CONNECTICUT SHELLFISH RESTORATION PROJECTS LINKED TO ESTUARINE HEALTH

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Abstract -

A series of CT Sea Grant/Extension shellfish restoration programs for hard clam (*Mercenaria mercenerica)*, soft clam (*Mya arenaria),* oyster (*Crassostrea virginica),* and bay scallop (*Arogopectin irradians)* were coordinated with local municipal shellfish commissions in the 1980's. Potential candidates for projects were identified by local environmental fisheries history, shellfish maps, natural beds and local shellfish surveys. Several restoration projects were undertaken with federal, state and local agency assistance. Results were highly site-specific; some yielded almost immediate positive results, and some were complete failures.

Estuarine health concerns as communicated by small boat inshore fishermen during initial site investigations correlated with project success. Local environmental fisheries reviews were often anecdotal so whenever possible, fishing statistics and US Fish Commission reports were consulted. Methods to restore shellfish populations included spawner areas, reseeding, re-shelling, re-cultivating, shell base restoration and spat collection. This paper reviews shellfish restoration projects in CT from 1979 to 1989 for the following river systems: East, Neck, Hammonassett, Oyster, Pattagansett, Poquonock and Niantic. These projects are reviewed in terms of "estuarine quality" which included water quality, siltation, sedimentation, tidal obstruction or barriers and upland watershed alterations.

Predictions/suggestions by the local residents and resource user groups were often confirmed; therefore, their importance and contribution should not be overlooked. Environmental fishery history reviews can be an important tool in understanding the declines in shellfish production from near shore areas. As much information as possible should be obtained before attempting shellfish restoration programs. In this way, scarce shellfish restoration resources can be maximized.

Podium Comments

Timothy C. Visel

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Ninth International Conference on Shellfish Restoration

First of all, I would like to thank Richard DeVoe and Dorothy Leonard for the correspondence and their assistance. I have wanted to attend for many years, and they have always been supportive of my efforts. In the past, the conferences I attended I learned more and the opportunity to share ideas and exchange information was a large part of my Sea Grant Marine Resource Restoration Partnerships. I'm from Connecticut and we have had our share of monumental problems related to shellfish culture. Connecticut has a long history of environmental degradation, unfortunately which continues today. So the presentation will cover what I term environmental fisheries history and the importance of knowing it. So much of our coastal environmental habitats have been degraded that what is present today is not indicative of Connecticut's natural ecology. I picked 6 shellfish projects that illustrate different problems and will explain my exposure to habitat changes or histories for each, some thing that could have saved a lot of clams, oysters and scallops. I'm not doing shellfish restoration any longer, so what I'm presenting are some University of Connecticut Sea Grant projects from 1978 to 1990.

I submitted the presentation abstract with six projects and later I found out I had 18 minutes, so observations and some data are in a paper I brought with me. Copies are back on the publications table.

One final thought – sometimes the habitat you see today is the last type of habitat you want to use or protect.

I would be pleased to answer any questions after the presentation.

Thank you.

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Introduction

In the late 1970's, The University of Connecticut Sea Grant Marine Advisory Service established three areas of habitat/resource restoration. They were established before UCONN was designated the 23rd Sea Grant College Program on October 5, 1988.

Sea Grant programs form a national network of 29 states along the Atlantic, Pacific and Gulf coasts, and states bordering the Great Lakes. The marine equivalent of the Land Grant College System a century before, each program supports research, marine advisory services and educational outreach, to foster the wise use of marine and coastal resources.

In Connecticut, the Sea Grant Office was a cooperative program with the University of Connecticut College of Agriculture Cooperative Extension Service. Faculty appointments were in fact within the College of Agriculture at the UCONN main campus located in Storrs, Connecticut. Connecticut's program was one of the smallest within the Sea Grant System.

Cooperative Programs and Outreach Clientele

Three areas that were established for Sea Grant habitat restoration initiatives were shellfish restoration/production, finfish habitat restoration and related marine resources. Sea Grant/Extension clientele were industry, educators, researchers, marine trades, municipal committees and commissions and the general public. Shellfish restoration however was a primary focus with local/municipal partnerships. These efforts often were conducted with municipal shellfish commissions.

SGMAS (Sea Grant Marine Advisory Service) operated from 1974 to 1986, with Dr. Lance Stewart as its Program Leader. Norman Bender was the Program Leader during the period 1986-1990 which saw SGMAS embark on a series of shellfish restoration projects

with municipal shellfish commissions and municipal Land Trusts, Conservation Commissions and Harbor Management Commissions. In 1881, the Connecticut State Law Public Act, also called the Natural Bed Jurisdiction Act, created an area inside of a boundary line that was within local town shellfish management authority. Outside of the 1881 jurisdictional boundary, the State of Connecticut, Department of Agriculture-Aquaculture Division had regulatory control. In 1984, the Coastal Area Management in Connecticut established a process for municipalities to develop harbor management plans. Conservation Commissions in Connecticut were under municipal Town Charters, and local Land Trusts were usually non-governmental civic associations. Some Connecticut shellfish governing authorities, such as shellfish commissions and oyster ground committees, dated back to 1790 and the first Connecticut colonial laws.

Some municipal SGMAS restoration projects included:

- Poquonnock River, Groton: scallops 1978-80 and oyster restoration 1985
- Clinton Harbor: bay scallops 1978 and oysters, flounder habitat 1988
- Oyster River, Old Saybrook: seed oyster production 1983-85
- Niantic Bay/Waterford/East Lyme: hard-shell clams 1984-86
- East River, Guilford/Madison: oyster bed/shell base restoration 1985
- Pattagansett River, East Lyme: oyster bed restoration 1986-87
- Herring Run Restoration (Alewife), Madison: Madison Land Trust and Madison Exchange Club 1987
- Dowd’s Creek Hammonasset State Park, Madison: baseline habitat index estuarine fisheries restoration 1987
- Hammonasset State Park, Madison: Tom’s Creek habitat restoration 1981-83
- Alewife Cove, Waterford: citizen monitoring and flounder habitat restoration 1988
- Neck and East River, Guilford/Madison: re-shelling shell base cultivation 1989
- East River, Madison: terrapin turtle egg boxes, Madison Land Trust 1989
- Quambaug Cove, Stonington: flounder habitat investigations 1990

The restoration/habitat work was centered primarily in the eastern portions of the state, where the water was cleaner and the shellfish industry much smaller. In the western areas, the shellfish industry was larger and recultivation, restoration and shellfish enhancement activities already were well established. For nearly a century, many of the Eastern Connecticut towns had no functioning shellfish commission or oyster ground committee. Shellfishing in several communities had declined from historic production levels found only a century before. Workshops and local meetings generated interest in "restoring" shellfish resources in several communities.

Whenever possible, efforts were made to bridge the gap between established shellfish production practices and many newly formed Shellfish Commissions. Educational materials/fact sheets were developed for Sea Grant/Extension clientele. Workshops were held to explain and introduce commercial shellfishing techniques and harvesting/shellfish cultivation practices. Annual seminars were held at the Avery Point Campus for municipal shellfish commissioners interested in shellfish surveys, habitat investigations and field demonstrations. Winter workshop programs addressed specific shellfish management problems and aquacultural production techniques. The content of this paper highlights six specific SGMAS shellfish restoration attempts between 1981-90.

Niantic Bay Quahog Enhancement Project

The Waterford/East Lyme Shellfish Commission was established by act of the Connecticut General Assembly (CGS-26-287) to cooperatively manage shellfish resources in Niantic Bay which lies between both communities. SGMAS was contacted to help with a hard clam culture project already underway.

Project History

In 1984, approximately 5,000 5mm to 8mm quahog (*Mercenaria mercenaria*) clam seed were purchased from Culture Clam on Cape Cod (Robert Porter, personal communication, 1984). They were planted in a 3'x8'x12" deep "bedding box" which was then covered with a protective metal mesh covering. When these clams reached littleneck size (and large enough to withstand natural predators), they were to be planted in areas of Niantic Bay in order to increase natural setting. Niantic Bay once contained deep water hard shell clam beds that were obtained by tongs, especially in Keeney Cove or the easterly spur of Upper Niantic

Bay. After several months, 50% of the clams had died and living clams showed no or poor growth. Investigations into why such a large mortality and poor growth had occurred were then initiated.

Field Observations

The bedding or culture box was located on the south side of Smith Cove part of the upper Niantic Bay/Niantic River System. It had good tidal exchange and was exposed an hour between outgoing and incoming tides. Residents recalled that clamming and oystering were popular summer time activities in the Cove many years ago. Upon investigation, it was apparent the bottom was soft for about 3 inches until a firmer substrate/sand pebble mixture could be found. A tremendous amount of maple/oak leaves were around and on top of the culture box. Upon removing the protective metal mesh cover, the surviving clams all had shell erosion, resembling acid/shell erosion and their shells appeared a chalky white. Low bottom pH (acid bottom) was suspected for the poor growth. It was discouraging to the Commission because growth measurements indicated that clams had actually gotten smaller. Following some culture techniques I learned in Cape Cod and Connecticut and detailed by Mackenzie (1970-1983), the substrate in the cutting box was replaced with a 50% clean sand, 25% clean gravel, 25% ocean quahog clam shell mix available in Rhode Island as a driveway cover. The gravel and sand was purchased locally at a building center.

After the surviving clams (about 2,500) were replaced in the new substrate in May, rapid summer growth was observed until late fall. That fall a strong Northeast storm deposited a thick blanket of leaves over the culture box. Upon removing the leaves, it was discovered that a thick blanket of “black mayonnaise” had covered the clams and nearly all of them had perished. “Black mayonnaise” is a term used in Connecticut to describe a rich, soft, black gelatin-like organic ooze found on many of our bay and cove bottoms. As part of an estuarine history, Nelson Marshall also was investigating the Niantic Bay ecosystem (personal communication, 1993).

Fisheries Environmental Review

A fishery history/habitat environmental review was initiated, and it was discovered that the hard shell clams beds had “disappeared in the 1940s,” when a bullraking fishery had stopped just before World War II (Brian Sullivan, personal communication, 1985). It was located on the Waterford side of

the Bay in the “deep water” around Keeney Cove. Investigations of the Keeney Cove area revealed that soft, deep, organic sediments had settled over much of the cove bottom. In an attempt to calculate the depth, a 10-pipe section got stuck and had to be manually dug out of the bottom. It was estimated that over 8 feet of organic debris had settled over the area. Any productive hard shell clam beds had long been suffocated. The area was undergoing intense euthophication; some euthophic events dated back to the 1920’s.

In conversations with commercial bay scallopers and retired quahog fishermen, all recounted that the bottom environment north of the railroad causeway had become softer and was “choked with weeds.” It was learned that in the 1960’s, studies were conducted with dynamite to try to dislodge dense eelgrass beds that had caused navigation problems, and it was believed this had caused the Upper Bay to stagnate (John Wadsworth, personal communication, 1986). The historical review revealed symptoms to be consistent with enhanced vegetation growth responses to nutrient enrichment. Much of the marine habitats in Niantic Bay River (above railroad causeway) had eutrophied (Public Hearing, Comments T. Visel, DEP Regulatory Review, July 9, 1986). Comments from fishermen indicated that a once very productive “flounder ground” also had disappeared in the 1920’s. Several fisherman blamed manure dumping at the time for the loss. A “large hook” tub trawl flounder fishery existed after a much larger fyke net flounder fishery ended around 1900. Storm water runoff exacerbated the condition bringing large quantities of leaves, sticks and other organic debris. Additional information indicated that much of Niantic Bay’s original circulation pattern had been altered by the construction of the railroad which effectively cut Niantic Bay into two separate sections (Olive Chendali, personal communication, 1985), the northern or river section (north of the railroad) and the southern or outer harbor (south of the railroad causeway). Previous to the construction of the hardened railroad rail bed, Niantic Bay had three barrier beach inlets that periodically opened and closed dependent upon storm events (John Wadsworth, personal communication, 1986). The ecology of Niantic Bay had been substantially altered by the construction of the railroad causeway reducing flushing and wave action in the Upper Bay. Consequently, areas that were periodically flushed of organics by waves and tides now had become areas of deposition. Recently, the Connecticut Department of Environmental Protection and municipal officials presented a very detailed Watershed Management Plan for Niantic Bay (August 2006). At public hearings, the efforts to restore finfish and shellfish

populations by controlling run off to Niantic Bay was favorably received by local residents. Presently, Niantic Bay upper bay and river is designated a Connecticut water body not meeting water quality standards for aquatic life support (DEP Submission 303 (d) of the Federal Clean Water Act, April 28, 2004).

Pattagansett System Oyster Restoration

The Pattagansett River was selected as a possible shellfish restoration site in 1986. The River is within the Town of East Lyme which had recently formed a Harbor Management/Shellfish Commission to oversee coastal resources as part of Connecticut's Coastal Area Management Program. One of the first projects was to restore oystering (*Crassostrea virginia*) to the community and locate any natural oyster beds in the Pattagansett System (January 24, 1986). A shellfish survey had located a small bed of large mature oysters next to the Fair Haven Bridge. The Pattagansett natural bed was selected as a National Marine Fisheries Service (NMFS) site for a resource emergency grant in 1968-1972. That program sought to restore oyster setting capacity along Connecticut's coast after 10 years of complete oyster set failures. It was determined that many of the River's natural oyster beds had been covered with organic matter and silt (Mackenzie, 1970). The resource emergency grant (NMFS Grant In Aid) cleaned shell bases, reshelled and transplanted approximately 100 adult oysters to approximately 25 locations. It was thought that the small oyster bed was one of the remnants of that earlier project (John Baker, personal conversation, 1980).

Project History

The oyster bed was surveyed and photographed by a University of Connecticut Dive Team utilizing SCUBA gear. The oyster bed had no clean cultch upon which oysters could set. Bagged oyster shell cultch donated by Tallmadge Oyster Company was planted to increase shell base and provide a clean substrate upon which oysters could set. Local commercial fishermen donated many hours of time to bag and plant oyster shell cultch in mid-July 1987. The first shell planting occurred with the East Lyme First Selectman, Mr. James Murphy, a commercial fishermen, Craig Andrews and a Harbor Commission member, Arnold Manwaring assisting in these efforts. Robert Beckett, an East Lyme

municipal employee, was the town contact person for the project. Mr. Beckett arranged for municipal transportation of the cultch from the Tallmadge Oyster Company in New Haven.

Project Observations

In May 1986, a shellfish restoration project proposal for the Pattagansett River was made to the East Lyme Board of Selectman; it was approved on June 12, 1986. During the month of June 1986, about 100 bushels was planted as a test shell base. The shell base cultch was covered in silty plant material within 72 hours. It was decided to turn the shells at least once to free them of plant material, much of it stems and stalks of the invasive reed *Phragmites australis*. Oak leaves and many sticks also were observed. A chain link cultivator was used to turn the shells and expose buried black shells as described by Mackenzie (1970). Within three days, the shells were completely covered again by organic debris. A larger, second attempt at direct cultch planting was made possible by Tallmadge Oyster Company and the State Department of Agriculture-Aquaculture Division in 1987. The same results occurred. By September 1988, much of the shell base was so completely buried by organic muck that a hydraulic cultivator, a manifold, sled device powered by a 5 H.P. gasoline pump was used. Jets of water dislodged the fines and algae leaves from the shells. The State Department of Environmental Protection approved the cleaning and some funds for monitoring (January 1989). At this point, Spring 1990, further cultch cleaning was deemed to be fruitless. A public report was made to the East Lyme Harbor/Shellfish Commission confirming early conditions reported in 1987 (“Black Mayonnaise in River Linked to Poor Salt Water Flow (Niantic News, April 27^{th,} 1987).

Environmental Fishery History

After the continued failures to keep the cultch clean, an investigation of environmental habitat conditions was undertaken. (In Connecticut, the industry expects at least 10 days before the cultch is so fouled as to be worthless as an oyster setting surface). Neighbors and retired area commercial fishermen detailed the existence of oyster and hard shell clam beds in the River but in the vicinity of the now-filled railroad crossing. Robert Beckett had family members that remembered oystering in the Pattagansett River; he became one of the strongest supporters of the project.

In 1891, the Railroad doubled tracked the line and replaced a 1,700 foot wide trestle pile-driven bridge with an earthen causeway and a 40-foot-wide culvert. The culvert was offset 45° to the natural flow. After the replacement of the trestle bridge area, fishermen noted that the River started to "fill in". According to Arnold Manwaring, the oyster and clam beds were gone by the late 1940's. He claimed the existence of "deeded" oyster ground on both sides of the present railroad, but this has not been researched. Aerial photography detailed the existence of huge accumulations of "black mayonnaise" just north of the present Amtrak causeway. The UCONN dive team, Robert DeGoursey and Patricia Brown from the Undersea Research Center, located an earlier oyster bed just north of the present railroad causeway under one meter of soft sediment (1988, JSR, pg. 459). The area had reduced tidal circulation and appeared to be changing to a more brackish environment. Comments from Robert Beckett who lived on the Pattagansett River for many years detailed how the River had gotten shallow and invasive reeds had started to grow in the upper watershed. The reeds were an invasive plant to Connecticut *Phragmites australis*. They had overtaken a good portion of the *Spartina alterniflora* and *patens* marsh behind his home.

It was evident from the UCONN dive team survey and direct observation of shell cultch planting that the area between the Railroad Causeway and the Fair Haven Road Causeway had been subjected to increased sedimentation and possible eutrophic conditions. However, impact to the marine environment was difficult to link to reduced tidal energy/flushing. A final programmatic environmental impact statement for the Federal Railroad Administration (FRA–RNC-EIS77-01-F 6/30/78) concluded on page 3-176, "The impact of existing corridor activities upon the highly productive natural marine environment is insignificant." The Town of East Lyme continues to develop shellfish plans in order to restore its once productive shellfish resources. The Pattagansett River has been designated a Connecticut water body not meeting water quality standards for aquatic life support (DEP Submission 303 (d) of the Federal Clean Water Act, April 28, 2004).

Restoration of Oyster Shell Base - East River Guilford, CT

The East River and Neck River natural oyster beds are typical natural beds recorded in Colonial literature. These beds were wild and exhibited none of the characteristics associated with managed cultural beds of the 19th and 20th centuries. The Neck and East Rivers historically provided an important food source.

Therefore, early management efforts sought to distribute the resource amongst the residents of the area. Commercial usage sought to maximize production while management access to the resource tended to limit catches on a per person or per day allocation. This would lead to some damaging actions as the oyster reef impacted navigation after 1949.

Natural oyster bed ecology in Connecticut continues to be poorly understood and complicates traditional resource management efforts. At some times oyster harvests needed to be greatly accelerated while at other times, they needed to be restricted. This lack of flexibility created resource management issues associated with river natural oyster reefs, great abundance followed by natural collapse. Natural oyster beds in rivers periodically create reefs and bars within the streams morphology. Areas of erosion uncover old buried shells, and currents spread these shells downstream and provide the setting surface for young seed oysters. As these oysters mature, they act to trap sediments and direct currents into new areas changing erosion and uncovering older shells from previous oyster reefs. This process can lead to periodic oyster reef buildups, several feet deep in some instances, impacting navigation in both of these rivers as the oyster reef continues to build. That had happened in the East River in 1924, 1949 and 1979 (Joe Dolan, personal communication, 1979). The Neck River was subject to a failed commercial oyster culture experiment when a canal was dug from the shore to increase saltwater exchange and oyster growth. But the Neck River also had experienced water depth decreases as oyster reefs continued to grow towards its junction with the East River. Complaints from recreational boaters described conditions that oyster reefs had grown 4 to 6 feet deep rendering some recreational docks useless. The shell/oyster reef accumulations were confirmed by members of the Madison Shellfish Commission, by J. Milton Jeffrey in 1979 and by paper chart depth recordings on transects for the entire Neck River natural oyster bed in 1981.

Project History

In 1957, the lower portion of the East River was dredged by the U.S. Army Corps of Engineers to create a harbor of refuge. Although initially opposed by local oystermen, as it removed about 600 feet of natural oyster bed, the maintenance dredging, it was soon learned, helped the oyster beds further upstream that had suffered increased siltation and deposition of black organic gelatin nicknamed “black mayonnaise.” Thus the dredging project had cleaned the area of organic debris allowing the

oyster beds upstream to be cultivated and cleaned. Most of the best oyster setting ground used by "tongers" was between a railroad causeway and an abandoned trolley causeway adjacent to US Route 1 (Joe Dolan, personal communication, 1978). Much of the organic debris upstream eventually found its way to the "sediment trap," as Mr. Dolan described it, dug by the Army Corps of Engineers. From 1978 through 1980, natural growers seed oysters harvestors were allowed to take seed from the area between the railroad causeway and Route 1 causeway. A proposal was made to restore the oyster reef habitat in the upper portion of the dredged channel in 1983. The Guilford Shellfish Commission supported a modest cultch planting effort. Cultch was donated by Frank Dolan, co-owner of a local commercial shellfish business in support of a proposal to the Guilford Oyster ground committee dated February 7, 1984.

East River Field Observations

In late June 1985, Mr. Dolan obtained approval from the Guilford Shellfish Commission to plant cultch in the area 200 feet south of the confluence of the East and Neck Rivers. This cultch planting was followed by additional plantings in 1986 and 1987. Shell planting was accomplished utilizing an oyster boat belonging to the Dolan Brothers Shellfish Company. Whole surf clam shells (*Spisula solidissima*) shipped from New Jersey were selected for their ability to form a firm shell base and obtain an oyster set. By 1987, the section of the East River from the confluence of the Neck River to approximately 400 feet west (about 2 acres) was planted. Permission was obtained from Mr. Dolan to conduct a dredge survey for some clam shells containing seed oysters during the summer.

In July 1987, a hand oyster dredge equipped with a metal pressure plate was utilized to examine shells for seed oysters. This was not an in-depth quantitative study but a presence or absence monitoring survey designed to obtain the number of one and two-year-old set on a bushel of planted clam shells. To sample the clutched area, five test sites were selected at random. Sampling was accomplished by conducting three one minute dredge over each test site. As each dredge was hauled, all extraneous material, such as glass, leaves and marsh grass, were separated from the clam shell cultch. At each test site, shells obtained from the dredge were shoveled into two five-gallon plastic buckets equal to a bushel measure. Each sample was examined for 1985 and 1986 spatfalls. Only oysters attached to clam shells and, therefore, planted were included in the results. Thousands of seed oysters were observed in underwater

video documentation photography conducted by the University of Connecticut Undersea Research Program (DeGoursey Dive Report, September 1, 1988).

Fisheries History

The East River is located in the eastern part of the Town of Guilford, Connecticut. It forms much of the boundary between Guilford and the western edge of Madison. The East River is intertidal and exchanges water freely with Long Island Sound around a barrier spit called “Grass Island,” also in the Town of Guilford. Its drainage lies mainly to the north and west, consisting of salt marsh, bogs and wetlands. The East River also receives fresh water from the Neck River to the east and from a small tidal creek to the west. The mean tidal range at the mouth of the East River is about 5.4 feet. A long sand bar at the River’s mouth identifies it as an ebb channel, and it is tidal for approximately four miles upstream. In 1940, a channel 6 to 12 feet deep and up to 100 feet wide existed at the River’s mouth (U.S. House of Representatives, 1941). In 1957, 1,500 feet of the lower East River was dredged to create a mooring area 100 feet wide and six feet deep at mean low water. This mooring area has been maintenance dredged in 1964, 1974 and 1981 (Otis, 1984).

The random sampling previously described yielded many two year olds and set from the previous spatfall on these shells. The oysters all appeared healthy and growing rapidly. The average number of oysters per bushel of sampled cultch was found to be 74 and ranged from a high of 130/bushel to a low of 2/bushel. No distinction was made between the 1985 and 1986 spatfalls. Several shells contained both year classes and had multiple spat, some up to 10 per shell. It should be noted that, from the appearance of the shell surfaces, many of the clam shell were partially buried and had formed a shell base. Dive survey reports indicated that the shell base could not be penetrated by hand (DeGoursey, 1988). It was not possible to determine to what extent the cultch planted thus far acted as a shell base or as a possible oyster setting surface. Underwater photography of the bed in the late fall of 1989 confirmed a healthy set of seed oysters. By 1988, approximately 26,000 bushels of clam shells have been planted.

A report on the success of the project was made to the U.S. Army Corps of Engineers and to the Madison and Guilford Shellfish Commissions. Key to the success of the project would be a co-management agreement with the Dolan Oyster Company not to let

the natural oyster beds “reef up” as they had in 1954, calling for the need to dredge the River. In 1957, “improvement” of the lower East River, according to local oystermen, eliminated most of the oyster resources in this area. Oyster sets continued to occur on what few shells remained on shallow bank edges (Walston, personal communication, 1987). These areas supported a small fishery utilizing tongs until 1966, when pollution closed the River to direct shellfishing (Walston, personal communication, 1987).

The oyster problem in the East River was widely discussed in 1948-1949. In an article titled “Oyster Problem is Not Simple – Guilford Has Rare Opportunity For Development” (December 1, 1948, The Clinton Recorder) Reuben Hill of Guilford, who had tonged oysters in town for more than 60 years, said the East River oyster are in “overcrowded conditions.” They might be of value only if broken apart and moved down river where they might have more room and better feeding conditions. Joseph Dolan also proposed moving oysters down to the mouth of the river where the bottom was firmer and wave/tidal active could keep the bed clean (personal communication, 1979). To prevent the oyster reef buildup Mr. Dolan proposed raising the catch to 10 bushels per day instead of 2 bushels per day but this was not approved. At the time, East River oyster estimates ranged from 25,000 to 100,000 bushels. This situation also had occurred in the late 1920’s according to Mr. Dolan. Although very supportive of restoring a section of the lower East River natural beds, Mr. Dolan felt that tidal circulation of the whole river had been impacted by Route 95, Route 1, trolley and railroad causeways, and that at one time, oysters extended four miles upstream instead of the two miles they existed at present (1980’s). He proposed moving the oyster set from the navigational channel each year to the area between the railroad causeway and trolley causeway. He feared that the navigational project would continue, and the best use of the dredged area was now oyster set/seed oyster collection, and that final grow out should occur upriver. He said the railroad causeway had caused a “plug” in the tidal flow, that the culvert opening was too narrow to accept the entire flow of the East River. Following up on this suggestion, the Madison Shellfish Commission requested a surface salinity profile of the East River.

On August 7, 1987, a salinity profile was taken of the East River in Madison, CT. The survey was started at 4:30 pm at dead low tide. There were five survey points: 75 feet south of the railroad bridge, 75 feet north of the railroad bridge, at the trolley pilings, at the Route 1 bridge, and at the Route 95

bridge. The survey was conducted to illustrate the change of salinity that takes place when the tides comes in. At the above mentioned sites, salinity was taken of the surface water using a Goldberg refractometer which measures the change in refraction angle of the light as it passes through the water being tested. Brad Burnham, a Connecticut College graduate student, recorded the data for this field study.

The results of the salinity profile (data) are interesting. Observations of the incoming tide from 4:30 pm (D. L.W.) to 8:30 pm revealed the existence of a tidal restriction due to the railroad causeway. These disruptions in tidal flow were observed immediately upstream of the railroad bridge. Disturbances such as the above were not observed in any other portion of the East River. A look at the salinity data shows a large delay in surface salinity measurements over a relatively slight distance between the survey point 75 feet south of the railroad bridge and Route 95. While salinity changes were nearly simultaneous from the mouth of the Neck River to the railroad bridge, a delay of up to two hours occurred between the railroad bridge and Route 95 (one quarter of the distance between the Neck River and railroad bridge). This may be explained by a disruption in the saltwater wedge which delayed intrusion of saltwater up the East River described by Mr. Dolan. If significant tidal restriction exists it may manifest itself in a souring of the bottom and deepening of the river channel near the railroad bridge. An extremely deep depression, 14 to 18 feet, was found in the vicinity of the railroad causeway, but 90 feet north of the causeway, the River depth was 4 to 5 feet deep of built-up oyster shells. (Reports to the Madison Shellfish Commission – Shellfish Resource Assessments and Oyster Spatfall Surveys of rivers in Madison Connecticut, April 25, 1988 – Branford H. Burnham, Connecticut College).

Although the railroad causeway was north of the restoration site, its direct impact upon estuarine health could not be directly linked. The lower portion of the East River continued to obtain good oyster sets and the restored area did show substantial spatfalls.

Considerations for Other Projects

It is evident that a greater understanding of natural oyster bed ecology could provide additional restoration opportunities in many Connecticut municipalities (MacKenzie, 1970). Shell deposits that could be utilized as a cultch source occur in most estuaries (MacKenzie, 1983). In areas of continued oyster

setting, on-site reshelling activities should be evaluated. The suitability of pilot projects require that careful review of site- specific biological, environmental and social limitations. It was felt that the East River was a good candidate for a small restoration project; oyster setting was frequent. It had good overall estuarine quality of habitats. The Shellfish Commission and the industry both supported the effort and conflicting uses were seasonal. Under no circumstances was the growth of seed and adult oysters to impact upon navigation. In this case, implementation of new shellfish management policies could possibly eliminate or reduce the need for continued maintenance dredging. If channel depths can be controlled by removing excess oysters or shell, navigation dredging costs would be reduced, and the environmental impacts associated with upland disposal of dredge spoils lessened. This area of cooperative management between the boating and shellfish communities is one of the ways to enhance/restore oyster reef habitats. In eastern Connecticut, some eight court- designated natural beds existed at the turn of the century. At least six of them - East River, West River Patchoque River, Menunketesuck River, Connecticut River and Mystic River natural beds have been dredged in navigation projects. If estuarine quality is sufficient, research could be undertaken using the East River as an example of how to restore oyster productivity and habitats to river systems that had been navigationally dredged.

Clinton Harbor Bay Scallop Restoration

In the early and middle 1970's, the National Marine Fisheries Service and the Sea Grant Marine Advisory Service (SGMAS) investigated the potential to restore the bay scallop (*Argopectin irradians*) to Clinton Harbor. Local reports and US Fish Commission landing statistics confirmed the presence of a bay scallops. These were made available to the SGMAS who, upon a review of historical information, selected sites for juveniles replanting/seeding. On December 5, 1978, 10,000 seed scallops from the Milford NOAA National Marine Fisheries Service 5-30 mm in diameter were transplanted into the harbor. Participating in the reseeding effort were John Baker, Director of the State of Connecticut Aquaculture Division (Department of Agriculture), Dr. Edwin Rhodes, Shellfish Biologist of the National Marine Fisheries Service, and Lance Stewart, Program Leader of the UCONN Marine Advisory Service of the UCONN Avery Point Branch Campus. Seed scallops were broadcast from Cedar Island Marina to the junction of the Indian and Hammock Rivers opposite Clinton Town Beach (Letter to the Madison Shellfish Commission,

December 8, 1978, to Mr. Charles Schroeder from Dr. Lance Stewart Marine Advisory Service).

Project History

The US Fish Commission reports that the last significant oyster harvest in Clinton occurred in 1949. That agrees with many comments from retired commercial fishermen and area accounts of a Clinton Harbor bay scallop harvest. Madison residents reported scalloping as did George McNeil, a local oystermen who operated out of the Harbor for many years. Everyone was very supportive of the attempt, and both Madison and Clinton Shellfish Commissions voiced approval. Spawning stock assessment and enhancement are two viable methods for scallop fishery management (Peter Auster, 1983).

Field Observations

That fall, (1979) Frank Dolan reported catching two bushels of adult bay scallops at the junction of Cedar Island under his winter conditional opening oyster beds. He called the SGMAS office to tell me about it. I explained the project and told him that we had planted seed scallops on the inside of the Harbor, he then told us the eelgrass flats and scallop fishery were on the outside of Cedar Island not in the River as he described it. This caused a review and questions to be asked about the Harbor, and comments confirmed the presence of large eelgrass beds in the Outer Harbor and along Hammonasset Beach to a line of rocks locally known as West Rock. The best scalloping was near the long abandoned fish trap pier. Within three years (1982), reports of adult scallops ceased being found on Cedar Island. At the time, the Inner Harbor contained eelgrass beds but not the Outer Harbor. A decade later, as part of a failed oyster shelling project conducted by the Clinton Shellfish Commission, a more extensive review of the ecology of Clinton Harbor was undertaken.

Environmental Fisheries History

In 1987, Clinton Harbor, the Inner Harbor and the lower Hammonasset River experienced an intense eutrophic event. Dense mats of algae and seaweed stagnated in late August causing noxious smells and localized fish kills. Reports of the Harbor conditions were reported in area and regional press media. It was during this time that information became available that a

Barrier Island Breach, locally called the “Dardanelles,” existed which effectively separated Cedar Island from Hammonasset Point. The Dardanelles had a history of opening and closing several times since the Civil War. It resembled a typical barrier beach/barrier inlet relationship. During the environmental history review, the picture of the earlier scallop fishery in the Outer Harbor become clear. Apparently, the Dardanelles allowed tidal exchange at half to full tides. According to J. Milton Jeffrey, who was a past Madison Shellfish Commission Chairperson, the Dardanelles, he felt, nourished the outer eelgrass beds with silt from the Hammonasset River (personal communication, 1984). Soon after the Dardanelles were closed, the eelgrass began to recede and scallops disappeared. The presence of outer eelgrass beds also was confirmed by several sources, including reports of deep accumulations of eelgrass, cast up upon Cedar Island and gathered as a soil nutrient in Colonial times. Several residents of the towns described these outer beds of eelgrass as dense enough to break the waves and prevent erosion on Cedar Island. Furthermore, seed scallops were always cast up on Cedar Island after a good fall storm. (Art Lang, personal communication, 1987). Scalloping occurred in the channel areas adjacent to Cedar Island and consisted of a hand hauled dredge fishery (George McNeil, personal communication, 1987). On the flats, long handler scoop nets were used.

This was the scallop fishery that was reported to SGMAP in 1977. The Dardanelles were closed the last time by cabling together junk cars and “stringing” a necklace of autos across the strong current followed up by dredge spoils from the Inner Harbor. Many commercial fishermen in the area felt that closing that Dardanelles in 1949 changed the ecology of both the Inner and Outer Harbors.

The 1949 US Fish Commission Report details some 5,000 bushels of bay scallops being harvested from Clinton that year. Shellfish surveys conducted in 1988 yielded information that euthophic conditions exist and much of the productive oyster beds had been buried in black mayonnaise and had been suffocated. The Hammonasset today is listed as a river that exceeds a daily recommended allowance for nitrogen. More recently, an environmental group, “Citizens For A Clean Hammonasset River” has asked for a nitrogen level view for the river watershed. The lower Hammonasset River has been designated a Connecticut water body not meeting water quality standards for aquatic life support (DEP Submission 303 (d) of the Federal Clean Water Act, April 28, 2004).

Poquonnock River, Groton, CT Oyster Project

The Poquonnock River lies within the boundary of the Town of Groton, CT. Its watershed drainage is an airport facility to the west and the State of Connecticut Bluff Point Nature Preserve to the east. Its headwaters are immediately to the north and run primary north to south as they empty into Long Island Sound. It contained historic anadromous fish runs (primarily smelt) and oyster bed resources (Elmer B. Edwards, personal communication, 1985). Several areas had been deeded as oyster ground at the turn of the century, but the Groton Oyster Ground Committee had made no new additional designations since 1910. Locally, the Poquonnock River oysters often were discussed, but no significant catches were reported (Ken Holloway, personal communication to the Chairperson of Groton Shellfish Commission, 1978).

In the 1977, the Sea Grant Marine Advisory Service assisted the Town of Groton in reestablishing its municipal shellfish commission under Connecticut State Statutes. The first shellfish restoration project was to reestablish an oyster bed in the upper Poquonnock River, the site of oystering during the last century. Steve Jones, of the Groton Shellfish Commission, was the contact person for the project.

Project Description

The Poquonnock River was written up in the US Fish Commission Reports as having a heavy oyster set. Despite this reference, no active oyster beds were found. One of the limiting factors for oyster culture has been the lack of clean suitable substrate. Russ Nelson, a local shellfish constable, had noticed heavy sets of oysters on mooring chains. A two-step process supported by the Groton Shellfish Commission was created to establish a small oyster bed. The construction of a 14’x18’ spat raft (Styrofoam® log) from which to suspend Vexa® spat collectors was the first step. The donation of oyster shell cultch to form a shell base upon which to place the open spat collectors was the second part of the process and was made available by Hillard Bloom of Tallmadge Oyster Company. Using student volunteers from Project Oceanology, a marine educational non-profit organization located at the mouth of the Poquonnock River, some 100 1/2-bushel capacity spat collectors were made from bay scallop shells and hung off the spat collector raft in

June of 1984. A tremendous oyster set was obtained, and by October, the shell-based bags were opened and placed on 1,000 bushels of oyster shells and shellbase donated by Tallmadge Oyster Company of Norwalk, CT. The area to be planted was selected in close consultation with local shellfish commission members who had detailed information on historic oyster beds (oyster bed designations) in the Poquonnock River. Almost immediately, the shellbase and seed oysters were covered in the black, partially decomposed, organic matter called "black mayonnaise" and suffocated. No oysters survived ("Specialist Warns Agency of Black Mayonnaise Threat", The Day, June 12, 1985). A final report was made to Ronald Chappel, Chairperson of the Groton Shellfish Commission on July 31, 1986.

Environmental Fisheries Review

Upon the results of the oyster restoration project, local area fishermen were interviewed about the Poquonnock River. It was determined that much of the oyster resources were previously located north of a railroad causeway. This causeway was built as a commercial spur to the city of Groton and located on the east side of the Thames River. This spur had been rebuilt in the 1920's, and the open wood trestle was replaced by a causeway and small culvert. A retired local oystermen, Elmer Edwards recalled, that the historic beds had a long since been "covered up," and he blamed the narrow opening in the railroad causeway for it. This information was eventually confirmed by Dr. Robert Whitlatch, Department Head of Marine Sciences at the University of Connecticut.

Other residents confirmed these observations and upon closer inspections revealed that much of the soft shell clam resource also had perished. The current bay scalloping fishery and hard clam fishery now was confined to be mostly below the railroad causeway but, "black mayonnaise" was becoming more prevalent even in these areas. Flounder fishing and bay scalloping also had recently declined in the River prompting additional concerns and additional shellfish study by Project Oceanology (1985).

Investigations by way of a hand-hauled seed oyster dredge revealed heavy accumulations of leaves upon the shell base and opened spat bags. In some cases, two to three inches had accumulated over the test site in just a few weeks. Consequently, further efforts to restore bottom oyster beds to the area were abandoned.

The creation of the railroad causeway had certainly reduced tidal flushing, but several fishermen stated that it also acted as a “wave break,” waves and tidal action had helped keep the oysters clean. Flounder fishing and had declined north of the present railroad causeway. A final report of the project was given to the Groton Shellfish Commission in December of 1986. The report mentions increased sedimentation and decreased tidal/ware action as contributing factors. A month later, Dr. Robert Whitlatch, blamed “Dense building around harbors and the coming of the railroad for much of the oyster loss - larvae were very sensitive to being smothered by siltation when the railroad came through it. It basically cut off the small estuaries and reduced the amount of fresh and salt water mix.” Project Oceanology agreed to help the Groton Shellfish Commission conduct annual shellfish assessments.

According to Captain Edwards, most of the early Poquonnock River oyster production was north of the New York, New Haven and Hartford railroad (Town of Groton land records, Volume 42, Page 40). Most of the river bottom was granted out for oyster culture but had to be abandoned due to weed growth and soft bottoms. It appeared that many of the complaints about manure dumping from nearby farms may have provided part of the cause. In fact, J. W. Collins in his 1889 Notes on the Oyster Fishery of Connecticut mentions the negative impacts of “stagnant water.” He states, there (Poquonnock River) the current is checked by eelgrass, and during hot weather it sometimes becomes peculiarly offensive and causes the death of the oysters within the limits of the stagnant water” (United States Fish Commission, Vol. 9, 1889; GPO 1891). In another account, Ernest Ingersoll further mentions the Poquonnock River as one of the few examples of “off bottom oyster culture.” He writes, “On the Poquonnock River, near Groton, white birch branches are stuck in the river mud about spawning time in 14 or 15 feet of water at low tide. To these the spat adheres in great quantities. They are left undisturbed for eighteen months by which the set becomes good size seed – the average yield is about 5 bushels to the bush. The grounds are so soft and muddy that no other method is feasible. About 50 acres (1881) are under this kind of cultivation and the area is extending” rapidly (pg. 544). The 1889 Fifth Annual Bureau of Labor Statistics shows almost the entire Poquonnock River under oyster cultivation. But the best oyster area was between the two railroad causeways, the commercial spur to Groton and the northeast corridor line (Elmer Edwards, personal communication, 1984). The commercial spur is now abandoned but reduced the 1000-foot-wide river to less than 30 feet direct open exchange. A small portion of the Poquonnock

was hardened. “A portion of the bottom of this pond they prepared for oyster raising – by spreading scallop shells over six acres, and gravel and beach sand over 2 acres and planted 2,500 bushels of seed oysters – which have not reached market size. (The Coast of Connecticut and its Fisheries by Howard Clark, reports on Ernest Ingersoll, pg. 319, Geographical review of the fisheries – Connecticut – US Fish Commission of Fish and Fisheries – GBG, Section 2, GPO 1887). Efforts to find this hardened oyster culture bed were unsuccessful in 1986.

According to Russell Nelson and Ken Holloway, the oyster fishery declined because the River filled in with “a black organic mayonnaise-like muck.” Mr. Holloway also reported on a mass mortality of Poquonnock shellfish he believed resulted from excess street water runoff. They both felt the flushing of organic debris and thatch from the marshes was eliminated between the railroad causeways preventing waves from resuspending this material and taking it out with the tide. Although no direct reference linking greater sedimentation rates for the Poquonnock could be found, one did appear for a similar sized cove to the east, Quiambaug Cove located in Stonington, CT. On June 30, 1987, Edgar P. Farnell wrote to me about the impact of the road and rail causeways upon sedimentation rates in Quiambaug Cove. “When my father (deceased in 1972) was young, he recalled that every spring landowners along the Cove would use a team of oxen and plow to dredge the Cove every year between the bridges at a perigee tide. This, no doubt, improved the tidal flow, because when I was a boy, the Cove had little of the muck which now prevails.” In addition to his comments about tidal flow, Mr. Farnell added comments about the decline in fisheries. “The build-up of muck and heavy vegetation is more of a concern. It certainly has had an effect on the Cove (Quiambaug) as a whole including clams, oysters, crabs, fish and mussels.” Similar comments can be found for most of Connecticut’s coves that have railroad or road causeways. Members of the Groton Shellfish Commission continued in the 1980’s to ask that rail and road causeways be widened to allow waves and tides to churn up the organic debris in the upper Poquonnock. Recent reports from the town now report that shellfish populations are now largely absent from that area.

Further east, Benjamin Rathburn, a member of a Noank Fishing Community, went even further by stating in February 1989, “What about railroads; their bridges and trestles have done more to degrade and restrict access to state waters than almost all other activity combined.” In many fishing families, a sense lingered that causeways had been damaging to the coves and their

livelihoods in many eastern Connecticut coves. This was the situation in the late 1980's, but the opinion was not universally held. To this day, disagreement exists between resource managers and scientists about the role of the railroad causeways in habitat quality, sedimentation and tidal flushing. Today, the Poquonnock supports a modest hard shell clam fishery in its lower reaches. Sizable quantities of oysters and bay scallops have disappeared. The Poquonnock River had been designated a Connecticut water body that does not meet water quality standards for shellfishing.

Oyster River Shellbase Restoration Project

The Oyster River is located in the southern part of Old Saybrook and flows directly into Long Island Sound. Its drainage lies mainly to the north and east, consisting of salt marsh, bogs and wetlands. Approximately 50% of the adjacent upland areas of the Lower River have been extensively developed as a summer home community. Bottom conditions in the upper and lower sections ranged from very soft mud to firm mud/sand matrix. Between beds, where the ebb current velocity is reduced, mud accumulations are exposed at low tide. George Goode, in the US Fish Commission Reprints 1887, GPO, stated that a small natural oyster bed existed in the Oyster River.

Project History

This project was initiated in 1981 as part of a University of Rhode Island master's degree program. It continued as a SGMAP long-term study of natural oyster bed seed oyster/relay (depuration) project.

In April of 1981, after obtaining a letter of support from the First Selectwoman, the first shellfish assessment survey was conducted in the Oyster River. The purpose of this initial survey was to determine (1) the density of any existing oyster populations, (2) if recent spat falls occurred, and (3) where siltation problems were likely to exist.

Surveys were conducted with a hand-hauled oyster dredge, a pair of oyster tongs and a hard clam rake. Field work was conducted from an eighteen-foot skiff powered with a 40 H.P. outboard motor. The hand dredge weighed approximately 30 pounds, and consisted of a triangular metal frame containing a pressure plate, chain and mesh bag, and cutting bar with two-inch spaced

teeth. The oyster tongs were eighteen inches wide, with teeth spaced 1.5 inches apart. The clam rake was a basket type.

Results indicated that the Oyster River had experienced a spatfall failure – no seed oysters or significant recent oyster setting had occurred for quite some time. To make room for new seed oysters, the River was opened to natural growth seed oyster harvesters. Approximately 2,200 bushels of oysters were removed. It was decided to try an oyster shell base restoration/cleaning program as described by Clyde MacKenzie (1970-1983). This program included the use of small hand-hauled seed oyster dredges equipped with a pressure plate to help scour and clean oyster shell bases, the planting of clean dry shell cultch and recultivation of the shell base if required. A small culture program with scallop shells occurred in 1981.

In July of 1982, 2,000 bushels of high-quality shell cultch were donated by Hilliard Bloom of Tallmadge Brothers Oyster Company to the Town of Old Saybrook. The cultch was loaded into town vehicles in New Haven, Connecticut and trucked to the Oyster River. Cultch planting was accomplished using a dump truck equipped with a sand window and a chute. A 5 H.P. Homelite® trash pump delivered water into the truck body creating slurry of shell material that flowed down the chute onto a plywood-covered scow. The water jet was utilized to wash the shell overboard. In October of 1982, the six stations were again resurveyed.

Results indicated a good oyster set occurred. Relative to the previous six stations, where only one seed oyster was observed, over 1,500 seed oysters or set were counted in 1981/1982. In 1983, the town of Old Saybrook and its local shellfish commission formally assumed responsibility for the program. Results of this project were presented at the 1983 Northeast Fish and Wildlife Conference (1984 Proceedings, pp. 291-294). In 1992, the Oyster River project was cited as an example of the successful farmer who cannot just “let nature take its course” with open system shellfish (Landua, 1992) management.

Project Observations

Initial resource assessment surveys of the Oyster River showed conditions similar to those experienced in the Hammonasset River in the Town of Clinton, the East River in Guilford and the Neck River in Madison. The Oyster River beds also exhibited the characteristics associated with unmanaged or uncultivated oyster beds - overcrowding, high mortalities (due to burial) and poor

seed oyster setting (due to the lack of clean cultch) as described by Mackenzie (1970).

The initial seed oyster survey showed poor recruitment even though, during the previous eleven years, significant oyster spatfalls occurred in Connecticut (John Volk, personal communication, 1981). Natural growth harvesters subsequently thinned the oyster beds of overgrown adults and recultivated the buried shell base as part of the recommendations submitted to the Old Saybrook Shellfish Commission (1981).

Immediately after the spring 1981 shellfish surveys, a meeting of municipal, state, and federal officials was held in Old Saybrook. At this meeting, various management objectives and procedures were evaluated and consolidated into a specific management plan. A program of careful monitoring and thinning of the adult oyster beds was favorably received and supported. The final management program encompassed three management procedures: 1) commercial seed oystering with hand dredges, (2) a cultch program, and (3) a small transplant to certified water for recreational shellfishing. In 1981, Old Saybrook, under a special supervision and administrative agreement opened a conditional relay area for recreational shellfishing adjacent to a local public beach.

One of the goals of the program was that it would be self-sustaining and that oyster production levels could be gradually increased. Discouraging news came in the spring of 1984 - much of the previous shellbase now contained a thick blanket of leaves and exhibited huge increases of the marine seaweed called sea lettuce (*Ulva lactuca*). Much of the existing shell bases were covered in the black organic material that is locally called “black mayonnaise”. It was decided to look into ecological changes in the Oyster River watershed J.C. Hammond, one of the last Chatham oysterers, detailed how the dense beds of *Ulva lactuca* had killed oysters on Cape Cod. Initial surveys revealed conditions very similar to those he had described in 1978 on Cape Cod.

Environmental Fisheries History

A meeting was organized and sponsored by the Connecticut River Estuary Regional Planning Agency and the Sounds Conservancy, an environmental non-profit organization established by Chrispery Percy dedicated to rebuilding Connecticut’s finfish and shellfish populations. During the meeting, the build-up of silt and impacts upon the oyster resources was described by John

Volk, Director of the State Department of Agriculture-Aquaculture Division. The situation in Old Saybrook was detailed as many of its rivers and coves were impacted by siltation. Jack Millofsky, a member of the Old Saybrook Shellfish Commission, had the lead role in organizing the meeting. After the meeting, several Oyster River neighborhood residents discussed the River with us. We soon learned that the River had supported many other fisheries such as eels, flounders as well as blue crabs and stripers. (We had already obtained information about flounder from Anthony Ronzo, a proposal opponent who turned into a strong program proponent). Other residents also described the existence *smelt* and a small fyke net flounder fishery. Recreational trot lines also were set in the River for fluke and blackfish. Eelgrass and hard clam beds were located at the River's mouth (Barbara Maynard, personal communication, 1982). However, with the historical information came the environmental comments - "too much street water" and we should "look at the shopping plaza runoff and Rt. 95" for answers to our questions. Increased bacterial levels had closed the Oyster River to direct shellfish harvesting in 1971. Shell cultch necessary for successful oyster recruitment was very quickly fouled.

Old Saybrook had located industrial development along much of the Oyster River upper watershed. Oyster River neighborhood residents commented that the Oyster River was often brown and full of silt. Many felt that it was "street water" from paved surfaces in the upper watershed, but no direct link could be located. However, in 1986, a heavy rain washed billions of round, commercial grade, plastic pellets into the Oyster River. They were eventually traced to a plastics manufacturer on the west side of the upper Oyster River watershed. Apparently, the spill had washed into a direct storm water drain and then into the Oyster River. The Oyster River was monitored after this incident just prior to and after heavy rains, and the River was very muddy and often contained heavy amounts of leaves and partially composed organic matter. These observations confirmed the reports of residents who had first seen water quality changes (Letter to Judy Preston, The Nature Conservancy, May 15, 2002). Today, a citizen's environmental group is educating the public about the need to preserve and restore natural drainage in the Oyster River, Old Saybrook Watershed. It is sponsored by The Nature Conservancy (TNC), NOAA Restoration Center, CT Department of Environmental Protection, CT Sea Grant and the Noank Shellfish Cooperative. It is part of a new community–based oyster restoration program in Connecticut (Molnar 2004). The Oyster River estuary has been designated a Connecticut water

body not meeting water quality standards for shellfishing (DEP Submission 303 (d) of the Federal Clean Water Act, April 28, 2004).

Summary

Fishermen Recognized Environmental Problems Years Before

A common link was found in all these projects – man's impact on natural drainage. Shellfishermen realized this impact and continued to complain about "street water" and organics being washed into coves and estuaries.

Against this unfolding regulatory climate, the inshore fishermen had no effective way to mobilize public opinion or influence policy. This was combined with the belief that this resource user group was part of the problem–resource depletion rather than resource utilization. This was especially important to the inshore shell fishermen who often felt that productive shellfish beds were an important part, if not the most important part, of the estuarine ecosystem. Unfortunately, many of the comments by these fishermen have proved to be sadly and entirely correct as it related to habitat associations to anadromous and demersal fish populations.

The inshore fishermen, who often fished local bays and coves in the 1950s, had pretty much "given up trying to get something done." There was a belief that by the time people figured out "what had happened," it would be too late for the fisheries. Part of the success of Cooperative Extension Programming was the "bridging" of the scientific community to citizens who would benefit from their information. And we had to be optimistic about the job. In the 1960s and 1970s, only a few researchers primarily located within the Bureau of Commercial and Recreational Fisheries (Fish & Wildlife Service were working with inshore fishermen. Most of the technical information available to inshore fishermen was printed in the 1950s and 1960s, and Sea Grant did not have the capacity to produce technical information that was cove or river specific. The shellfisheries were relatively new both to Sea Grant and Land Grant. Many of fisheries had preexisting regulatory institutions at the state and federal level that complicated fisheries management and research efforts. Some of these institutional lead agency conflicts still exist today.

My shellfish restoration efforts also were influenced by field research and exposure to the shellfish industry during a 10-year period during which I was employed full or part time by three cooperative extension services; URI, UMASS and finally, the University of Connecticut. In all three states, I conducted adult and outreach education for inshore fishermen. It targeted part-time and full time commercial fishermen, about half of whom were involved in the shellfisheries-hard clam, soft shell, clam, oyster and bay scallop fisheries. It soon became apparent that bottom manipulation was an accepted practice and associated with increased shellfish production. The experiences of these commercial shellfishermen (it didn't matter what fishery) all related personal observations of bay, cove and river bottoms. Some retired fishermen attended these educational sessions just for interest, so occasionally we had viewpoints represented from the 1920's to late 1970's/ early 1980's. Within a 10 year period, about 2,000 fishermen participated. Although it was far from a peer review study, the generalized comments below are representative.

1. Almost all reported increasing concerns about accumulations of organic debris – leaves, sticks, vegetation, algal blooms that has changed fisheries habitat from hard bottoms to soft in the areas they fished.

2. A negative correlation between the growth of bottom vegetation to a loss of shellfish productivity – much of the concern involved tidal movement restriction, stagnation and low oxygen levels. In some cases, the growth of vegetation was so thick it suffocated shellfish and eliminated benthic species fishes (mostly flounder and blue crabs).

3. Almost all of the fishermen recounted experiences in tidal coves and bays about the advantages of working the bottom, removing organics and silts from the sediments and breaking up hard bottoms. This was quite evident with hydraulic hard shell clam shellfishing here in Connecticut after 1958. Nearly all spoke of the need to have hard, clean bottoms in part of the bay, cove or estuary in which they fished.

Conclusion

Restoration Efforts Without a Fisheries History or Baseline Habitat Index

Shellfish restoration efforts often were not successful due to a large extent to an under estimation of the habitat degradation. Coastal ecosystems that had previously confirmed habitat associations could not be verified. In fact, reliance upon a review of the scientific literature was to a large extent the chief cause of these failures. What commenced as a restoration effort soon developed into a fishery history/historical review of scientific habitat conditions. In my opinion, no habitat relationship should be reported without actual field observations and sampling. This is a critical fisheries restoration issue that needs the funding resources it deserves.

Looking Back

A prior need to develop an accurate habitat index standard or baseline was necessary. Although the literature cites certain habitat associations, actual field surveys often presented opposing or conflicting information. Some of this disconnect can be attributed to a change in coastal resource management policy in the 1970's from a focus upon habitat biology to a focus upon the collection of analytical data from environmental impacts to those habitats. Also, the environmental degradation of Connecticut's coastal estuaries lagged far behind the research and management agencies' ability to assess the damage. Only after "resource failures" did the degradation became widely accepted or acknowledged. Several Connecticut estuaries were still labeled as "pristine" or "healthy" even as most of the estuarine-dependent habitats they once contained no longer existed, sometimes for as long as decades. This delay in observation and field work can be attributed to a lack of site-specific habitat information. The association of habitat to resource productivity is usually non-specific relating to commonly accepted or reported habitat associations. Most often, the only site-specific research conducted is environmental impact reviews for coastal development. This approach is highly reactive and very often species-specific. Such assessments routinely consider present observed conditions and only rarely survey over seasons. Thus, it is possible to miss significant ecological habitat considerations without a historical time frame or reference. Site-specific research is dependent upon other sources of historical information such as logs, newspaper accounts and past practice of user groups. Combined, they can represent an in-depth environmental fisheries history.

In My Opinion

The most important component of any shellfish restoration project today should be an environmental fisheries history of the critical, or in today's terminology "essential," fish or shellfish habitat.

A through understanding of the ecological implications of the shellfish reef and shellfish beds in general to the bio diversity of the habitat in question needs to be reviewed. Nearly all the shellfishermen, about equal numbers of whom were commercial, and recreational felt that a healthy shellfishery was indicative of a healthy "environment." Many took the time to detail and question why shellfish resources declined and why this decline proceeded other dramatic declines in estuarine species. It is my hope that continued research regarding estuarine quality will be accelerated with direct observations of shellfish habitats, and any such research will involve shellfish researchers and the shellfish industry as equal partners.

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