

Abstract Proceedings of the

Shellfish habitat restoration workshop

Conference Room, Biological Station
Fisheries & Oceans Canada
St. Andrews, New Brunswick
Canada

June 15-16, 1993

by Dr. Barry C. Jones,
Chairman
September 13, 1993

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Gulf of Maine Council on the Marine Environment*

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New Brunswick Department of Fisheries & Aquaculture*



**Gulf of Maine Council on
the Marine Environment**

Conference
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Introduction

During April, 1992, Environment Canada sponsored a workshop in Halifax, Nova Scotia, for senior Canadian environmental managers on behalf of the Gulf of Maine Council on the Marine Environment. The objective of this venture was to "educate" the higher, decision-making levels of government as to the mandate, work and plans of the Council relative to the preservation of the environmental health of the Gulf, and to obtain their commitment to support and pursue such activities.

As a result of this workshop, the New Brunswick Department of Fisheries and Aquaculture made the commitment to sponsor another workshop, in 1993. The focus of this workshop was to be placed on the restoration of shellfish habitat throughout the Gulf of Maine.

The purpose of this workshop was to give key players in the industry, such as managers, researchers and industry representatives, the opportunity to discuss the situation in the Gulf of Maine and what effects it has on the shellfish which inhabit it. The ultimate objective was to promote more harvesting openings in the Gulf through improving the marine environment in the Gulf of Maine.

Workshop Announcement

Convened by: The Gulf of Maine Council on the Marine Environment

Sponsored by: New Brunswick Department of Fisheries & Aquaculture

“Shellfish Habitat Restoration Workshop”

to be held June 15-16, 1993

at the
Conference Room, Biological Station
Fisheries & Oceans Canada
St. Andrews, New Brunswick

Workshop Objective:

The objective of this workshop is to facilitate the exchange of information and experiences among managers, researchers and industry representatives relative to the habitat of economically significant marine shellfish in the Gulf of Maine in order to identify and promote the mitigation of detrimental environmental impacts on such resources and the livelihoods of those who depend upon them.

Topics to be Discussed:

- History/ Status of Shellfish Fisheries
- Present Management Practices
- Environmental Impacts on Habitat
- Technical Solutions to Problems
- Current Mitigation Initiatives

Workshop Registration:

There is no registration fee for this workshop, but space may be limited. To reserve your place please mail, fax or telephone the following by May 31, 1993:

Dr. Barry C. Jones
Dept. of Fisheries & Aquaculture
P.O. Box 6000
Fredericton, N.B.
CANADA E3B 5H1

Telephone: (506) 453-2047
Fax: (506) 453-5210

Please forward the following information:

Name: _____

Affiliation: _____

Address: _____

Telephone: _____

Fax Number: _____

Accommodation/ Meals:

Accommodations are available within the Town of St. Andrews a short distance away from the Conference Centre. The following are some of the facilities that can be contacted for this purpose:

- | | |
|-----------------------|----------------|
| Shiretown Inn | (506-529-8877) |
| St. Andrews Motor Inn | (506-529-4571) |
| Blue Moon Motel | (506-529-3245) |
| The Algonquin | (506-529-8823) |

For further information, please call Barry Jones as above.

Please copy this announcement and forward it to anyone whom you think might be interested

Shellfish Habitat Restoration Workshop

Conference Room, Biological Station
Fisheries and Oceans Canada
St. Andrews, New Brunswick

Convened by: Gulf of Maine Council on the Marine Environment
Sponsored by: New Brunswick Dept. of Fisheries & Aquaculture

Agenda Completed

Tuesday, June 15:

- | | |
|----------|---|
| 8:30 am | Registration |
| 9:00 am | Welcome/ Introduction (Dr. Wendy Watson-Wright, Director, St. Andrews Biological Station) |
| 9:15 am | History/ Status of Shellfish Fisheries <ul style="list-style-type: none">• Canada (Greg Roach)• United States (Clyde MacKenzie) |
| 10:30 am | Coffee |
| 10:45 am | Present Management Practices <ul style="list-style-type: none">• Canada (Dave Doncaster)• United States (Dana Wallace) |
| 12:00 am | Lunch (1 1/4 hrs) |
| 1:15 pm | Environmental Impacts on Habitat <ul style="list-style-type: none">• Government (Jack Pearce/Clyde MacKenzie)• Industry (Larry Foster) |
| 2:30 pm | Technical Solutions to Problems <ul style="list-style-type: none">• Government (Shawn Robinson) |
| 3:00 pm | Coffee |
| 3:15 pm | Current Mitigation Initiatives <ul style="list-style-type: none">• Gulf of St. Lawrence (Barry Jones/Stephen Lanteigne) |
| 4:00 pm | Gulf of Maine Fact Sheets Update (Joe Arbour) |
| 4:30 pm | Adjourn for the day |

Wednesday, June 16:

- 8:45 am Review
- 9:00 am Current Mitigation Initiatives (continued)
- New Hampshire (Steve Jones/Richard Langan)
 - New Brunswick (Marianne Janowicz)
 - Maine (Brian Beal)
- 10:30 am Coffee
- 10:45 am Current Mitigation Initiatives (continued)
- Nova Scotia (Bruce Pettipas)
 - Massachusetts (Sandra MacFarlane)
- 12:00 am Lunch (1 1/4 hrs)
- 1:15 pm Separate Working Groups:
- Identify Problem Areas/ Prioritize
 - Identify Potential Solutions/ Evaluate
 - Recommendations
- 3:00 pm Coffee
- 3:15 pm Reconvene/ Summarize Groups Findings
- 4:00 pm Recommendations
- 4:30 pm Workshop Summary/ Adjournment

Dr. Barry Jones,
Chairman,
New Brunswick Department of Fisheries and Aquaculture

History/Status of Shellfish Fisheries

Greg Roach
N.S. Department of Fisheries
P.O. Box 2223
Halifax, Nova Scotia
B3J 3C4

The shellfish resources on the Canadian side of the Gulf of Maine were utilized by Native Indians before the arrival of the Europeans and were used for subsistence by early settlers before commercial fisheries developed. The lobster fishery, which developed in the late 1800, is the most important commercial fishery with some 1,400 inshore licences issued to fishers who fish the lobster fishing areas in the Gulf of Maine. Canadian landings from these Gulf of Maine areas have been very strong over the past several years, peaking in 1991 at 12,000 mt, a record level for the 1900's. Very important scallop fisheries are carried out on the Canadian side of the Gulf of Maine. An offshore fishery, which targets Georges Bank, has been producing annual yields in the 6,000 mt (meats) range while an inshore fishery in the Bay of Fundy has recently produced yields in the 2,300 - 3,000 mt. (meats) range. Commercial clam fishing is carried out in these general areas: Charlotte Co., N.B., Minas Basin and Western Shore, N.S. Recent soft shell clam landings have been in the 1,600 mt range. A sea urchin fishery has been developing over the past few years on the Canadian side of the Gulf of Maine. Activity is presently concentrated on the New Brunswick side of the Bay of Fundy where landings have grown from approximately 30 mt in 1989 to 426 mt in 1992.

History/Status of Shellfisheries in the Gulf of Maine (U.S.)

Clyde L. MacKenzie, Jr.
Northeast Fisheries Science Center
National Marine Fisheries Service
Sandy Hook Laboratory
Highlands, New Jersey 07732

The species included are the soft-shell clam, sea scallop, mahogany quahog, blue mussel, oyster, and northern quahog. In 1991, sea scallops were the most important shellfish landed in Maine with 263,000 bushels, soft clams were next with 103,000 bushels, mussels were third with 40,000 bushels, mahogany quahogs were next with 39,000 bushels. Some 8,000 bushels of American oysters, 880 bushels of European oysters, and 500 bushels of quahogs were also landed. Massachusetts production of soft clams was 98,000 bushels. Production of other Massachusetts species are not included; the southern part of the state produces substantial quantities of shellfish.

Clam shells in kitchen middens left by Indians have been aged at 1,710 years. The Indians probably harvested clams with sticks or tools made from bones. The early European colonists also used clams for food. For the first 250 years after the first European settlement, clams dug for food were almost entirely for local subsistence. Commercial sales away from the coasts began after 1850.

Early in the 1800's, soft clams were in demand for food as well as for bait used by offshore finfisheries employing hooks on trotlines. As the demand for clams grew, large numbers of people in local towns dug clams and shucked them for both markets. Fishermen in Maine ports and the Massachusetts ports of Gloucester, Boston and Provincetown bought clam meats fresh and salted. In addition, fishermen from Europe purchased the clam meats. In the 1920's and 1930's, use of clams for bait ended when fishermen substituted otter trawls for trotlines in New England fisheries.

In the late 1800's in Maine, most clams for eating were canned in factories which also canned the juice. From 1901 through the 1930's, the state limited the length of the canning season to 15 September to 1 June each year as a conservation measure.

In the early 1900's, fried clams became a popular food, especially at seashore resorts in summer, but also year-round in inland restaurants of the state and the demand for clams rose more, especially in the summer. Beginning in the 1940's, fried clams in take-out stands were becoming a popular food in Massachusetts as well as Maine. The development of improved equipment and techniques for frying was responsible for the popularization of fried clams in New England.

The industry gradually shifted from home shucking to shucking plants producing meats for frying. About 13 shucking plants were built in Maine. From Ipswich to Newburyport, Massachusetts, about 100 fishermen shucked clams in their homes for the frying market, and the practice continues on a small scale. Nowadays, most clams are shucked in about 13 fish houses in that area. Each employs as many as 12 shuckers. Seabrook, New Hampshire, is another center for shucking Maine and Massachusetts clams to be sold in Massachusetts. The town has about 100 shuckers, who open clams in 9 shucking houses. Clam shucking in Seabrook dates back an estimated 200 years.

In 1898, 550 men dug clams in Maine; in 1942, there were 1,350; in 1948, 3,326; in 1958-1964, about 1,000; in 1972-1985, 3,500-5,000; and in 1992, 1,683. Currently, 400 men dig clams on the north shore and 150 diggers in Boston Harbor in Massachusetts. In the 1980's, Maine production declined because clams became scarce in its two easternmost counties. The cause was light sets.

Sea scallops occur along the entire coast of Maine from fairly close to shore out to deep water. They are dredged in depths mainly from 90 to 100 feet and they are also caught in shallow estuaries by scuba divers.

Mussels are common on intertidal flats and intertidal flats in Maine. They also occur in Plymouth Bay and Barnstable Harbor, in Massachusetts. Indians used mussels for subsistence and made spoons from their shells. The European colonists used them for food and fish bait, but, afterward, they did not become important for commerce until the World War II years, 1943-46. Production was nearly 38,000 bushels per year then. The mussels were all canned. Production fell to very little after that until the late 1970's when the demand for mussels rose sharply. By 1979, Maine had issued 30 leases totalling about 700 acres for culturing mussels. Great Eastern Mussel Farms has gathered about 40,000 bushels of seed mussels a year from beds and plants them on its leased beds of 150 acres. Maine has 7 other mussel dealers and 13 boats. Landings peaked at 400,000 bushels in 1988, but fell afterward because of competition from large supplies being produced in Massachusetts, and has been about 33,000 bushels since then. Currently, the supply of mussels is excellent, but limited markets are a bottleneck to production.

In 1976, a new fishery was found for mahogany quahogs in Machias Bay (northeastern Maine). The quahogs were 2 inches long and were sold as littlenecks to be eaten on the half-shell. Initially, there were 120 boats and each got 60 to 70 bushels a day. Now, there are about 45 boats dredging them. Daily landings average about 20 bushels a boat.

Management of the Clam Resource

David Doncaster

Department of Fisheries and Oceans, Blacks Harbour, N.B.

The Federal Department of Fisheries and Oceans has primary responsibility for the overall management of the clam resource. Numerous other agencies have roles or responsibilities that affect the successful management of the clam resource. For example, Environment Canada classifies harvesting waters based on microbiological quality, the Provincial Departments of Health and Environment establish criteria for sewage disposal.

Management of the clam resource is done in close consultation with the industry. A number of committees have been established to discuss issues of concern.

DFO's management program has three main components: Biotoxin Monitoring and Enforcement, Contaminated Area Enforcement, and Resource Management Initiatives. The Biotoxin problem is increasing, requiring monitoring and patrol of all harvest areas. Clam flats closed due to sewage contamination are patrolled to prevent illegal harvesting. DFO has initiated (or assisted in) clean up measures, implementation of special harvesting programs, and development of alternative processing technology for contaminated areas. In reference to resource management, DFO has undertaken an ongoing analyses of clam flat population dynamics. This research information will be applied to resource management issues. Regulatory changes have been made to permit a differentiation between recreational and commercial harvesters, modify size limits and develop a limited entry fishery.

The single most important issued affecting the clam resources is the loss of harvest areas to microbiological contamination.

Softshell Clam Management

Dana E. Wallace, Maine Dept. of Resources (Retired),
3081 Mere Point Rd., Brunswick, Maine.

More intensive management of softshell clams on the rim of the Gulf of Maine is now timely. The need is growing to pool out information, identify priority research where findings can be applied and results in increase production. We must plan how we can get public and industry acceptance of management techniques already used and proven of benefit.

Residents of coastal towns have attitudes and beliefs about their clams and their uses and have been influenced by many factors for many generations. There are the rights to intertidal zones as passed down from The English Magna Carter, the Massachusetts Colonial Ordinances and the Maine Law in 1821 when we became a state. That law established that the towns had control of their clam flats under the jurisdiction of the state. From the late 1800s to 1963, private and special laws governed the town's rights to excluded non-residents. In 1963, towns were given the authority to pass ordinances for the conservation and management of their flats.

The town of Brunswick ordinance, passed initially in 1964 and as modified, frequently serves as a management discussion outline. The 1993-4 ordinance deals with the responsibility of the town for its shellfish resources and its authority: to establish a Limited Entry Fishery based on the resources with 10% licenses sold to non-residents to conform to state law, to document the status of the clam populations by surveys to be used as the basis for the closing of flats to allow the growth of clams or other management options, to allow towns to join together in regions for reciprocal digging rights and responsibilities.

As a part of management, shellfish committees and volunteers deal with pollution sources and press for abatement. Polluted-prohibited flats can become a part of the town management program for enforcement and potential restoration.

Comments are made on the close cooperation and communications about clams between Canada, Maine, and Massachusetts that existed from 1946 to well into the 1960s. It is suggested that this collaboration can be reestablished to consider such "unfinished business" as: finding ways to attract natural setting, protect and manage clams to commercial production, and continue to develop hydraulic equipment to gather small clams for transplanting. Much more must be learned about clam predation and effective control measures. It is necessary to learn the most effective ways to use hatchery raised clams to enhance natural production in public aquaculture and to phase into feasible private aquaculture farming operations. It is vital to continue to work with everyone involved in pollution abatement and restoration work to open closed clam flats.

Information and education about our successes in management and pollution control must be more widely disseminated for us to gain necessary public support for our missions.

Environmental Impacts on Habitat From the Government's Perspective

John B. Pearce
Deputy Center Director
DOC/NOAA/NMFS/NEFSC
Woods Hole, MA, USA 02543

In regard to major issues concerned with environmental "impacts", it must be recognized that concerns of governments are principally with microorganisms and toxics as these affect shellfish or use of harvested shellfish for human consumption. These issues are tied closely to ownership of harvesting areas and present and future management of shellfish beds, and marketing of harvested shellfish.

Traditionally, a variety of microorganisms affecting human health when shellfish are harvested from contaminated areas, and consumed without proper food preparation (cooking, marination, etc.), have been the principal concern of various levels of government. More recently, the presence of toxic trace metals and organic substances have become an issued in approving shellfish for human consumption and certifying the healthfulness of shellfish for marketing purposes. Marine scientists also have recognized that certain contaminants and microorganisms can cause disabilities in living marine resources, including shellfish, which affect reproduction, growth, development, and recruitment of shellfish populations. Even where certain contaminants are not present in amounts or forms thought to be injurious to human health, such materials can affect various life history stages of shellfish, or may result in perceptions by consumers that shellfish are unsuitable for human consumption.

Thus, as we move from shellfish industries based principally on wildstocks to industries that will be predicated on culturing and eventual marketing of artificially reared shellfish, such factors or perceptions must assume a paramount place in the management of shellfish and the shellfisheries and marketing endeavors.

Most shellfish beds, growing areas, and harvesting areas, are within estuaries or embayments of the coastal zone. Most of man's activities which tend to produce or result in release of contaminants that may have the aforementioned injurious effects, either to the shellfish themselves or to human consumers, are ancillary to these waters or are located along riparian systems draining into estuaries. Therefore, as man's developmental activities, including urbanization and industrialization, have been carried out in ways which result in release of contaminants (either point or non-point source), they have tended to compromise the shellfisheries. Effects have ranged from those of microorganisms having their origin in septic systems or poorly treated sewage, to those associated with runoff from urban or industrialized areas, discharges from industrial processing plants, or materials carried from agrarian activities including fertilized fields, livestock pens, and treatments of agriculture products with pesticides. All of these sources result in cumulative effects on the shellfisheries.

If we are to increase the growth, and harvesting of wild shellfish stocks, as well as implementation of marine mariculture, we must begin to manage terrestrial habitats so that activities of these do not compromise shellfish production systems. Studies done by the National Oceanic and Atmospheric Administration, the Shellfish Sanitation Branch of the Food and Drug Administration, the U.S. EPA, and various state agencies have provided recommendations for necessary steps to be taken. Solutions will be found in education and communication so that terrestrial managers can manage development in a way that does not compromise aquatic habitats. Therefore, principal roles for government will be found in research, monitoring, and the effective translation of aquatic research results into protocols useful to terrestrial governments and managers.

Shellfish Habitat Restoration Technical Solutions to Problems - Government

Shawn Robinson
Dept. Fisheries and Oceans
Biological Station
St. Andrews, N.B.

Shellfish resources have been an important part of the economy of the Gulf of Maine for several thousand years. Records on harvesting are available in the prehistoric kitchen shell middens from the native Indians in the area and they show an extensive use of the intertidal and near subtidal areas. However, in the last few decades, problems with the nearshore resources have begun to occur through man-induced changes to the environment. Through a combination of physical and biological impacts, the shellfish resources especially some of the intertidal ones, are being lost to the local industry. In a literature search on potential corrective actions, the author found restoration studies in past have centred primarily on the freshwater environment (71%), and less on the estuarine (12%) or marine (14%) environments.

The role of government can be divided into 5 basic categories.

1. **Impose and modify legislation.**

This will provide the framework to rectify the existing problems and to circumvent new ones before they occur. The review of existing legislation as it pertains to shellfish is also critical as several "loopholes" may exist.

2. **Enforcement.**

Without effective enforcement of the legislation on past activities as well as present initiatives the rehabilitation of the shellfish areas will not occur and the situation will continue to worsen.

3. **Provide information.**

This is one of the most important functions of the government because it is generally free from "proprietary of information" restrictions. Examples of pertinent information from the soft shell clam will be presented to demonstrate the value of particular types of information to management for decisions on restoration.

4. **Implement programs.**

This capability of the government may be a "hands on" approach, such as a sewage treatment facility or it may be a pilot program in conjunction with an existing industry to try to ameliorate some of the changes to the fishery that are happening. Some examples will be given for the soft-shell clam fishery in southwestern New Brunswick.

5. **Provide for future options.**

As the spending ability of governments are decreasing due to financial restrictions, it is important that the tools are available for private industry to solve some of the problems they are facing today as well as in the future. This could involve imposing new legislation which allows for creative solutions to problems, developing new standards for assessing the environment and fishery products, initially assisting with developmental projects, and perhaps looking at some form of privatization for certain fisheries.

Bouctouche Sustainable Development Project

Barry Jones and Stephen Lanteigne
New Brunswick Department of Fisheries and Aquaculture
P.O. Box 6000
Fredericton, New Brunswick
E3B 5H1

Increasing closures of oyster culture harvesting due to negative environmental impact in Bouctouche Bay on the Gulf of St. Lawrence shore of New Brunswick is causing a significant hardship on both the industry and the local community. To overcome this problem, the Minister of Fisheries and Aquaculture for the Province of New Brunswick appointed a Task Force in mid-1992.

The Task Force provided guidance and authority to a multi-agency Working Group (consisting of provincial and federal departments, industry and community representatives) established to study, recommend and implement actions to mitigate the undesirable circumstances. With financial support from the New Brunswick Environmental Trust Fund of \$55,800, a Field Team was employed to carry out activities of the project.

The activities of the Working Group were assisted by the formation of two committees, namely the Communications Committee which was responsible for public education and promotion, and the Technical Committee which was responsible for planning and setting priorities.

The first major task was to identify and solicit the participation of the responsible agencies which were required to make the project function properly, including significant community involvement. On this basis monthly meetings were held to identify and develop status reports on all apparent pollutant input sources. Means of verification and mitigation were then considered and implemented as possible within existing plans and budgets.

The Field Team carried out a sanitary beach survey to locate inadequate domestic and industrial septic and effluent input sources, and assisted in the application of a home-oriented septic conversion program which was supported by a \$50,000 grant from the Environmental Trust Fund.

In April, 1993, new funding for the project of \$98,400 was approved by the Environmental Trust Fund to implement recommendations of the Working Group in its first Annual Report. These principally include extension of the home septic conversion program, a public education initiative and field sampling to assess the input of what are perceived to be major pollutant sources.

Shellfish Habitat Issues in New Hampshire

Stephen H. Jones and Richard Langan,
Jackson Estuarine Laboratory,
University of New Hampshire, Durham, NH

The small coastal area of New Hampshire has relatively abundant and varied shellfish resources. The coastal area is dominated by the Great Bay Estuary (GBE), where the most important shellfish are oysters (*Crassostrea virginica*) and soft-shell clams (*Mya arenaria*). In the other coastal estuaries, soft-shell clams are most important, although blue mussels (*Mytilus edulis*) are also abundant and surf clams (*Spisula solidissima*) are harvested off-shore. Prior to 1989 when New Hampshire was determined to be out of compliance with NSSP guidelines, there were three active oyster culturists in Great Bay, using primarily suspension and off-bottom culture techniques for both *C. virginica* and *Ostrea edulis*. Presently, only recreational harvesting is permitted, but new legislation will consider leasing some closed oyster beds for commercial aquaculture if NSSP guidelines can again be met.

The importance of large point sources of microbial contaminants relative to water quality limitations on shellfishing has diminished in importance with the recent upgrading of most of the coastal wastewater treatment facilities. However, contaminants from nonpoint source pollution continue to limit shellfishing. At present, none of the clamflats in the coastal basin are open and half of the flats in GBE are closed, leaving 16% of the 3370 acres of flats open. More than 60% of the oyster beds are also closed. Only 30% of the classified water of coastal New Hampshire are classified as approved for shellfishing, all in the GBE. Several strategies are being used to improve water quality and restore shellfish habitats. Recent research suggests that natural processes may enhance settlement of microbial contaminants from the water column at low tide in Great Bay, resulting in an approved area being surrounded by prohibited area. Other research indicates that enrichment of estuarine water from nonpoint source nutrient and organic pollutants may enhance the growth and survival of fecal-borne bacteria and indigenous bacterial pathogens like *Vibrio vulnificus* and *V. parahaemolyticus*. However, studies at UNH show that relaying oysters from contaminated to uncontaminated areas is effective in removing these pathogens. Contaminants such as heavy metals and toxic organic compounds have been detected in blue mussels and oysters at levels that are elevated compared to more pristine site in the Gulf of Maine but not in excess of public health criteria. Activities designed to mitigate sources of toxics and to restore shellfish habitats near those sources are also underway.

The last assessment of oyster resources in New Hampshire was conducted in 1981 by the N.H. Fish and Game Department. A total of 54 acres of major oyster beds were identified in GBE with a standing crop of ~120,000 bushels of oysters > 80 mm. 20,000 bushels, or ~17%, of the resource is located in areas open to recreational harvest and approximately 5,000 bushels are harvested annually. Our recent studies indicate that recruitment in the closed areas is lower than in the recreationnally-harvested areas, and the size-class distributions in the closed areas are skewed toward older, larger oysters. The NH Fish and Game Dept. planted surf clam shells in two oyster beds in 1985 and found that the new shell collected more spat than either liver oysters or existing shell. Spat survival was ~50%. Continued shellfish habitat and aquacultural research conducted by the authors and Dr. R. Grizzle focuses on relay and depuration strategies, evaluation of present indicator bacterial and new methods of pathogen detection, shellfish growth responses to changes in seston flux, and artificial cultch and spat settlement.

The Premier's Clam Bed Action Committee

Marianne Janowicz
New Brunswick Department of Fisheries and Aquaculture
P.O. Box 6000
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E3B 5H1

This presentation described the purpose of the Committee appointed by the Premier of New Brunswick in 1990—to work toward eliminating point and non-point pollution sources in portions of Charlotte County so that an open clam harvest may once again proceed. The report indicated the composition of the committee, the activities undertaken since the spring of 1991 and the successes. It posed questions relating to the retention of pollutants within clam meats, in areas with specific geophysical characteristics and the feasibility of anticipating complete remediation in coastal areas.

Soft-Shell Clam (*Mya arenaria*) Culture In Maine : How Stock Enhancement May Be Used to Mitigate Poor Water Quality Or Failed Management Programs

Brian F. Beal
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Maine 04654
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Maine is the largest producer of soft-shell clams in the world. The easternmost counties of Hancock and Washington produce between 50-75% of all clams landed in Maine each year. Since 1984 clam landings in these two counties have fallen by 84%. This has meant the loss of 1800 part-time and full-time jobs with a concomitant loss of nearly \$36 million to the coastal economies. The reason for the decline in clam production can be traced to increasing levels of fecal pollution and improper management of clam harvests.

In 1987, a small, community-based shellfish hatchery program was established in the town of Beals, Maine. The impetus for stock enhancement using hatchery-reared, soft-shell clam juveniles was that annual abundances of natural, commercial size sets was so low that traditional efforts to manage clam stocks was not effective. With funding from several federal, state, and local groups, including the various communities, the Beals Island Regional Shellfish Hatchery was established. The annual production is ten million 10 mm to 12 mm individuals with an annual operating cost of \$70,000. Clam broodstock are conditioned so that spawning can occur during late March or early April (nearly two months sooner than clams ripen in the wild). Larvae are reared in each of two 2500 liter round tanks until they metamorphose at a size of about 175 microns. Clams remain in the hatchery from this early juvenile stage until they reach a size of about 1.6 mm. They are then transferred (15,000 at a time) to numerous floating wooden trays lined with a fiberglass window screening material. The trays are placed in the subtidal of a protected cove where they remain for five months. In late October, clams are removed from the floating trays and are placed into window screen bags (45,000 to 60,000 per 0.2m² bag). Bags are then placed in rigid lantern net-type holding bins. Bins are designed so that they will remain two to three meters off the bottom of the cove, but 3-4 meters below the surface of the cove during the winter. In early April, the 10-12 mm clams are removed from the overwintering bins and are seeded to clam flats.

Results from several manipulative fields experiments in eastern Maine are described. These tests relate directly to hatchery production and show that efforts to raise 12 mm and larger seed for transplanting should be abandoned in favor of a higher production of 8 mm to 10 mm individuals. These animals can be effectively protected from predators using a 12 mm flexible netting that is either affixed to wooden frames sticking up out of the sediments which enclose the clams, or placed directly on the sediment in which the clams reside. If the latter method is used, small floats should be affixed to the netting to lift it off the flats during periods of tidal inundation. Otherwise, the netting will interfere with the normal feeding of the animals resulting in slower growth.

Nova Scotia - Mitigation Efforts Gulf of Maine Region

Bruce Pettipas
Nova Scotia Department of Environment

During the period 1965-1990, thirty-six municipal sewage treatment plants, and nine municipal landfills were constructed or established in the region. With the realization in 1990 that many of these recently constructed/established sewage treatment facilities and landfills were not meeting acceptable environmental standards due to poor predesign, design, operation and maintenance, the Province undertook a number of major initiatives.

Since 1991 in the field of sewage treatment the Province has adopted a new standards and guidelines manual for the collection, treatment and disposal of sanitary sewage; adopted a new effluent quality policy based on receiving stream sensitivity; enhanced our permit review/approvals process; enhanced our predesign study program; established mandatory self-monitoring programs for new facilities; drafted mandatory operator certification requirements; and increased enforcement of effluent requirements.

The Province is currently developing a new provincial solid waste management strategy which will incorporate our new environmental standards and waste diversion goals into the strategy. The Province has recently adopted the principle of full containment, leak detection, and leachate treatment at new/upgraded landfills; and has drafted a new standards and guidelines manual for sanitary landfills.

Current mitigation efforts in the field of sewage treatment include commissioning of ten predesign studies for the following communities - Amherst, Cumberland County; Bridgetown, Annapolis County; Digby, Digby County; Greenwood, Kings County; Middleton, Annapolis County; Parrsboro, Cumberland County; Stewiacke, Colchester County; Truro, Colchester County; and Windsor, Hants County.

Current mitigation efforts in the field of solid waste management include the development of two regional integrated solid waste management strategies - Annapolis Valley/Western Shore Region which includes nineteen municipal units from Kings County to Shelburne County; and Northern Regional which includes twenty-one municipal units from Cumberland County to Guysborough County.

When Shellfish Management is not enough: Shellfish habitat mitigation through land use changes and planning efforts

Sandra L. MacFarlane
Town of Orleans Conservation Department,
Orleans, Ma. 02653.

Declining shellfish productivity in the waters of Cape Cod, Ma. and increased acreage of closed shellfish growing areas due to contamination, prompted the formation of both county and municipal water quality task forces to identify the problems and propose solutions. Land use practices were identified as the major contributor to shellfish habitat degradation. In Orleans, Ma., the existing stormwater drainage system was characterized as contributing bacterial contamination, nutrient enrichment and toxic substances to the receiving waters. Five principal drains were retrofitted to allow filtration of the stormwater prior to discharge. Groundwater will be mapped for direction of flow to determine nutrient loading in the embayments to ameliorate eutrophication. The town is developing resource management plans for the estuaries to assess the current natural resources, compare to historical information and devise methodologies to use the natural resources while protecting them for the future. Citizen participation is critical to the success of these projects for funding as well as approving additional regulations.

New Brunswick Department of Fisheries and Aquaculture
Gulf of Maine Council on the Marine Environment

Recommendations of the Shellfish Habitat Restoration Workshop

(in priority order)

June 15-16, 1993

DFO Conference Centre, Biological Station

St. Andrews, N.B.

It is recommended that:

1. All point and non-point pollution sources, including runoff, impacting upon shellfish should be identified and prioritized so that our limited resources can be applied to mitigate the most important elements with greatest effectiveness; regular monitoring should be an integral part of the process.
2. Coastal zone management systems which include pro-active planning and pilot projects should be developed and applied in all regions, with appropriate linkages among them for cooperative interaction.
3. The problem of inadequate septic systems of homes and cottages should receive special attention everywhere since it constitutes a major impact on shellfish, and a difficult one to address.
4. Shellfish beds should be inventoried and best land-use practices should be identified for these areas and zoned as such to assist management endeavours.
5. Public education and school programs should be developed and applied to improve the general understanding of human activity impacts on shellfish, their habitat and local economies.
6. The current water quality strategy using faecal coliforms should be reviewed through an international conference with the objective of finding the best all-around environmental indicator and promoting its broad scale application.
7. Community groups should be fully involved in all aspects of research, development and management of shellfish resources located in their regions under the goal of stewardship; use of volunteer resources for data collection should be encouraged and training provided for accuracy and consistency.
8. Communication linkages should be further developed among researchers, managers, industry and local community members, and among jurisdictions in order to facilitate continued contact, data and information transfer relative to shellfish resources.

9. Further research into shellfish population dynamics, their habitat, bacterial loading and hydrodynamic relationships should be conducted and applied to resource management; additional funding for this should be justified and sought.
10. Shellfish habitat remediation and enhancement programs should be developed and applied in all regions to maximize resource production, and identified in regional data bases.
11. Management plans which include limited licensing should be developed and applied to all significant shellfish stocks, and more uniform regulations should be developed and enforcement improved in all regions.
12. Research should be conducted into the role of nutrient enrichment of estuaries in the process of eutrophication and production of organisms containing marine biotoxins which could impact on shellfish.
13. In support of shellfish research, development and management, regional data bases and directories should be established, with the appropriate protocols for timely access.
14. Regional differences and commonalities in shellfish resources, their biology and habitat, management and harvesting should be recognized and integrated in joint planning.

Summarized by:

Dr. Barry C. Jones, Chairman
August 24, 1993.

Gulf of Maine Council on the Marine Environment

Endorsement

At its Annual Meeting of July 16, 1993, in Portsmouth, Massachusetts, the Gulf of Maine Council on the Marine Environment unanimously approved the following recommendations arising from the "Shellfish Habitat Restoration Workshop" of June 15-16, 1993, held in St. Andrews, New Brunswick, and sponsored by the New Brunswick Department of Fisheries and Aquaculture on behalf of the Council:

1. The Council recognizes the significance of the fourteen recommendations produced by this workshop and supports them in principle as important relative to the goals of the Council, and
2. Directs the Working Group to incorporate these recommendations into the Gulf of Maine Action Plan during its current re-evaluation of the plan, giving due consideration to the priorities developed among them by the workshop.

Presented to the Council by:

Dr. Barry C. Jones,
Workshop Chairman
July 16, 1993.

Summary

The members of the Shellfish Habitat Workshop used the workshop as a mechanism to outline problems and issues facing the Gulf of Maine marine environment and the habitat it provides for shellfish.

From the use of information generated in their presentations and discussions, the working groups produced a list of fourteen recommendations for improving the environment of the Gulf. These recommendations were then ranked and prioritized in order of what the members considered to be the most important.

On July 16, 1993, at its annual meeting, the Gulf of Maine Council on the Marine Environment supported in principle and endorsed the fourteen recommendations produced by the workshop. These recommendations were recognized as important relative to the goals of the Council. In addition, the Working Group was requested by the Council, to incorporate these priority-ordered recommendations into the next Gulf of Maine Action Plan.

By holding the "Shellfish Habitat Restoration Workshop" progressive movement has been initiated toward achieving the ultimate goal of opening shellfish harvesting in the Gulf of Maine.

**New Brunswick Department of Fisheries and Aquaculture
Gulf of Maine Council on the Marine Environment**

Participants list

Shellfish Habitat Restoration Workshop

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Registration Total — 57.

(** Speakers)

(all phone and fax numbers lacking the exchange are in the 506 area)