7. Minimal recongnition of rights to organize: The rights of appropriators to devise their own institutions are not challenged by external governmental authorities.

For CPRs that are parts of larger systems:

8. Nested enterprises: Appropriation, provision, monitoring, enforcement, conflict resolution, and governance activities are organized in multiple layers of nested enterprises.

Ostrom's design principles overlap with the conclusions of other research on common pool resources and communal action dilemmas. Agrawal (2002), Ostrom (1990, 1997, 1999), Wade (1988), and Baland and Platteau (1996) all find similar basic characteristics that must be present in a group for successful solution of a CAP. These characteristics pertain to four basic variables: characteristics of the resources; nature of groups that depend on the resources; particulars of institutional regimes through which resources are managed; and the nature of the relationship between a group and external forces and authorities such as markets, states, and technology. Ostrom (2000) examined a large body of literature concerning common-property

resources. She developed a revised list of attributes that increase the likelihood that self-governing associations will form. In this list, she gives attributes of both the resource and the appropriators:

Attributes of the resource:

1.) Feasible improvement: Resource conditions are not at a point of deterioration such that it is useless to organize or so underutilized that little advantage results from organizing.
2.) Indicators: Reliable and valid indicators of the condition of the resource system are frequently available at a relatively low cost.
3.) Predictability: The flow of resource units is relatively predictable.
4.) Spatial extent: The resource system is sufficiently small, given the transportation and communications technology in use, that appropriators can develop accurate knowledge of external boundaries and internal microenvironments.

Attributes of the appropriators:

1.) Salience: Appropriators are dependent on the resource system for a major portion of their livelihood.
2.) Common understanding: Appropriators have a shared image of how the resource system operates, and how their actions affect each other and the resource system.
3.) Low discount rate: Appropriators use a sufficiently low discount rate in relation to future benefits to be achieved from the resource system.
4.) Trust and reciprocity: Appropriators trust one another to keep promises and relate to one another with reciprocity.
5.) Autonomy: Appropriators are able to determine access and harvesting rules without external authorities countermanding them.
6.) Prior organizational experience and local leadership: Appropriators have learned at least minimal skills of organization and leadership through participation in other local associations or learning about ways that neighboring groups have organized.

In all of these authors' research, the findings suggest that small groups of local users are more likely to solve CAPs than are larger groups or the intervention of an outside authority.

Traditional Fisheries Management

Fisheries management has traditionally recognized the inefficiency problems inherent in fisheries, and has attempted to resolve them by implementing top-down controls on fishing effort. Management has often been designed with Hardin's tragedy in mind, with fishermen viewed at as self-interested pillagers of fisheries. Rather than working with fishermen to design plans to overcome communal action problems, managers have attempted, almost always unsuccessfully, to impose their own solutions.

One solution is to raise the cost of fishing to account for external costs. This can be accomplished with Pigouvian taxes. The taxes can be imposed on the right to fish, or on any number of different measures of fishing effort. This is politically unpopular, as fishermen are already seen to be suffering from the collapse of many fisheries. It is also complicated. If you tax inputs (horsepower, length of net, etc.), you encourage fishermen to change their input mix. Each type of input would have to be taxed in order to affect all fishermen fairly. There are also non-technological ways to change fishing effort, from changing fishing technology, to fishing at different times or different areas, and these differences would have to be addressed as well. Not only would such a tax system be complicated, it would also encourage black market trading in taxed technology.

Taxing outputs (pounds of fish) seems simpler, but it also has drawbacks. It encourages underreporting or not reporting catch at all.

Managers can simply decide what technology should be used and create laws demanding it. They can outlaw certain technologies, and demand certain mesh sizes. Unfortunately, limiting certain types of technologies encourages increases in unregulated,

often inefficient technologies. In addition, these rules often carry with them huge enforcement costs.

Another basic solution is to determine how much fish should be caught, and implement a catch quota. Although this sounds reasonable, it is more complicated than it seems. First of all, fisheries biology is not an exact science, and it is difficult to forecast the exact MSY for any stock. Even if this figure could be precisely identified, other problems emerge. Having a fixed quota results in a race to catch as many fish as possible before the quota is reached. Boats may be forced to face unsafe conditions in order to catch fish while they can. Also, quotas flood the market, resulting in lower prices while the fish are landed, and higher prices while the fishery is closed.

Another management tool is to restrict the number of people able to fish by enacting a limited entry system. Managers can determine how much fish can be caught sustainably, how much each fishermen is able to catch, and an optimum number of licenses to fish. This system suffers from the same biological uncertainty as does the quota system. In addition, once the number of licenses is set, each licensed fishermen has an incentive to increase his effort to maximize his gain from the rents created by limiting the number of fishermen. It is also politically difficult to determine who will be allowed to fish. Selling the licenses may be efficient, but it is politically unpopular. Linking license availability to past fishing history raises the problem of new entrants – how will they enter the fishery? License limitations may be easier in new fisheries, but once a person has the right to fish, it is very difficult to take that right away from him.

One way to avoid these problems is to combine limited entry with a quota on catch. This is the concept of the individual transferable quota, or ITQ. By being

transferable, fishermen are able to sell the quotas rights among themselves, ensuring they are held by those fishermen able to catch the quota most efficiently. Fishermen that hold the rights are then able to spread their effort out over the year, resulting in a more efficient catch distribution. Despite economic efficiency, many fishermen oppose such plans in fear that the quotas will wind up in the hands of a few large processors able to afford to buy up many quota rights.

Any attempt to control fishing effort can be subverted. The fact that fishing often takes place in small vessels in a large ocean area makes enforcement costs an important concern. Fisheries management has suffered failures in recent years, and these failures have not gone unnoticed by fishermen. Fishermen often distrust managers, and have a valid suspicion of the validity of their estimates and "scientific certainties." However, without the support of the fishermen, almost any management plan is doomed to fail. If the fishermen don't stand behind the rules imposed upon them, the rules are often basically worthless.

Spawned in part by collective action theory, a new trend is emerging in fisheries management. Rather than continuing with top-down management imposed upon fishermen, managers are beginning to involve fishermen in the process. This co-management approach is apt to be more successful for many of the reasons discussed in the section on collective action problems. Small groups of users familiar with local conditions are able to design policies that fit the resource and the resource users best. When fishermen are involved with management, they are more likely to abide by the decisions imposed by it, which lowers enforcement costs.

One problem with co-management is that it lacks a precise definition. Any situation in which two groups cooperate on resource management could be defined as "co-management". However, a number of authors have examined various forms of co-management and discussed their findings.

Acheson (1997, 1998) and Acheson *et al*(2000) studied the effects of co-management in the Maine lobster fishery. The Maine coast is broken into management zones, in which local users play a large role in management. Each zone is governed by a zone council that creates and implements policy specifically suited to their zone. All of this is conducted under the guidance and supervision of the state. Prior to the creation of the zones and zone councils, the state had tried unsuccessfully for almost forty years to enact a trap limit law. Seven zones and their boundaries were established in 1997. By 1998, each of these zones had established their own trap limits. Clearly, this is an example of successful co-management.

Pinkerton and Weinstein (1995) and Singleton (1998) have also studied examples of co-management, primarily in the Pacific Northwest. They conducted numerous cases studies in which local user groups attempted to develop institutions to manage fisheries resources. They describe many of these attempts as successful, and suggest that co-management offers an efficient alternative to the traditional top-down management approach.

Townsend (2002) examined fourteen cases in which fisheries participants negotiated bargains to deal with exploitation inefficiencies. Once the government established use rights, resource users were able to devise efficient allocation arrangements amongst themselves. In many cases, bargains were struck quickly in

situations where the government had been unable to devise solutions for years. Townsend does not consider these cases to be examples of co-management. He considers them cases in which the economic incentives of use rights were fostered efficient use of fisheries resources.

Chapter 7

DATA AND DATA ANALYSIS

Methods

The state collects catch and effort data from all shellfish dealers within Maine. Dealers complete monthly forms in which they enter the number of bushels or pounds landed each day and the number of diggers who harvested them. They must also enter the town in which the clams were landed. For this study, I collected data for the entire state. I then separated all landings originating in Cushing, St. George, Thomaston, and South Thomaston.

The data used for this analysis came from three sources:

- Data for the years 1978, 1979, 1980, and 1981 were obtained from Ralph Townsend at the University of Maine. He collected the data while they were still available from the state to use in a study on the impacts of management programs on harvest efficiency (Townsend, 1985). The data are no longer available from the state.
- Computerized, standardized landings data were obtained from the state for the years 1998, 1999, 2000, and 2001.

Reliable landings data for Maine soft shell clam harvests are difficult to obtain prior to 1998. State records are incomplete and often inaccurate. Dealers are not always vigilant in their data entry. State data collection, computation, and entry methods have varied over the past 30 years. Landings data were collected in bushels in the 1970s and 1980's and in pounds in the 1990's. The pound to bushel conversion factor has varied

from 50 pounds per bushel to 65 pounds per bushel. The documentation concerning when these conversion factors changed is not reliable. It is therefore difficult to know if a "bushel" documented in 1978 is equal to 50, 55, 60, or 65 pounds. These inconsistencies complicate efforts to draw meaningful conclusions between pre and post-management figures.

The character of the Georges River fishery has changed over the last 3 decades. Anecdotal evidence from area harvesters suggests that the early eighties represented the fishery most similar to today's in terms of the number of harvesters and the acreage of open flats. For this reason, and for reasons of data availability, data were collected for 1978 to 1981.

Conversion problems make comparisons between 1978-1981 data and 1998-2001 data difficult. However, it is feasible to compare information *within* these year groups. For instance, 1978-1981 catch per unit of effort data for the Georges River area can be compared with state data as a whole during that time. The same can be done for 1998-2001.

1978-1981 Data

Data for 1978- 1981 were compiled from state dealer sheets. Dealers listed daily totals of bushels purchased and the number of diggers who harvested them. According to Townsend (personal communication), a variety of ambiguous entries occurred in the raw data. In any given year, one-third to one-half of the landings data could not be associated with reliable effort data. Landings information for which reliable effort figures were not

available was listed separately. The current study used only data associated with reliable effort data.

In Townsend (1985), data were deleted from the file for three reasons: 1.) All clams dug under depuration permits were excluded. As listed in chapter 4, depuration digging has higher average yields than traditional digging. Including depuration figures in totals would distort the catch per unit of effort data. 2) The data for three large dealers contained seriously misleading information and was removed. These dealers submitted information that was implausible compared to other dealer reports. 3.) The data for September 1980 were excluded. In September 1980, the DMR embargoed all digging of clams in Maine due to a high risk of paralytic shellfish poisoning. Dealers were permitted to buy clams on September 1 because some diggers possessed clams dug legally the day before. For many reasons, reported landings were extremely high for that day. In addition to data deleted from the original study, data from the March 1978 Georges River area were deleted. Only 6 bushels were reported in this month (for unknown reasons), and the resulting CPUE figure was deemed an outlier and omitted from the final comparison.

Each daily entry can be converted to a CPUE figure by dividing the number of bushels by the number of harvesters. This gives an average estimate yield for one digger for one day (yield per digger day). In order to standardize the results with later data, all bushel figures were converted to pounds using a 50:1 conversion factor. [1] To make the

[1] This conversion figure was used because of its simplicity and the fact that it is most commonly used today. However, as stated earlier, because the conversion factor used by the dealers and the State from 1978-1981 is not known, it is *not* possible to compare landings from 1978-1981 to those of 1998-2001. Instead, landings were compared *within* these two time periods.

comparison between Georges River landings and state landings more meaningful, Georges River data were removed from state totals.

1998-2001 Data

Data for 1998 to 2001 were obtained from Ron Aho, DMR area biologist for Mid-Coast Maine. He compiled the data from state dealer reports. From 1998 to the present, dealers list each purchase separately. Each purchase is assumed to represent the amount harvested by one digger on one day (yield per digger-day). Depuration landings are not identified separately. In an effort to exclude depuration landings, all harvests greater than 300 pounds were discarded for this study (it is unlikely that any one harvester would be able to dig more than 300 pounds in one day unless working on a depuration crew). Data were compiled into monthly totals for landings and digger days. As in the previous years' data, Georges River data were removed from state totals to make for a more meaningful comparison.

CPUE – State vs. Georges River 1978 - 1981

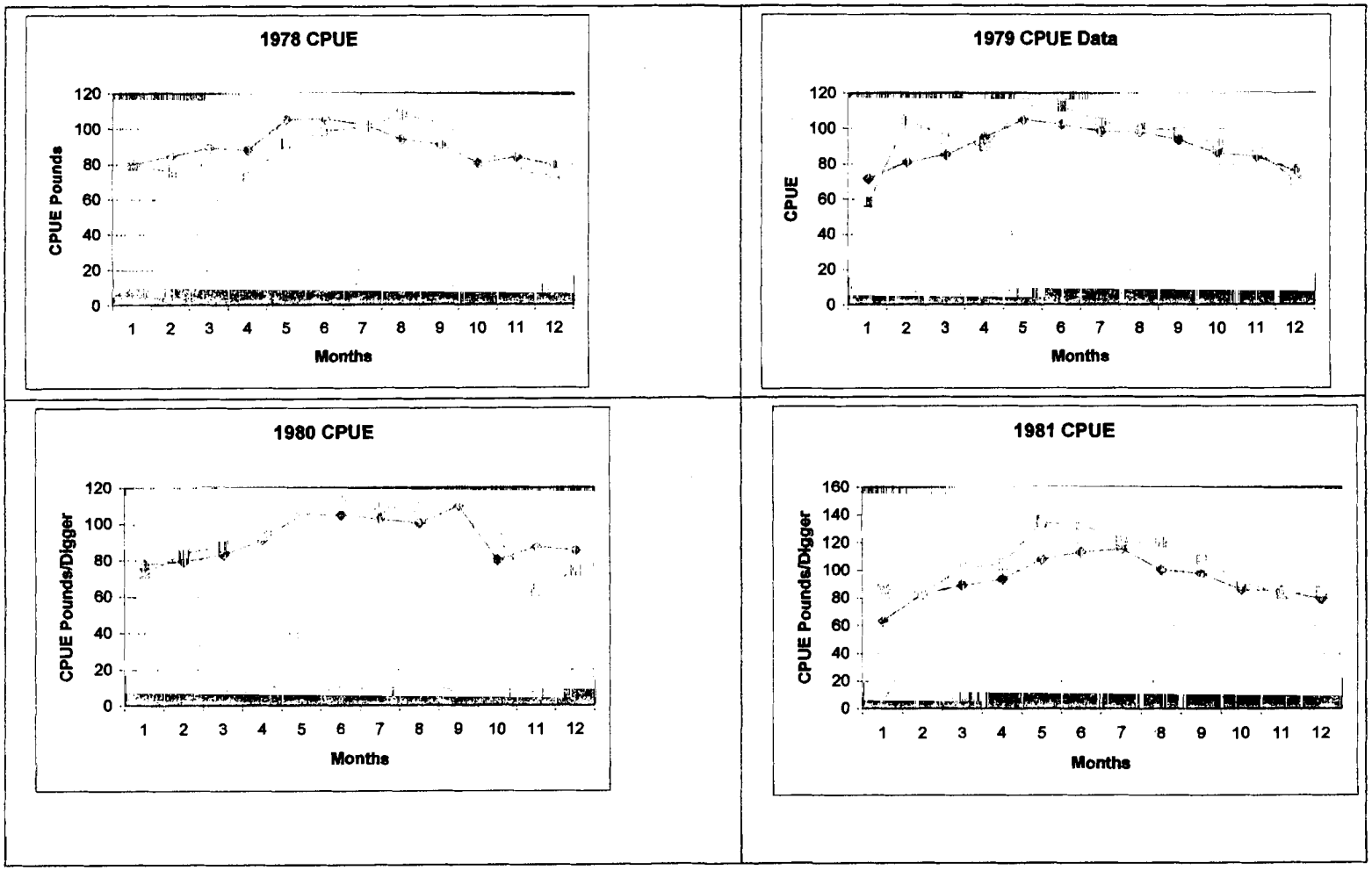


Figure 4

State CPUE

Georges River CPUE

CPUE – State vs. Georges River 1998-2001

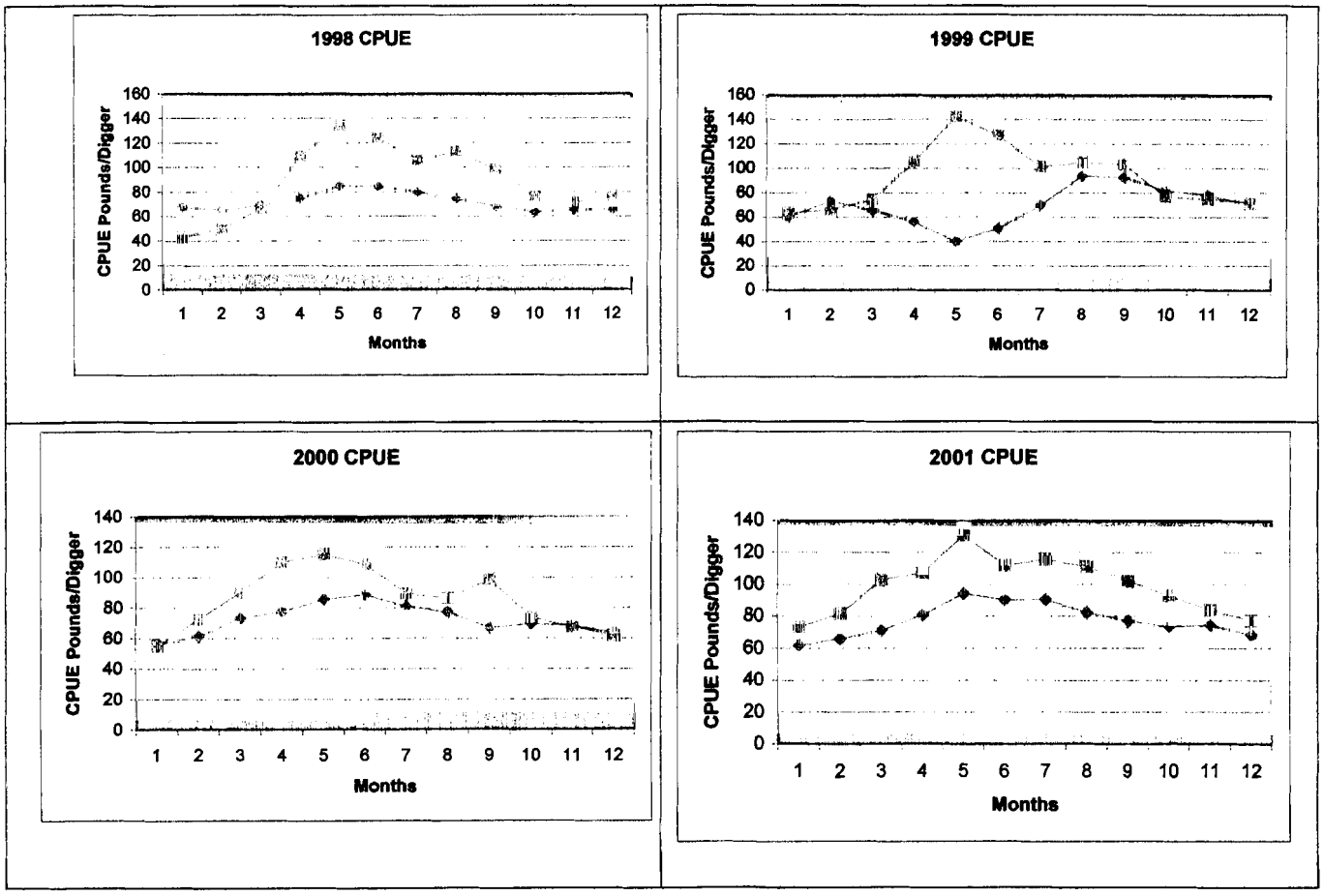
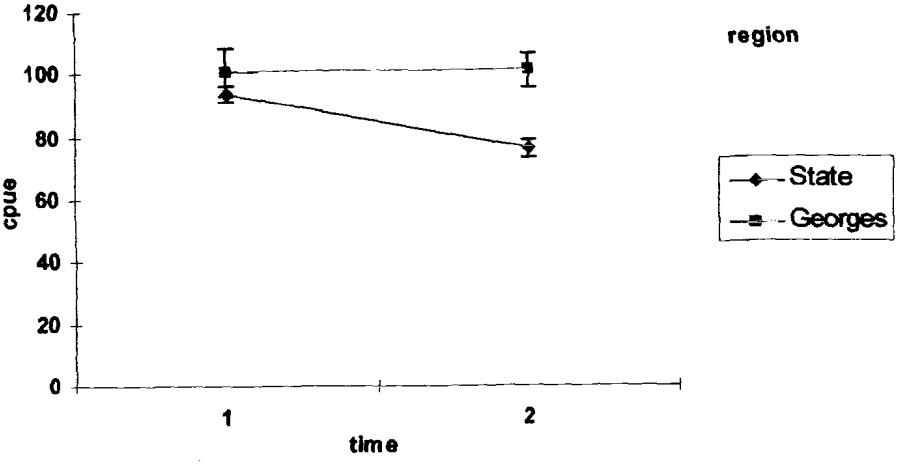


Figure 5

Figure 6
Line Graph – CPUE, State vs. Georges River
Time 1 vs. Time 2
(error bars indicate standard errors of the mean)



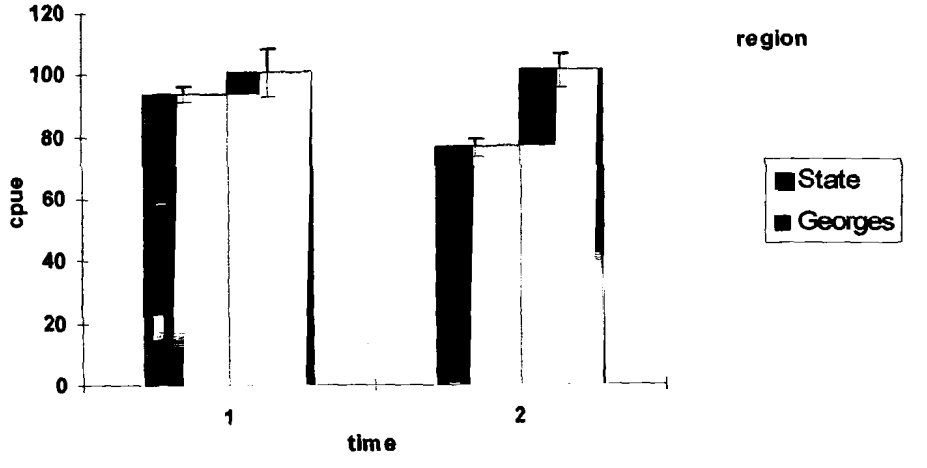


Figure 7
Bar Graph – CPUE, State vs. Georges River
Time 1 vs. Time 2
(error bars indicate standard errors of the mean)

Results

Georges River CPUE increased dramatically versus state CPUE in the years after management for which we have data. A 2-way, factorial ANOVA (model 1) was conducted to determine if this difference is significant. The ANOVA was based on annual CPUE for each region over Time 1 (1978-1981) and Time 2 (1998-2001).

This analysis shows the Georges River CPUE to be significantly higher than the state average after management was enacted. The state average CPUE was 93.8 pounds per digger-day for Time 1 (standard deviation of 2.7), and 76.3 pounds per digger for Time 2 (standard deviation of 2.8). The Georges River area CPUE was 100.9 pounds per digger-day for Time 1 (standard deviation 7.6), and 101.3 pounds per digger day for Time 2 (standard deviation 5.6). The probability (p-value) that the observed change in the relationship between Georges River area CPUE and the state CPUE would arise strictly due to chance is 0.0043.

Table 2
CPUE – State vs. Georges River

	Time 1		**Time 2**	
	CPUE	Standard Dev.	CPUE	Standard Dev.
State Average	93.8	2.7	76.3	2.8
Georges River	100.9	7.6	101.3	5.6

Table 3
ANOVA Table – CPUE - State vs. Georges River, Time 1 vs. Time 2

Source	DF	SS	MS	F	probability
Time	1	295.402	295.402	11.2882	0.00568
Region	1	1030.07	1030.07	39.3622	4.1E-05
Time*Region	1	321.673	321.673	12.2921	.00433
Error	12	314.029	26.1691		
Total	15	1961.18			

Chapter 8

DISCUSSION AND CONCLUSION

A number of different factors led to the development of the Georges River program. Certain issues provided incentives to formulate a town ordinance. Others provided incentives for a multi-town plan. In this chapter, I will discuss these factors individually, and then develop a broader discussion about the program's development, how it ties in with current theory, and its broader implications to resource management.

Maine State Law

In 1963, the Maine Legislature passed a law allowing all towns to enact shellfish ordinances granting preferential harvesting rights to residents. In January of 1996, Georges River area residents petitioned the legislature to enact a law granting the same privileges to multiple-town programs (L.D. 1717). This law was approved on May 12, 1996.

With L.D. 1717 in place, Georges River area residents were able to exclude others from the resource, a right co-management theorists and economists alike espouse as vital to effective conservation. The ability to exclude others provided a great incentive to enact local management. If the Georges River's flats had been opened without a local ordinance in place, diggers from all over the state would have been able to harvest the clam resource. It should be noted that Maine state law requires that at least 10% of all licenses be made available to non residents. However, 90% can be reserved exclusively for locals. By enacting a local ordinance, residents could limit "outsiders'" share of the resource to roughly 10%.

The state of Maine allows towns to manage their own shellfish resources, and provides them with an incentive to do so – the ability to exclude others. It also provides biological knowledge and assistance to towns through area biologists. These factors facilitate the development of and support local management.

Distribution Fights

Knight argues that social norms and institutions are developed as a result of distribution fights. Almost all rules benefit some more than others. People struggle to establish rules that will increase their share of assets. Over time, these rules are often established as norms within the community.

The establishment of a town ordinance in the Georges River area fits nicely with Knight's theory. Local residents were able to increase their individual benefits by implementing a town management plan. Had they done nothing, it is likely that diggers from all over the state would have quickly exhausted the resource. Without a management plan in place, there would be no incentive for any diggers (resident or non-resident) to constrain their effort. The benefits of constraint would be just as likely to fall to someone else as to the person who conserved. Generating a local ordinance allowed residents to increase their share of the resource by excluding others.

Residents could also have opted to work with Spinney Creek to manage the resource. Day-to-day management decisions would have been left to Spinney Creek (Tom Howell's February 1996 letter to the town of St. George), and the towns could have simply collected a per-bushel fee. However, this would have decreased the amount of benefits falling to town residents. This proposal was rejected.

A well-drafted local ordinance provides two benefits. First, it provides preferential benefits to area residents. Second, it reduces incentives to overexploit and increases incentives to conserve. The majority of municipal ordinances have one real purpose: to provide preferential harvesting for locals (Winters, personal communication). Local residents want to gain a greater share of the resource than outsiders. The only way they can exclude outsiders is by creating a local ordinance. Therefore, the primary purpose of these ordinances is not to preserve the resource, but to ensure a greater portion of the harvests goes to locals. Preferential harvesting rights create the incentive to conserve. Locals can be confident that the benefits of conservation will fall to them. Improvement to the health or size of the resource is therefore a secondary benefit.

Conservation rules constrain individual behavior in order to provide a group benefit. Schlager and Ostrom (1992) point out that individuals are more likely to exercise rights of management when the likelihood they will receive the benefits of management is high. In Maine, 90% of a town's commercial licenses can be reserved for local residents. Town programs can develop rules to constrain everyone's behavior, but provide 90% of the benefits to locals. This provides a clear incentive to implement town management. The likelihood of effective management increases along with the security of benefits.

Political Entrepreneur

Olson (1965) pointed out that groups may not be able to devise rules despite the apparent benefits they would generate. Organizing imposes costs, and the benefits of organizing are not always certain or substantial enough to overcome these costs. A

catalyst of some sort may be needed to initiate and encourage an organization effort. Olson (1965) and Hardin (1982) both identified the political entrepreneur as an important potential catalyst to collective action.

Latent groups do not organize because the individual benefits of action do not overcome the potential costs. Group members cannot be sure their efforts will succeed; any costs they incur may be in vain. Even if they are successful, benefits will flow to the entire group, including those who did not cooperate. Under these conditions, it is rational for an individual to do nothing but sit back and wait for benefits to be provided. By doing so he incurs no costs, but receives just as many benefits as anyone else. Everyone thinks the same way, and a collective effort does not take place.

Political entrepreneurs can help to overcome the obstacles to collective action. As defined by Hardin (1982), "Political entrepreneurs are people who, for their own career reasons, find it in their private interest to work to provide collective benefits to relevant groups." Sherman Hoyt fits this description. In 1995, he was looking for a new career. He felt that organizing stakeholders and creating a management program might provide it (personal communication with Sherman Hoyt). He began work as an unpaid volunteer. By the second year of program development, he was able to collect a salary from grants. Recognition of his hard work and effective leadership led to a job with Cooperative Extension in 1999.

Hoyt was also interested in developing a sustainable fishery for altruistic reasons: he is a resident of the area, and has ties to the community. By organizing the Clam Restoration Project, he benefited both the community and himself.

Many people involved with the program say it would never have come about without the efforts of Sherman Hoyt (personal communications with Shellfish Committee and Joint Board members). As mentioned in the background section, locals were generally in favor of a multi-town program, but it was Hoyt that inspired them to act. There are many other individuals who volunteered their time and energy to help build the program. However, Hoyt was the key player who spearheaded organizational efforts and was instrumental in program development.

Geography and History of the Area

The layout of the area is conducive to a multi-town plan. The five towns are aligned along the river. Although St. George has some flats on its ocean side, the most productive flats are contained within the estuary. Historically, diggers worked the entire area irrespective of town boundaries, so it seemed natural to develop an estuary-wide ordinance.

By 1994, many towns along the coast of Maine had developed municipal shellfish ordinances. Because the Georges River was closed, none of the towns had developed municipal programs. The fact that none of the towns had ordinances in place made it easier to develop a multi-town plan. It is easier to build a program from the ground up than to try to patch together individual programs. If any one of the towns had had a program in place, they might have resented the other towns benefiting from the work they had already undertaken. The fact that all the towns were closed, and all had something to offer the program, meant that they could start on equal ground.

The Georges River Tidewater Association established a precedent for multi-town cooperation along the river. Stakeholders from all of the towns worked together to improve water quality. It was because of these efforts that the flats were opened. The Tidewater Association served as proof that local-level stakeholders could make great accomplishments in the area. The Tidewater Association was the first to suggest that a multi-town ordinance be developed. They have maintained a good relationship with the SMC, and have assisted with shellfish activities such as water quality testing and shoreline clean-ups.

The long-term closure of the river allowed the clams within the flats to grow in both numbers and individual size, unabated by human predation. Local harvesters working for depuration companies witnessed large numbers of mature clams within the flats. Unlike other fisheries, where the size and numbers within a stock must be predicted, residents were actually able to see the clams that had been growing throughout the closure period. They could see the clams that would be theirs once a program were established. This potential gold mine was an incentive to act.

Depurators

Local harvesters believed they were being treated unfairly by Spinney Creek, the depuration company doing business in the area at the time the restoration project began. They perceived Spinney Creek as an outsider who was benefiting disproportionately from "their clams" (personal communication with Shellfish Committee and Joint Board members). This perception of unfairness was supported by Spinney Creek's 1996 letter

to the town of St. George in which they offered to pay a per-bushel surcharge of $5, ten times the rate they had been paying at the time.

Animosity toward Spinney Creek fostered an "us against them" mentality. When Roger Gagne suggested the five towns enter into an exclusive arrangement with Spinney Creek, the idea was soundly rejected. Locals wanted to manage the resource for themselves. Spinney Creek's offer created an additional incentive for local cooperation. Many of the harvesters felt they needed to work together to "take back" the resource from outsiders (personal communication with Shellfish Committee members). By enacting a local ordinance, two groups of outsiders (depuration companies and non-residents) would have their share of the resource reduced.

Attributes of the resource and of harvesters

The sedentary nature of (mature) clams removes one of the difficulties present in the management of mobile fisheries. A soft-shell clam will not travel between management zones within its adult life cycle. Ostrom (2000) states that knowledge (predictability) of the resource, known spatial extent, visible indicators of resource health, and feasible improvement facilitate self-governance. Each of these factors positively influenced by the sedentary nature of clams (see next page, "Attributes of the resource").

Taylor and Singleton (1993) believe that a sense of community in a group increases the likelihood of successful collective action. Organizing to overcome a CAP creates transactions costs in the form of search costs, bargaining costs, and monitoring and enforcement costs. Community economizes on the need for transaction resources to overcome these costs.

A number of characteristics influence the sense of community in a group. Taylor and Singleton (1993) identify stability of relations, multiplex relations, direct relations, and shared beliefs and preferences as important factors influencing a group's sense of community. Cultural heterogeneity can undermine efforts to cooperate.

Residents of the Georges River area have a strong sense of community. Many of the stakeholders involved in the development of the program had lived in the area for years. Their children attended local schools together, and they worked together on the flats and in local community groups. Mid-coast Maine does not exhibit cultural heterogeneity to any large extent. There are "summer residents" and year-round residents that make up different classes. The management program provided incentives for all residents to work together, regardless of their social standing. The plan would not only provide jobs for commercial harvesters – it would provide all residents the opportunity to dig a "mess" of clams. However, the majority of the people that worked to pass the shellfish management plan were year-round residents of the same or similar social class. These factors made it easier for the group to identify possible solutions and to bargain.

Ostrom (1990, 2000) developed two lists of factors that facilitate the development of a self-governing resource system and successful solution to CAP's. These lists are discussed in the literature review. Her (2000) list describes attributes of the resource and of the appropriators that increase the likelihood a self-governing association will form. The Georges River Program possesses many of these attributes:

Attributes of the resource:

1.) Feasible improvement: Harvesters could see that a large number of good-sized clams had developed during the time the river was closed. This provided a "goal" of being able to harvest these clams, and provided evidence that clam stocks could improve under certain conditions (if years of rest could improve resource health

compared to open-access harvesting, perhaps management could also improve the resource).

2.) Indicators: Harvesters were able to see the health of the stock both by digging for depuration crews and by observing the siphon holes on the flats.
3.) Predictability: Clam stocks are fairly sedentary, and although a stock-recruitment relationship is not known, it is generally believed that a large parent population will lead to large future populations.
4.) Spatial extent: Many harvesters had worked the estuary for years, and were familiar with the both the resource and the estuary in which it occurred.

Attributes of the appropriators:

1.) Salience: Harvesters believed they would be able to earn a decent income from the resource.
2.) Common understanding: Most of the people interested in harvesting the resource had dug clams before both on the Georges and elsewhere, and were familiar with how their actions would impact other harvesters and the resource itself.
3.) Low discount rate: Once their rights to the resource were secure, harvesters displayed an interest in developing a sustainable fishery rather than quickly depleting the resource.
4.) Trust and reciprocity: Harvesters and stakeholders were all local residents and most were familiar with each other. They were more likely to trust neighbors from the area than those "from away".
5.) Autonomy: The SMC and Joint Board are able to develop their own rules. Although the program must be approved by the state DMR, they can act largely autonomously.
6.) Prior organizational experience and local leadership: The Tidewater Association provided an example of what local stakeholder groups could accomplish. Sherman Hoyt was an experienced leader. The Joint Board was composed of local selectmen familiar with municipal management processes.

Ostrom (1990) also describes "8 design principles" that tend to be present in long-enduring common-pool resource institutions. The Georges River Program also has many of these attributes:

1.) Clearly defined boundaries: Clam flats within the estuary were entirely contained within the five towns, so boundaries were well-defined.
2.) Congruence between appropriation and provision rules and local conditions: Rules were devised by the harvesters and local stakeholders. The governance structure, the numbers of licenses assigned, the times when digging was allowed, the schedule and type of conservation and management activities, and the penalties for rule infractions were all devised by the people who best knew the resource.

3.) Collective-choice arrangements: Harvesters serve on the SMC. The ordinance is reviewed and approved on an annual basis by both the Joint Board and the Shellfish Management Committee. However, harvesters do not serve on the Joint Board, which has ultimate decision-making authority.
4.) Monitoring: Although harvesters do not have enforcement abilities, they do monitor each other, and report transgressions to the warden and to each other.
5.) Graduated sanctions: The ordinance outlines penalties that increase with the severity and frequency of the crime.
6.) Conflict-resolution mechanisms: This ordinance does not outline exact conflict resolution mechanisms. Although mechanisms are in place to resolve conflict between the towns, no specified mechanism is in place to resolve conflict between diggers or between the SMC and the Joint Board
7.) Minimal recognition of rights to organize: The state of Maine recognized the towns' right to develop and maintain regional management.

Laws within the state of Maine provided incentives to establish local-level management. Preferential harvesting rights increased harvesters' incentive to conserve. These facts, combined with attributes of the resource and harvesters, facilitated self-governance in the Georges River area.

Knight suggests rules emerge as people fight to increase their share of assets. Schlager and Ostrom suggest that the likelihood of successful management increases as harvesters gain more rights to a resource. The presence and security of rights to a resource are therefore important factors in the development and maintenance of management. The fact that clams are sedentary once settled increases the security of harvesters' rights. The relative strength of locals' rights to the Georges River clam resource increased the likelihood of effective management.

The concept of co-management is gaining popularity in fisheries management circles. Local-level groups are slowly increasing their participation in management decisions over fishery resources. Advocates of co-management have gathered a good deal of evidence to assert that local-level decision making is a key determinant to

management success (Feeney *et. al*, 1996, Ostrom, 1990, Singleton, 1998). However, local level control alone does not explain how and why the Georges River Program began, and how it developed into an effective management plan.

Management Alternatives: Co-management vs. Property Rights

The resource economic literature states that ownership rights to resources and product are important determinants of economic efficiency (Agnello and Donnely, 1975). Since Anthony Scott (1955) proposed sole ownership of fisheries resources, economists have been in agreement that privatization of fishery resources would solve their inefficiency problems. However, freedom of access to ocean and coastal resources is deeply ingrained in western culture. Creating formalized ownership rights over fishery resources is often not feasible.

Common property theorists argue that the solution to current fisheries management crises is to allow resource users to develop management institutions tailored to fit local conditions (Feeney *et al.*, 1996). Common property theorists give examples of successful local governance institutions and argue that resource users are best equipped to manage resources. They assert that traditional management has been unable to devise successful solutions to collective action problems. Numerous examples of failed centralized management exist to back their claims (Wunsch, 1991, Ostrom, 1990). Traditional practice has implemented one solution to fisheries inefficiencies: centralized governance. However, traditional theory has identified two solutions: centralized management or privatization of the resource. Common property theorists have dismissed the latter as summarily as the former, but without equivalent evidence.

Lack of secure property rights complicates any attempt to reduce fisheries externalities. Although property rights would reduce inefficiency, co-management theorists favor other alternatives. Taylor and Singleton (1993) claim a sense of community helps groups to bargain away externalities and overcome collective action dilemmas. The greater a sense of community a group possesses, the greater their likelihood of successful resource governance development and solution of communal action dilemmas.

Schlager and Ostrom (1993) identify four basic types of property rights and resource users in fisheries resources. They determine that the more rights a resource user has, the more likely they are to use the resource efficiently.

The authors point out that economists draw an important distinction between owners, who hold a complete set of rights, and all other users, who do not hold complete rights. Quoting Posner (1975), they state that the rights of alienation combined with rights of exclusion produce incentives for long-term investment in a resource. This argument is at the foundation of economic efficiency theory in resource management.

Despite Posner's argument, Schlager and Ostrom stress the importance of rights of exclusion rather than alienation. They state that the right of exclusion increases the likelihood that resource users will capture the benefits of coordinating their activities. However, they neglect to mention that alienation *further* increases this likelihood by allowing resource users to capture returns on investment through sale or lease.

Schlager and Ostrom examined 44 subgroups of fishers in their study to determine how varying levels of rights impacted the likelihood of effective self-governance. They classified each sub-group into one of four categories of users: authorized users, claimants,

owners, or proprietors. However, they break their results into only *three* categories: authorized users, claimants, and owners and proprietors. Of the 44 subgroups examined, 26 were proprietors, and only one was an owner.

The authors state that owners and proprietors are more likely to develop successful self-governance than are claimants. They also state that claimants are more likely to do so than are authorized users. They discuss in detail the benefits conferred by each additional level of rights. Each level, that is, until alienation. They place the most emphasis on the right of exclusion, and then gloss over the additional benefits of alienation. Their argument is clear and thorough for the first three levels of rights holders. Each level is more likely than the one before it to develop successful self-governance. The obvious inference is that the likelihood of successful self-governance increases with increasing property rights. However, this conclusion is conspicuous by its absence. If the authors were to make this statement, they would be tacitly admitting that ownership creates the greatest incentives for successful resource management. Throughout this paper, they go to great lengths to avoid making this statement.

The majority of soft-shell clam management in Maine takes place at the local level. Townsend (1985) found that harvesters working on managed flats experience 15% higher yields than those working on unmanaged flats. This finding backs up the claim that local-level management can be very effective. However, the story does not stop there. Townsend (1986) found that diggers working on depuration crews experience 60% higher yields than those working on unmanaged flats. When depurators are few, or when depuration companies are given exclusive access to particular resources, the management

approximates private ownership (Townsend, 1986). This finding suggests that there are benefits to be had beyond those conferred by the right of exclusion.

Implications and Conclusion

The Georges River area clearly had a number of attributes that facilitated the development of a self-governing institution. Once the Clam Fishery Restoration Project began to meet, they made a number of choices that led to the development of a successful program. Ostrom (2000) says the development of a self-governing association is affected by the type of larger regime in which the association is imbedded. The state of Maine provides municipalities with an environment conducive to self-governance. It provides towns with valuable biological knowledge and assistance through area biologists. It also gives municipalities a large degree of autonomy in designing their programs. The ability to exclude (all but 10%) of outsiders is a strong incentive to implement management. Knight argues that rules emerge as a result of distribution fights. This argument is supported by the fact that most municipal shellfish programs in Maine (including that of the St. George area) restrict non-resident licenses to no more than 10%.

The ability to exclude others increases incentives for long-term investment in municipal shellfish programs. Stock enhancement is one type of long-term investment in a shellfish resource, and is a major component of many municipal programs. However enhancement projects are complicated by the lack of a reliable stock-recruitment relationship for soft-shell clams. Although adult clams are sedentary, immature clams are sometimes highly mobile. A town that engages in stock enhancement may therefore provide benefits to itself, to another town, or to no one. This uncertainty decreases the

strength of town property rights over its soft-shell clam resource, and can act as a counter-incentive to long-term investment.

Ostrom's 1990 list describes attributes present in successful *long-standing* self-governance institutions. Although the Georges River program has a majority of these attributes, it has not been in existence long enough to qualify as "long-standing". It remains to be seen whether or not the attributes it possesses, combined with other factors, will result in a successful long-standing program.

The Program has already survived several conflict challenges. The change in administrative municipality, along with conflict over power sharing, the warden's role, town funding, and the aiding and abetting incident all created conflict. Any of these incidents could have resulted in decreased confidence in and eventual dissolution of the program. Only time will tell if the SMC and Joint Board possess the ability to weather conflict over the long-term.

Sherman Hoyt was a huge influence in program development. However, the program has continued successfully thus far despite his decreased role. A few key players seem to be continual forces on the Shellfish Committee and Joint Board. Several of these players have complained of being tired of doing a large portion of the work. So far, a new participant has stepped up each time a key player steps down. Enthusiasm and participation have varied. However, harvesters seem to recognize the benefits of their conservation efforts, and continue to fulfill their conservation hours in order to be eligible for a license. Although enthusiasm for the program has waxed and waned, it has yet to completely disappear. People continue to serve on the Shellfish Committee and Joint Board, and do the work necessary to keep the program running.

Townsend's (1985) finding that management increases yields by 15% can be used to support the concept of town management. However, if increased yields were the primary aim of town programs, depuration would be a popular alternative to town management. The fact that it is not implies that town programs are concerned with something more than harvesting efficiency.

Knight's theory of distribution fights offers a plausible explanation of this "something more". By enacting a local ordinance, municipalities increase their residents' share of shellfish resources. The state of Maine does allow private leasing of shellfish harvesting areas. However, private leasing has not become a popular alternative to town management (Hal Winters, personal communication). Developing a lease would create distribution fights within the town. Dividing up the resource into shares would be difficult. It would be difficult to determine a method for determining each individual's share. To develop a practical lease arrangement, some people would have to be excluded. The SMC displayed an unwillingness to exclude locals when they determined that 128 licenses would be made available in 1996. This figure corresponded to the number of locals who desired a license at the time. By enacting a local ordinance, residents can significantly decrease "outsiders'" share of benefits without having to divide the resource up into exact shares within the town.

Co-management theory suggests that local users are best suited to devise self-governance institutions to manage resources. This study concurs with Schlager and Ostrom's (1992) finding that local governance institutions benefit from the addition of property rights, be they formal or informal. However, this study also suggests that stronger property rights could potentially increase the effectiveness of management.

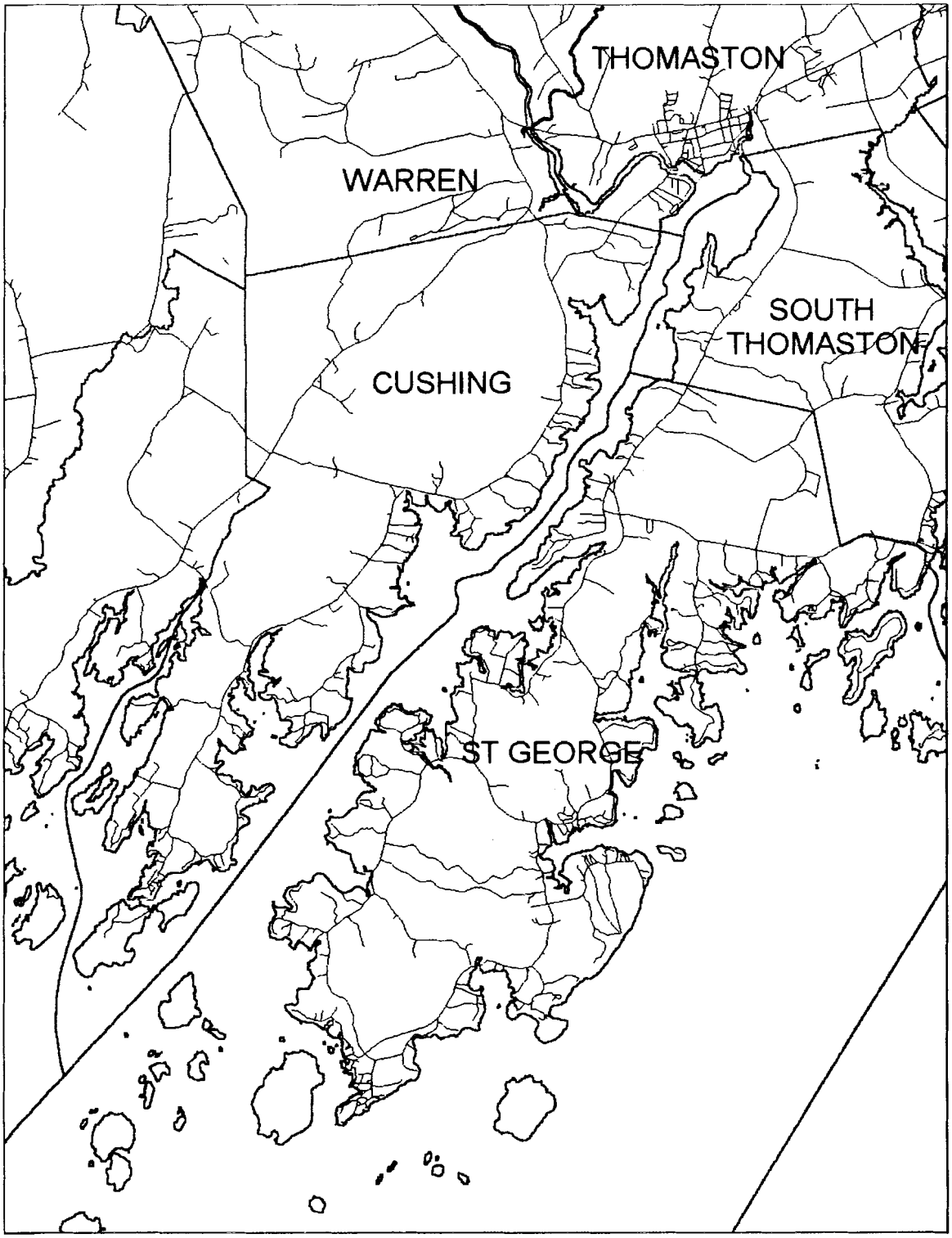
Increases or reductions in stock size may be due many factors other than management. The problems created by biological variability can be further complicated by inaccurate or incomplete landings data. It is therefore difficult to determine the success of the Georges River program based on the health of the stocks. Before the success of the Georges River program can be determined, "success" must be defined. If the purpose of the Georges River Program is to provide employment to local residents, it has thus far succeeded. It has managed to keep the majority of the resource available exclusively to locals. It has also maintained conservation-minded behavior among diggers, who fulfill 10 hours of conservation time each year to obtain their license.

Success in clam management must be defined in order to be determined. The endurance of the program, employment generated, or the health of the stock are all possible factors with which to define success. Each of these determinants is complicated by biological variability and other factors beyond the control of management. However, the Georges River Program has been a success in several definable ways: 1.) It has managed to overcome a communal action dilemma to get rules passed. 2.) These rules appear to be working. The stock does not appear to be declining, and the program has generated employment within the area for over 5 years. 3.) It has assured that the majority of the resource is reserved for locals.

The Georges River program benefited from a number of fortunate circumstances. Attributes of the harvesters, area geography, the resource itself, and Maine state law facilitated development of the program. The Georges River Estuary experiences greater CPUE than the state average. It is reasonable to suggest that this increased CPUE is due at least in part to management. The increased yields available in the area provide rents

unavailable in other industries. As long as the Georges River continues to experience greater CPUE than other areas of the state, the demand for licenses should continue. Because conservation time must be completed to be eligible for a license, participation in the shellfish committee should continue as well. The program seems poised to experience "success" into the near future.

Figure 8
Georges River Area



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The Georges River Regional Shellfish Management Ordinance for the Towns of St. George, South Thomaston, Thomaston, Warren and Cushing for the years 1996, 1997, 1998, 1999, 2000, and 2001 were also used as a reference.

Biography of the Author

Kristin E. (Togue) Brawn was born in Portland, Maine, on August 3, 1970. She was raised in Cape Elizabeth, Maine, and attended Cape Elizabeth High School. She graduated from Duke University in Durham, North Carolina on May 17 1992 with a BA with distinction in Geology. Her senior thesis on the composition of pegmatites within the Stillwater Complex, Montana, was published in *Chemical Geology* in 1994.

Togue has worked with or within the commercial fishing industry for over 10 years. Before coming to study at the University of Maine, she worked in commercial fishing trade show development sales and fishing equipment sales. She maintains her connection to the industry by working in a waterfront lounge. Togue is a candidate for the Master of Science degree in Marine Policy from the University of Maine in August, 2002.