Sapropel and Climate Change
Fisheries Habitats Degraded by Putrefied Organic Debris in High Heat Low Energy Conditions
Marine Sapropel - Notes for Information
Submitted to EPA/DEEP Long Island Sound Study Committee on Non Point Source Pollution and Watershed Workgroup for Review and Possible Comment
The Role of Nitrogen Recycling in Poorly Flushed Coves

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January 2013
Revised April 15, 2013
Inclusion of Appendices Limited Distribution
Revised July 1st 2013

A New Need for An Environmental History Effort for The State of Connecticut[1]
EPA Nitrogen Watershed Inputs for Long Island Sound May Need a Review
Long Island Sound Study Habitat Restoration Work Group meeting
September 10, 2013, Kings Park, New York

Postponed Full Agenda to November Meeting
Revised to October 1st 2013
Resubmitted To The LISS Habitat Working Group for Review and Comment
January 2014

Foreword

In one of the first comprehensive Long Island Sound Environmental workshops – sponsored by the NOAA Estuarine Programs Office and US Environmental Protection Agency EPA (US Dept of Commerce 14th and Constitution Avenue May 10, 1985 – Battelle Contract E68-03-3319 and was published 1//15/1986. The subject of bottom sediments and oxygen depletion were discussed, one presenter Dr. Donald Rhoads of the Dept of Geology and Geophysics of Yale University reviews this topic on pages 47 to 57. Dr. Rhoads mentions the need to study the role of sediments in low oxygen conditions and Long Island Sounds organic matter loadings. In his summary on page 56 Dr. Rhodes asks what are the distribution of Sapropels? What are the distributions of the biological storage system low sulfide and purging systems high sulfide? The write up at the end of the report includes a question and answer session in which sapropels are highlighted many times and included as a critical study area.

To my knowledge sapropels (putrefied organic matter) would never be mentioned again. In fact many people have never have heard the term. This is on its own is not surprising as this area of research has been almost totally neglected – (my opinion) but the absence of sapropel studies, reports and information about it does support my view. There is nothing written about it so for many readers this will be the first time sapropel is mentioned or discussed. My question regards how could this have happened – Sapropel has been identified and researched for a long time, and now is a huge issue for the nitrogen TMDL model for Long Island Sound. It also has for reaching habitat restoration implications – including as long neglected research area of habitat succession.

Sapropel and climate change is perhaps the number one issue for Long Island Sound – especially during this long period of extended heat. Dr. Rhoads 1986 conference paper is key to understanding current Long Island Sound issues and he also correctly predicted the habitat compression issues just before the lobster crash (pg 56). Sapropel now appears to be a huge issue in the TMDL nitrogen reduction models perhaps needing now a complete revision.

The section about sapropels is also on page 56 of his paper in which he introduces the bacterial reduction processes in the sulfide biome and is found these sentences.

> "Underlying the dysaerobic and anaerobic water one typically finds organic rich black (ie sulfidic) muds that are termed sapropels. These are rich in iron monsulfides; the physical properties of these muds are distinctive and the best description that I have heard of them is that they are like a "black mayonnaise." Dr. Donald Rhoads workshop participant, May 10, 1985.

Introduction

In the 1970s and 1980s coastal fishers from Boston to New York commented about habitat changes. Small boat fishers, hard clammers, bay scallopers, oyster planters and winter flounder skiff trawl boat owners all reported similar habitat changes, the bottoms were getting softer and muck filled, they now contained "black mayonnaise". Mr. John Hammond a retired oyster planter on Cape Cod was watching the change also. For decades Mr. Hammond had studied the impacts of temperature and energy to subtidal shellfish habitats surrounding Chatham, especially the Monomoy system that flanked Chatham's eastern edge. To him the changes in bottom types were changing to one of composting which as an accomplished agricultural researcher and gardener he was quite familiar. When I worked on the Cape and then employed by the University of Massachusetts Cape Cod Extension Service stationed in Barnstable, it seemed almost every week the Hyannis Waste Water Treatment Plant was in the news. Fishermen had linked the plant to the buildup of organic "oatmeal" [1] that now covered bay bottoms especially Lewis Bay. Mr. Hammond urged caution, and the public perception at the time certainly had made that connection to the plant but he was more concerned about bacteria and shellfish closures in areas which contained poorly flushed bays. His view was habitat conditions or habitat quality was declining. Excess nitrogen was a problem but that was dissolved nitrogen but what greatly concerned Mr. Hammond was marine compost and changing climate conditions, an increase of terrestrial organic matter – leaves.

It started according to Mr. Hammond after a region wide leaf burning ban. He wasn't alone Joseph DiCarlo of the Massachusetts Division of Marine Fisheries felt the same way – leaves that were once burned now were dumped into streams which contained alewife runs.

Organic inputs from watershed sources can be attributed to both natural and anthropogenic activities (Brionetal 2003) and can be a large factor in assessing ammonium impacts – a biological available but often less mobile nitrogen form (Burgin and Hamilton 2007). User group reports of changed habitat conditions especially those related to organic matter buildups may have signaled an increased supply of ammonium from a sulfur anaerobic oxidation reduction processes. This was the marine compost that Mr. Hammond described in the 1980s.

Nitrogen and Shellfish Habitat – A Cape Cod Case History

According to Mr. Hammond nitrogen from septic systems had a chance to be "taken up" (attenuation) by grass, trees and shrubs. He was far more concerned with "hard nitrogen" stored in organic matter (leaves, dead greases) that now accumulated in poorly flushed coves, rivers and bays. He termed it as composting and ruining habitats for clams, oysters, and bay scallops. One morning he took me down to the old line of oyster shops along the Oyster Pond River to show me this material, which consisted of oak leaves, dead eelgrass stems and dead grasses. The deeper accumulations had turned black and when disturbed gave off the strong odor of sulfur – the rotten egg smell from coastal marshes so much reported in late August. "This is your nitrogen problem – it's the plants and leaves that die and collect to compost for decades" (he said). To him more nitrogen meant a better chance of grass clippings and leaves being swept into waterways. The rule changes against burning fall leaves had already impacted some Cape Cod local water courses and some smaller alewife runs were nearly filled with discarded leaves (personal observations) but he suspected something else, it was getting warmer and the number

[1] Oatmeal or Chaff is an old term that signifies pulverized or ground organic matter. It can consist of stems, pieces of leaves, grass blades sticks, bark and clippings. In areas of pavement it consisted of ground up leaves – and became problematic after a regional leaf burning ban (personal observation). Connecticut DEEP top 40 environmental accomplishments lists open burning as established on June 1, 1972. Section 22a-174(f) of the Connecticut General Statutes.

of winter gales was diminishing. The climate conditions he felt were turning against the fish and fishers as well. Leaves were collecting everywhere mixed with other organics forming a black jelly like material very acidic and sulfur rich – we know that material as black mayonnaise but the scientific community knows it as Sapropel. By the time I was employed by the University of Massachusetts (1981), I was familiar with the damaging impacts of this material.

Mr. Hammond would discuss my term of "black mayonnaise" several times, he liked it, he had seen it before on Long Island New York, he was invited to visit (years unknown) several duck farming operations there that had heavily manured local waters which termed into deep black deposits of similar material that covered shellfish bottoms and was suspected in many fish kills. Worse yet skiff commercial fishers had noticed something else, that winter flounder had no fins or had necrosis (flesh rot) caught in these areas. Although he suggested the material be dredged out years before Chatham quahogers now reported similar winter flounder being caught in the Oyster Pond River. Mr. Hammond had then linked the flounder fin loss to the same conditions, high heat, poor flushing and compost. He felt the fins of winter flounder were dissolving from acid or "sour" bottoms as he described them. His studies on habitat conditions began in the middle 1960s – during a period of cold and storms which favored bay scallops while fewer storms and warmer temperatures made his planted oysters grow much faster. It seemed hard to believe that bay scallops liked bitter cold and strong storms (which we do not) and that such conditions favors hard clams and winter flounder. The temperature and energy conditions he felt had a direct link to these habitats. Mr. Hammond had several reports (many of which we given to me) that supported his claims. Some three decades later, the scientific community has largely confirmed Mr. Hammond's observations. The North Atlantic Oscillation was weakening – a west based negative aspect (1970s) climate and temperature were indeed turning against local small boat fisheries, instead of hard sand and a mixture of estuarine shell (which supported more alkaline conditions) that habitat was changing to softer organic (compost filled) and now acidic bottoms.[2]

Fishers had noticed these changes and on the fisheries also[3]. By 1982[4] fishermen north of Quincy Bay to Jamaica Bay New York were catching winter flounder with fin rot disease and they also noticed the increase in "black mayonnaise," a marine compost that is called Sapropel.

[2] Environmental fisheries history is a long term view of many disciplines including biology, botany geology, archaeology, ecology, and climatology detailing specific indicators for fish and shellfish habitat quality.

[3] The habitat conditions that favored hard clams winter flounder and bay scallops were ending, those that favored channel whelk, soft shell clams, and oysters was about to begin. In Southern New England the warmer temperatures would cause a region wide habitat failure for lobsters but set the conditions for the largest increase in blue crab populations in a century especially in CT.

Mr. Hammond sent me a newspaper clipping about that long after I returned to Connecticut in 1983. The plant he held responsible for the accelerated habitat change on Cape Cod was eelgrass, a plant that was well known for its ability to trap organic matter.

Mr. Hammond had watched Pleasant Bay quahogers make "their last stand" against the onslaught of eelgrass on the Cape. Eelgrass was observed to overrun, smother and then suffocate quahog beds and then bind together organic debris over them. In high heat and during low energy conditions Sapropel soon followed under eelgrass meadows. Below eelgrass meadows were the remains of an earlier successful habitat for the hard clam.[5] He had observed this ability to trap oak leaves which were already very acidic and rot under summer heat. But Mr. Hammond wasn't, the only one to notice this eelgrass and Sapropel connection.

Much earlier, a group of researchers in the late 1930s were also looking into (black muds) most as a potential energy source and in the North Sea, a particular strong eelgrass Sapropel connection had already been made in coastal regions.

Eelgrass Zostera marina ability to complex (bind) organic matter and the presence of sapropelic muds is detailed in a 1938 paper (Trask 1955)[6]. It was determined by Nichols (1920) [7] that Zostera was capable of binding inches of organic matter upon tidal flats. In high heat these deposits were able to leach hydrogen sulfide directly into adjacent waters. In times of prolonged intense heat and few strong storms it had become a dominant habitat type in Southern New England in the 1920s.

Sapropel has huge implications for the Long Island Sound Study (and other regional EPA estuary programs as well) as it can shed enormous amounts of ammonium from sulfate reducing bacterial

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[4] In 1982 Peter Auster finished a study for the New Haven Based educational organization Schooner, Inc. and detailed the incidence of winter flounder fin rot in sampled populations in New Haven Harbor. See information for the Morris Cove Section which in this study showed 22% prevalence. See appendix for report abstract and data.

[5] Personal observation, Pleasant Bay Orleans, Sherril Smith Mass DMF Clam Survey 1982.

[6] Parker D. Trusk, US Geological Survey, Washington, DC in his 1938 paper titled "Organic Content of Recent Marine Sediments" (1938 reprinted 1955) describes eelgrass organic production levels found in Denmark (1926) as high as 100 grams per square meter.

[7] Nichols found that extensive meadows of eelgrass could trap inches of organic debris (detritus) causing the relative elevation of eelgrass stands to rise (1920-1921).

processes associated with the nitrogen cycle.[8] In high heat low energy periods hydrogen sulfide production soared in poorly flushed basins.

In a study of Norwegian fjords, Kaare Muster Strom (1938) is credited with first describing the chemical toxicity of hydrogen sulfide, in marine waters from anaerobic sedimentation and organic mud deposits. Toxicity is related to the degree of stagnation with high organic carbon percentages commonly over 20% in sampled areas (1939) Coastal Sapropel deposits in habitat shallows such as bays that still communicate with the sea and contain oxygen but such intensification in sediments of organic substances is that such deposits consist almost totally of black mud and there is no animal life. Strom further describes the importance of core studies as indication of increasing stagnation and attributes such change to climatic change upon adjacent continents (dry, hot summers and cold winters). For the more oceanic types core samples provide proof of transitions between ventilated to unventilated bottom waters Pg 362- land-locked waters and black muds, Kaare Munster Strom, University of Geological Museum, Oslo

Norway, manuscript received March 4, 1938 and upon request was not edited, pages 365 to 372.

For more recent studies, see Schneuenberger et al 2003 – Also Marine Sapropel Bouloubassi et al 1998 – Historic Characteristics of Ancient Marine Sapropel, see Parker D. Trask, U.S. Geological Survey Washington, DC, 1939. Recent Marine Sediments Library of Congress card number 67-26966 (1958).

Sapropel can store enormous quantities of nitrogen as an extraordinary organic carbon rich deposit, with levels exceeding 30%. Fishers mostly shell fishermen described in the late 1970s Sapropel as black mayonnaise, a jelly like substance that frequently had strong hydrogen sulfide smells and accumulated rapidly covering previous sand bivalve shell habitat types. Similar situations have been described in the North Sea.

In 1936, the American Association of Petroleum Geologists gathered research papers from the world's top scientists studying marine sediments for economic development[9] Some 44 authors sent papers beginning in 1937 most on Sapropel deposits. The combined manuscript was copyrighted in 1939 but due to the European war which would soon become World War II; it was eventually published in 1955, surviving largely intact with only a few hundred paper copies. Parker D. Trask, then of the US Geological Survey founded under his chairmanship, a Committee

[8] See, An Urgent need to Reexamine Nitrogen Models for Long Island Sound, Appendix #1.Bays andcoves with restricted circulation or restricted flushing had a backwash effect of trapping nitrogen excess nitrogen was then converted into an organic sink withich could shed enormous quantities of ammonia compounds fueling intense brown algae blooms.

[9] Reference for Sapropel and marine humus (compost) – recent marine sediments edited by Parker D. Trask vs. Geological Survey, Washington DC. 1958.

on Sedimentation of the National Research Council and pressed for a bound hard book reissuance in 1968. He claimed at the time these papers were not only important to geology but to climate change studies as well. It was the last time (1939) many of these researchers would meet and discuss geology and unfortunately by the time this collection was printed for the public, several of the primary authors had passed away three decades later. The current copyright of 1955 now belongs to the Society of Economic Paleontologists and Microbiologists, although in the original publication date 1939 and printer is London, Thomas Marby & Co., L. Fleet Lane, E.C. 4.

The work was reprinted by special arrangement on behalf of the original authors as the 1955 copyright states pursuant to the 1926 revolving publication fund approved by the midyear meetings and association members of The Society of Economic Paleontologists and Mineralogists.

A more recent New England Study (see Dr. Arthur Gaines' Study of the Narrow River-Pettaquamscutt Lakes 1975, Rhode Island). This coastal lagoon has a series of lakes that are poorly flushed and subject to heat induced anoxia. Sulfurous mud is deposited over time and core testing found distinctive markers indicating both the 1938 and 1954 hurricanes. Dr. Gaines found in his work much of the same as Parker Trask found-- extremely high levels of hydrogen sulfide, the black water death described by so many turn of the century biologists (1900s). In his 1975 study Dr. Gaines reports that he found sulfide levels 10 times that of the Black Sea in this Rhode Island water body. This Sapropel digestion produces this rotten egg odor hydrogen sulfide gas in late August that has plagued coastal residents of this region for decades. It is locally known to stain the houses a weak yellow color and then black.

Sapropel in high heat sheds ammonium a nutrient that fuels brown algal blooms; several species have been termed harmful to shellfish especially the Bay Scallop (HABS). When Sapropel starts to emit the hydrogen sulfide smell, it is shedding enormous amounts of ammonium. This signifies a high heat low energy habitat failure reversal for several shellfish species. .Sapropel can impact nitrogen TMDL studies as nitrogen compounds tend to increase if flushing capacity is reduced by the buildup themselves (less hydraulic capacity).

A Connecticut Study funded in 1992-1994 was to examine coastal rivers and salt ponds for what was described by eastern CT fishers as a black jelly like substance termed "black mayonnaise" by coastal residents. Attention was drawn to eastern CT coves with restricted tidal flushing, mostly landward of railroad causeways as impacting those areas. Information from the earliest oyster culture records mentioned a 1870s period of hard bay bottoms that were then abandoned from eutropic- like conditions in the 1920s. Habitat conditions however had greatly changed as most previous winter flounder bivalve shell bottoms became muck filled. Fishers described these habitat changes as negatively impacting local fisheries.

Core studies were conducted by Paddon et al, in Connecticut July 1, 1992 to June 30, 1993 and August 16, 1993 to August 3, 2001 in several Connecticut coastal coves and rivers. Dr. Paddon did collect numerous cores containing alternating layers of bivalve shell between gelatinous organic rich mud of the black mud facies. Long Island Research Fund award CWF-310-R and CWF-266-R. These reports are available from the Long Island Sound Resource Center, DEEP CT, located at the University of Connecticut Avery PT Campus. There were made available in 2012 some two decades after research commenced.

Summary

These two core studies are currently under review.

Other studies are now examining the impacts of hydrogen sulfide toxicity – now suspected in some high heat, blue crab die offs in western Long Island Sound during July 2011. The impacts from hydrogen sulfide are just beginning to be recognized as causative agents for late summer fish kills, perhaps as significant as low dissolved oxygen. The role of organic debris in high heat as a source of hydrogen sulfide and nitrogen sinks should not be overlooked. A tremendous increase in forest canopy may be significant sources of nitrogen and phosphorus into Long Island Sound. In some coves in Connecticut Sapropel has accumulated to over 10 feet deep (North/ Middle /South Coves, Essex, CT.)

The oyster fisheries of the last century were the ones who noted the negative impact of black muds upon oyster populations. Winter flounder fish kills in the late teens were immense on Long Island, both linked to high temperatures and few storms.

The significance of Sapropel and the environmental conditions that create it there should not be overlooked. In fact the accumulation of such organic deposits do act as a nitrogen sink – storing nitrogen compounds for decades. For relatively shallow areas, subject to thermal warming and long connections to the sea – such as the sills mentioned so many times by Kaare Muster Strom 1939, exhibit poor "flushing" characteristics make Sapropel deposits long lasting. Information obtained from Jim Turek, NOAA Restoration Center in 2009 indicated energy and temperature were factors in recent benthic substrate and habitat changes in Southern New England (see Appendix sections 1, 3, 5). Complicating nitrogen source studies is that New England's forest canopy is now largely restored/renewed from past colonial agriculture. Oak/Maple leaves on pavement has been shown to be a large factor in marine "oatmeal" organic inputs. Organic matter and low dissolved oxygen, warm waters impacts nitrogen cycling and residence times. As such as the impact of organic matter upon nitrogen models need a review/discussion.

I welcome suggestions/comments.

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The Cycle of Sapropel

The Question of A Habitat History for Bay Scallops

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April 2013

This latest warm period which began in earnest in 1974 came after a strong or negative North Atlantic Oscillation during the 1950's. Before that time a period known in northern New England as the "Hot Term" but those living closer to New York City recall it as "The Great Heat," a remnant of the 1880 to 1920 "great" heat waves that struck New England cities. To the poor who lived in poorly ventilated multi story structures in cities then with little centralized sanitation there was nothing great about these heat waves, they killed people by the hundreds. The winters could be cold but the storm track which so typifies a NAO had cold air dropping deep into the great lakes region which soon became hot. A cooling shore breeze caused by land thermal heating became a welcome relief to people who could escape the aggressive summer heat. Many couldn't afford to move to the shore each summer for these cooling "airs." Steamship and later trains made possible the establishment of many coastal communities at this time, especially in Connecticut.

While USDA agricultural weather forecasters talked about these hot periods impacting New England farmers - New England fishers also felt the impacts. The North Atlantic Oscillation was strengthening and the prevailing winds became more westerly and drier is this air mass as a strengthening Icelandic low tended to draw circulation across the Great Lakes into New England. But with the dry heat came air mass stability – strong storms around then faded in both intensity and frequency. By the 1890s the Long Island Sound Devils Belt storms of the 1870s were then distant memories. The period 1880-1920 became one of warmth and shoreline stability – powerful storms were infrequent and winters temperatures were cold but not like the 1870s where temperatures were 20º f below zero continued for days at a time. It was the extreme summer heat and lack of hurricanes that would come to signify this habitat period and also New England's fisheries.

Shorelines were generally stable and many summer resorts were built close to the beach or on it, to capture those cool breezes as what was of value to city dwellers. These businesses would be wiped out by the weakening of the Icelandic low, which now allowed colder air to sink far south in a huge horseshoe shaped bulge – a giant horseshoe in the central United States. This storm track allowed two things, polar air to sink south into massive cold air breakouts that made it to Florida, and an increase in coastal storms coming up on the east side of the horseshoe as hurricanes with tropical moisture and its winter equivalent the much feared Northeasters. The climate was changing and a habitat battle was about to begin one mostly out of sight to the general public. The climate and weather patterns on the continent would also impact fisheries – not as short term changes but increasing or decreasing habitat quality. Farmers would look to seasons for weather impacts but the moderating impacts of marine habitats were some what insulated from extreme temperature fluctuations but not energy. Fishers measured these changes in decades.

Climate Change and Fisheries

In the marine realm storms were and continue to be events which highlight the sudden impacts of energy upon the shoreline and subtidal habitats they contain. We have a cultural bias towards the energy events at the coast and the New England Hurricane of 1938 quickly put everyone on notice – things were changing and no one could foretell the energy that awaited shoreline residents in the 1950s and 1960s.

People were shocked by the devastation of the 1938 hurricane. Coastal damage of that magnitude until then was rare as coastal residents had gotten use to a fairly stable and consistent shorefront but they weren't to only one to see changes. The morning of the New England 1938 Hurricane fishers started noticing changes also, some hours before it arrived.

The late 1920s had seen a return of much colder winters and an increase in Northeasters. One of the biggest surprises was the return of bay scallops first to the Cape Cod areas but then Rhode Island following the bitter cold winters of 1922 and 1923. By the 1930s the oyster boats at City Point, New Haven would be iced in for weeks but bay scallops had already returned to Niantic Bay.[10] It was colder and organic matter which tended to collect in warm storm free periods now was washed from coves and bays. Eelgrass which had grown thick during The Great Heat (1880-1920) was ripped out by storms as bottom habitats now changed. A more alkaline red algae assemblage replaced eelgrass as sediments set heavy with bivalves mostly clams as the pH of marine soils reversed – becoming more alkaline. As this change was gradual fishers celebrated the return of bay scallops but colder winters meant irregular oyster sets and blue crabs which once over wintered in Sapropel were killed by the loss of habitat as "winter kill" or cold water starvation. After 1931 strong quahog (mercenaria) sets also returned to northern waters.

[10] Bay scallops came to be known as the Christmas crop – not trees but seafood to support seasonal funds just before the holiday especially during the depression years, see similar accounts in George Goode, US Fish Commission Series Vol 2 pg 568 "Referring to the point (storms) Capt S. Pidgeon of Sag. Harbor, says that if possible, when driven before a storm they will work to windward and he has seen them swimming in schools, 10 feet deep." See part xx The Scallop Fishery pg 565 to 581 – The Fisheries and Fishing Industries of The United States, George Brown Goode Assistant Secretary of the Smithsonian Institution – Section V, Volume II, Washington GOP 1887.

The morning of September 21, 1938, John Hammond of Chatham Massachusetts recounted that clammers and oysters planters had noticed increases quahog sets but also an increase in hard clam predators mostly conch and starfish but generally higher mortality for oysters. So the return of bay scallops was a welcome Chatham fishery for the fall. Seed bay scallops were at in all the coves. They had anticipated a good fall crop of bay scallops in 1938. The discussion of the fall soon turned from inside the clam and oyster shops outside to the Oyster Pond River as small patches of bay scallops flapped shells on the outgoing tide heading out to Nantucket Sound, by mid morning these patches grew larger all heading out from the Oyster Pond River. Mr. Hammond recalled that everyone groaned as they watched "Christmas" swim out to sea[1]. No doubt a survival strategy for leaving shallow water and a few hour later/the fishers were in a survival mode themselves.

It was however a undependable crop, bay scallops were known for heavy sets, two or three years of good fishing and then nothing, one of the perplexing comments during the 1870s and early 1880s is that bay scallops can swim. Early bay scallopers often reported hearing them at night, "the quick shutting of the shells makes a loud snap which can be heard at a considerable distance" (US Fish Commission Series Vol 2, Section V, 1887 GPO) "and repetitions of this comical maneuver in progression with long rests between, carry it over long distances; and that scallops sometimes do make considerable journeys in large companies is well proved" ibid page 569. The sporadic nature of the harvest is mentioned in many historic reports, along with two factors strong storms and bitter cold winters but the most important factor was temperature. What scallopers were reporting was oscillation energy and temperature changes – they were keen observers and had narrowed the choices following the 1870s New England's mini ice age and the wide catches even then were perplexing.

> "One year there may be hardly any at all, and the next year a great plenty, I think the severity of the winter temperature has much to do with it. The year 1879 was a poor season, but this season (1880) young scallops are more plenty than ever before known" ibid page 570.

Fishers then focused upon habitat conditions but the marine environment in cold and stormy periods I suspect nitrogen was also limiting – so many of the coves were not able to sustain plankton densities to support extremely dense populations of scallops constantly so the bay scallop success was its ability of dispersal into those areas able to support it, (food wise). Bay scallops were perhaps the locusts of the marine environment in small coves. Small macro habitat nutrient levels may impact bay scallop carrying capacity. This seems to be substantiated by numerous comments by fishers that when bay scallops population were high oysters and soft shell clams were nearly always low (habitat carrying capacity). They could move into bays as well as move out, many reports on Cape Cod point to shock or surprise of bay scallops arriving in the fall, or dismay to see they have all left (sometimes at Pleasant Bay, Orleans, overnight).[11]

The short life span and large population fluctuations have perplexed shellfish biologists for over a century. The problem is a bias into the research process itself, it is likely that such high densities of bay scallops in relatively shallow and semi enclosed bays was not over the long term biologically and fisheries sustainable. Immense quantities of Bay Scallops could literally eat themselves out of food, we know from frequent reports the negative impacts of dense eelgrass populations on the size and meat weight of bay scallops. Without good food replenishment by ample circulation of water scallops often starved in eelgrass that is mentioned many times in the historical literature. Bay scallops because of their shortened life cycle needed enormous amounts of carbohydrate rich blue green algae. The blue green algae species is favored by cooler temperatures and available nitrate from the cold reduction of organic matter by oxygen. Experiments were underway at the turn of the century to enhance the algal capacity of seawater by adding nitrogen as it was often limiting in colder water (Riley 1967). Colder waters for New England usually brings more storms and these storms likely had a role in fertilizing local waters by the removal of marine humus or compost. That compost would build up during warm periods and recognizable for habitat changes would now be introduced back into the water column. We know that warm water compost as Sapropel. In high heat and limited oxygen Sapropel would "shed" enormous quantities of ammonia, not nitrate.

Habitat Quality for Bay Scallops and Sapropel

Most reports from fishers particularly baymen frequently mention changes in bottom firmness after 1974 and that is why. After a long warm period Sapropel tends to accumulate and nitrogen is "banked" in a huge sink of partially reduced compost. In high heat it putrefies sheds ammonia from a sulfur smelling black jelly-like material. A decrease in temperature would favor the blue greens algae while long hot periods favor the browns (see HABS). High blue green populations are supported by high nitrate levels while the browns thrive in high ammonia levels. Sapropel therefore could not provide the fuel for high populations of the bay scallops preferred food (blue /green) during a huge habitat quality transition. As storms increased and temperatures declined these habitat factors should be considered for the 1950s and 1960s.

1) Sapropel in cold water could now produce enormous amounts of nitrate – in available oxygen, big surges in bay scallops are often reported immediately after bitter cold winters.

[11] In the 1950s, bay scallop conflicts were common between Orleans and Chatham. One year it involved local police departments when apparently the entire scallop population moved to the Chatham side overnight.

2) A gradual shift in densities from the browns to blue/greens favored bay scallops during colder periods. As energy levels increased bay scallop abundance often shows that same trend.

3) In warm periods with little energy, an acidic sulfur rich substrate Sapropel often containing eelgrass replaces an alkaline estuarine shell habitat with red macro algae which is known to containing scallop setting and spawning chemicals (Maerl) in colder storm filled periods.

4) A cooler energy filled period tends to reduce Sapropel deposits and then become nitrogen limiting especially in very cold and storm filled regions. After many years of storms Sapropel deposits are reduced to zero as they are simply washed away. Long Island Sound was thought to be nitrogen limited in the late 1950s.

5) When presented with unfavorable habitat conditions including food availability bay scallops can move. Therefore possible explaining historic reports of a sudden arrival or departures mentioned so often by baymen and shellfish biologists (usually at night).

6) Bay scallops are also limited by food availability and may resemble terrestrial locusts, that "leave" habitats when food levels drop. Therefore, high consistent bay scallop populations may not be sustainable and competition with other benthic bivalve populations for food should be considered.

Summary

In reviewing the period known as the great heat (1880-1920) Sapropel and eelgrass meadows greatly increased and bay scallops disappeared. In the 1950s to 1960s Sapropel decreased with eelgrass and New England bay scallop landings soared. This period is known as the North Atlantic (New England) Oscillation. The last warm period 1974 to 2004 (from 2004 onward it appears we are in a habitat transition period very hot to very cold, and a significant increase in energy) is very similar to the 1880 – 1920 period. The 1920s onward as winters became colder and the number of gales increased bay scallops returned to the northern areas first, than Rhode Island and finally Connecticut. The coldest storm filled period 1950 to 1965 saw the highest Connecticut bay scallops landings. When the warm period began in the 1970s Connecticut lost its bay scallops first, followed by Rhode Island and finally Cape Cod and the Islands, it took two decades for this habitat transition and another decade for a complete habitat reversal. Eelgrass presence may be one of the most important habitat indicators we have of this reversal between estuarine bivalve shell and Sapropel. Coastal cores taken in Connecticut in the 1990s frequently show this bivalve shell, mud layering. Eelgrass is frequently first in after an energy event and eventually first out in a habitat transition. The Sapropel/eelgrass habitats should be considered transitional or sucessional habitats between energy cycles. Bay scallops and oysters populations reverse with failures in habitat quality largely determined by changes in temperature. High bay scallop populations need high nitrate levels in bays and coves to nourish preferred algal foods (Chlorella species – other blue green algae) which may not be sustainable and partially explain large fluctuations in population size. Bay scallops from historical records may move to areas of higher habitat suitability. [12]

Fishery Statistics Provide Important Habitat Quality Information – The Rhode Island Narragansett Bay Case History

After the cold and very stormy 1870s eelgrass was at low levels but bay scallops thrived especially in Narragansett Bay when eelgrass became dominant – bay scallops disappeared – after 1931 eelgrass died off and bay scallops reappeared. In Connecticut during the 1950s Sapropel and eelgrass was washed from Niantic Bay (frequent hurricanes) but bay scallop landings soared, when the late 1970s warmer temperatures and less storm Sapropel reappeared with eelgrass and bay scallops died out. It therefore appears bay scallops populations appear to be cyclic and Sapropel research may lead to a significant negative habitat relationship.

Despite much printed information the abundance of eelgrass to bay scallop landings actual data shows a nearly perfect negative habitat association, when eelgrass populations are low historically- bay scallop populations are high. During long hot and energy poor periods Sapropel collects and eelgrass does well and bay scallops do not. Sapropel might be the overlooked critical habitat factor for a bay scallop habitat indicator, part of a larger habitat successional "clock."

This seems to have already occurred. The Narragansett Bay deep water bay scallop fisheries were immense in the colder and stormy 1870s. With The Great Heat (1880-1920) these habitats changed and the scallop deep water fisheries failed. As it presence is linked to declining bay scallop habitat, low pH and sulfide toxicity to bay scallops during warm periods should be reviewed.

[12] Long Island Sound Researchers were recording immense blue/green algal populations that would suddenly collapse in the late 1950s – leading some to investigate seasonal nitrogen shortages. At the time the US Fish and Wildlife Service Scientists at Milford (today the NMFS NOAA Laboratory) where investigating Chlorella blooms and in a September 1957 National Geographic Magazine quoted Dr. Loosanoff stating "It's almost pure Chlorella – an acre of sea water, used to grow this one called algae, could produce for more protein than you can get from an acre of landing even with soy beans (Fossenden Blanchard Long Island Sound (1958) pg 147). At the end of the North Atlantic Oscillation blue green algal blooms were intense in the spring but faded as nitrate levels declined. Chlorella was a nutritious food for bay scallops and needed ample nitrate levels to sustain dense cultures. Two popular current feeds for bay scallops . Monochrysis lutheri and Isochrysis galbana also need high nitrate levels. This points to a temperature aspect of nitrate availability as higher temperatures favors ammonia under low oxygen saturation levels from benthic sediments reduction processes. (Related to the Sulfur cycle) colder temperatures typically show higher nitrate levels.

Its accumulation however may provide the future nitrate supply during colder periods to allow its recovery. Bay scallops and Sapropel may have a direct yet opposite habitat connection.[13]

The difference is scallop landings over time indexed for energy levels and temperatures could also be connected to Sapropel in ways we do not fully understand.

The basic question is during this warm period Sapropel has become a dominant habitat type. When it was largely removed by storms in the 1950s and 1960s its presence significantly declined to a corresponding increase in bay scallops, why?

Always willing to share information and comments – Tim Visel can be reached at tim.visel@new-haven.k12.ct.us

[13] A description of this deep water bay scallop fishery is available from The Sound School Adult Education and Outreach program titled The Great Heat and the Rhode Island Deep Water Bay Scallop (Argopecten irradians) fishery 1875 to 1905. Available from Susan Weber, susan.weber@new-haven.k12.ct.us. At this time, Rhode Island had its largest bay scallop fishery in deep waters on “beds” that stretched some twenty five miles in a generally north-south direction from Mount Hope Bay south on the east side of Narragansett Bay and on the west south of the Providence River to the Wickford, Quonset Point area. Bay scallops were in waters out to thirty five feet deep. Ernest Ingersoll, writing in Section V of the United States Commission of Fish and Fisheries (1887) described this unique deep water fishery, detailing a hard bottom dredge modified with a “kettle bail” and flat blade dredge which then was termed a “scraper.

APPENDIX I

An Urgent Need to Reexamine Nitrogen Models for Long Island Sound

Did TMDL Calculations Include Nitrogen Residence Times?

A Habitat History for Nitrogen Compounds

Information obtained during an EPA sponsored dredge workshop in November 14, 2013, at the University of Connecticut found that few workshop participants were aware of any dredged material differences including a habitat history of sediment types and succession differences in pH and sulfur contents. Questions to EPA and NOAA habitat specialists yielded few responses and no information regarding Sapropel. During warm periods with little energy Sapropel (locally called black mayonnaise) can become a dominant habitat type in estuaries. In fact, the buildup of Sapropel signifies a habitat reversal, largely the result of temperature and energy (storm level changes) and can influence nitrogen compound levels and resultant algal blooms. A much larger report submitted to EPA January 20, 2013 (19 pages) connected to the investigation of this habitat type as a cyclic event in Connecticut's environmental history is the need to determine natural fluctuations in nitrogen levels. Key to understanding the ability of marine composted materials is based in climate history and previous habitat reversals. Therefore the need to look at changes in terrestrial organic inputs especially acidic oak and maple leaves, and marine successional plants. In times of high heat and low energy, nitrogen can be sinked in organic accumulations. Marine core studies could prove to identify specific energy storm "markers."

George E. Nichols of the Sheffield Technical Institute, Yale University (1920), in his famous dissertation on the Vegetation Of Connecticut, Section 7: The Associations of Depository Areas Along the Sea Coast (Bulleting Torrey Botanical Club, Vol. 47, #11, Nov. 1920) describes the role of plants and includes the importance of comparison core studies. That the successional aspect is both cyclic and mechanical, he urged the closer examination of plants (including eelgrass) as successional associations, page 542) and cannot be ignored in estuarine depositional processes –

> "Plants assist in the building up process in two ways: first, through their mechanical interference with tidal currents, retarding these and causing them to deposit their load of silt; second, through the accumulation of their own dead remains."

The Long island Sound Nitrogen model is here heavily weighed on aqueous nitrogen (people nitrogen) while apparently missing the ability of marine compost Sapropel as a huge nitrogen compound source. A habitat history for nitrogen is now needed as Sapropel has been overlooked (as well as an increase in Connecticut's forest canopy) and the increase of leaves that contributes to its formation. Sapropel is the natural banking or sink of nitrogen and carbon changing climatic cycles - Nitrogen therefore as a "residence time" that may last decades even centuries. As of March 2013, not one EPA or DEEP study has been located that addressed this topic.

Tim Visel

The Vegetation of Connecticut.

VII. The Associations of Depositing Areas Along the Seacoast

Author(s): George E. Nichols

Reviewed works(s):

Source: Bulletin of the Torrey Botanical Club. Vol. 47, No. 11 (Nov., 1920), pp.511-548

Published by: Torrey Botanical Society

4. Successional relations along depositing muddy shores - Page 542 - Nichols

Introductory. – In discussing this phase of the subject attention may be confined to the salt marshes, brackish and fresh marshes being neglected. Generally speaking, a salt marsh seems to originate through the accumulation of silt and organic debris at lower levels and the consequent elevation of the substratum to a height at which the salt marsh grass is able to establish itself. Except for the prominent part played here by the accumulation of silt, the manner in which muddy bottoms along the seacoast become built up is essentially similar to that in which many lakes become filled in during their conversion into swamps (see Nichols, '15).

There is a close analogy to the early stages in the development of a flood plain (see Nichols, '16), except that, in the present case, vegetation plays a more active part and the inorganic debris is much finer. Plants assist in the building –up process in two ways: first, through their mechanical interference with tidal currents, retarding these and causing them to deposit their load of silt; second, through the accumulation of their own dead remains.

The actual succession of plant associations and its probable explanation.—In attempting to work out the successional relations of any given series of plant associations there are various methods of procedure, but all of those customarily employed necessarily are based on the study of the existent vegetation. In the large majority of cases, therefore, conclusions regarding the nature of any given successional series, where this extends over a period of time beyond that during which the area in question is actually under observation, must be founded wholly on circumstantial evidence. It is of course inevitable that any deductions regarding the future course of succession should be largely hypothetical, and, except in the comparatively few instances where historic records are available or where a fossil record has been left by successive generations of pre-existent plants, any reconstruction of the course of events in the past must likewise be largely assumed from theoretical deductions. Salt marshes, however, resemble peat bogs in that conditions have favored the preservation of a fossil record, since they are usually underlain by peat deposits which may extend to a depth of many feet, and the study of these salt marsh peat deposits has yielded some very significant facts.

Assuming the vertical or historic order of succession during the development of the marsh to have been coordinate with the present day lateral sequence of zones, as set forth in the second paragraph above, the peaty and mucky deposits under laying a salt marsh should show approximately the following sequence of layers, from below upward: (1) a layer of silt, with remains of eel grass, extending from a variable depth to low tide level; (2) a layer of silt, with but few vegetable remains, extending from low tide level up to the level at which the salt marsh grass becomes established; (3) a layer of muddy peat with more or less abundant remains of salt marsh grass, extending upward nearly to mean high tide level; (4) a layer of peat made up largely of the remains of the salt meadow grasses. But the actual examination of sections of salt marsh peat along the New England coast has revealed a very different state of affairs. Bartlett ('09) for example, describes a salt marsh near Woods Hole in which the salt marsh peat near the surface is underlain by the remains of a former *Chamaecyparis* bog, the stumps of large numbers of trees being preserved *in situ.* C.A. Davis ('10) reports that in the vicinity of Boston the peat deposits underlying the salt marshes likewise consist, in many cases of the remains of fresh water vegetation; in other cases peat deposits composed largely of the remains of salt meadow grasses extend from the surface downward to a depth below that of mean low tide level- in other words, to a depth many feet lower than that at which the plants which formed the peat could possibly have grown. In no case, Davis emphatically states, does the peat show the hypothetical arrangement of layers specified above. The peat underlying a brackish meadow near new Haven, and sectioned during operations for b rick clay, shows similar conditions: just beneath the surface (1) a thick layer of *Spartina patens-Juncus Gerardi* peat, followed in order below by (2) a layer of *Distichlis* peat, and (3) a layer made up largely of cat-tai and fern remains, with (4) numerous scattered stumps resting in place on the underlying gravelly substratum, about five feet below the present mean high tide level.

Keyed for Adult Education and Outreach Program of The Sound School Regional Vocational Aquaculture Center, 60 So. Water Street, New Haven, CT 06519 by Susan Weber

United States Environmental Protection Agency Notice of Intent Public Meeting

Scoping Comments for Public Record Due January 30, 2013

Dredged Material Disposal Sites in Long Island Sound

November 14- University of Connecticut at Avery Point, Groton, CT

Timothy C. Visel
10 Blake Street
Ivoryton, CT 06442

EPA FRL-9741-9 Notice of Intent Designation of an Ocean Dredge Material Disposal Site

Good Evening,

We have heard much about dredge material disposal tonight but it is important that we know what it is. Not all dredged material is the same and it is important to classify it beyond just a term.

My first experience with dredged material offshore was with a DAMOS project in 1978 for New Haven harbor. Knowing what the material was, it made sense to cap it. In 1983 at Osterville, Cape Cod, an upland dewatered site with organic material also worked very well. It was mostly a sticky gelatin like material and clean, mostly leaf litter, a good option for this material. In Massachusetts, especially on the Cape, creeks and rivers filled each summer with organic matter mostly leaves and dead sea grasses. Dredging projects were removing accumulated composting leaves and were mostly small maintenance projects. It is my understanding that several Cape Cod towns today share a community dredge to keep small creeks, coves and rivers clear of organics. Such dredging can help restore tidal flows reduce oxygen debts and recycle banked natural nitrogen compounds from organic composts, which can also help shore fisheries as it is basically a fish food.

We also need to examine site conditions as well to current climate and energy patterns. In the 1950s and 1960s dredged leaf and organics were disposed offshore in high energy zones in relatively shallow water. Immediately after dumping (old term) reports from fishermen often included fish increases feeding upon shrimp species. In fact, conversations with fishers and marina owners told me that with colder temperatures combined with much more coastal energy after a few months it was difficult to find the disposed material at all; it was gone. This was also when winter flounder fishers would head to the “disposal” sites to catch fish that was because that was ‘where the flounder were”. A similar disposal site fishing association occurred in eastern CT over organic material disposed by Pfizer Corp in the 1980s. Eventually this material Mycelium was recycled for a local mushroom grower. Organic matter quickly becomes part of the marine food chain, such as the breakdown of acidic leaf compost is a natural process and attracts marine species that feed on it.

When creeks, coves and tidal rivers are dredged especially along the Connecticut shore they tend to collect leaves, which rot in high heat and low energy conditions. Several Connecticut coves have deep accumulations of leaves, such as Hamburg Cove in Lyme, Connecticut. In certain areas here over 10 feet of leaves have rotted producing an acidic sticky material rich in nitrogen, a marine compost that when disturbed has a sulfide odor. This compost once it is dredged and placed in oxygen containing waters it becomes fish food and is quickly consumed by plant grazers and shrimp.

In many cases navigational dredging has become a leaf removal activity, after the prohibition on the fall burning of leaves, leaf material substantially increased on Cape Cod and other watersheds. Today navigation interests are in the leaf removal business, no different than land. Because of the huge amounts of terrestrial organic debris dredged material is often just clean aquatic compost. Dredged channels have better tidal flows and can at times restore habitats buried by this acidic compost. Therefore it is critical to know what the material is, is it leaves and organic compost, clays silts or sand or cobblestones. Is the material clean or contaminated, can it be reused or recycled. Dredged material may soon become a key component of reducing flooding and shoreline protection. We can use it to create buffer islands and marshes, clean dredged material is therefore of value to use now with future shoreline protection programs to mitigate sea level rise.

Our forests have returned the mature tree canopy and is now dense with leaves, and spring leaf runoff fills our coves and bays with them each spring. In periods of high heat and low energy huge deposits accumulate and produce a black jelly like material, which is basically food for many species. Dredging is an expensive way to remove these leaves from bay bottoms and we now have a lot of them.

I hope that the issues surrounding habitat restoration, mitigation, creation and enhancement can be applied to the disposal of dredged material. In the future dredging may not be looked at as a problem but in fact an opportunity.

Please include these suggestions as the Supplemental Environmental Impact Statement for Dredged Material Disposal Sites in Eastern Long Island Sound is developed.

Thank you for the opportunity to comment this evening.

Tim Visel
10 Blake Street
Ivoryton, CT 06442

Nitrogen Research: Three New England Communities' Response To Nitrogen Enrichment

Have we overlooked Natural Nitrogen Compounds In Calculating Total Maximum Daily Loads?

Questions Regarding Nitrogen and Marine Resources

Executive Summary – January 6th 2011

Tim Visel – The Sound School

In all three cases (communities of Clinton, CT, Old Saybrook, CT and Chatham, MA) the link between water quality (bacteria/nitrogen) and natural resources utilization or abundance was almost non existent. Chatham did do a good job about bacterial reduction as a possible way to increase shellfishing acreage. I was not able however to obtain Connecticut long term water quality studies for either shellfish harvesting or bathing beach water tests.

The link between nitrogen abatement and resource use or habitat viability was even more difficult. The Old Saybrook case was the most baffling. Much of the Old Saybrook water pollution abatement plan was focused up fecal coli form in the groundwater or failed septic systems that "insulted natural resources." (Old Saybrook Water Pollution Control Authority, Volume II, Issue II, April 2009.) The natural resources insulted were not however identified. The same fact sheet describes nitrogen and phosphorus as potential pollutants but fails to mention the largest nitrogen and phosphorous sources are non human – watershed, organic material (leaves) and atmospheric inputs are far larger. While fecal coli form is a serious drinking water problem many shore communities found that increased use of ground water turned well water saline anyway so the chances of obtaining sufficient drinking water supplies again were slim to none for many coastal areas as fully described in the body of the report. DEP studies in the Town of Clinton in the 1980s support this point of view. Most shore communities had to turn to piped (city) water services a century ago.

The nitrogen issue for Old Saybrook was somewhat even more perplexing. Although groundwater tests yielded nitrogen levels up to 30 mg/liter taken in proximity to leaching fields or septic systems, those results are not surprising. In fact, to properly view the potential nitrogen impacts, all sources should be reviewed. In Old Saybrook's case about 3,000 people of about 11,000 live in a potential 1,000 foot impact zone adjacent to marine watersheds. DEP calculates that about 10 pounds of nitrogen/per person/year from septic systems inputs into the environment with no vegetation attenuation. That yields about 30,000 lbs of nitrogen each year. However a broader nitrogen input view I feel is necessary. According to Evans (2008) about 78,658 lbs of nitrogen flows out the Connecticut River (non point sources) each day, a little over 13,000 metric tons/year. If the figures hold Old Saybrook's annual direct impact to Long Island Sound nitrogen input is about 12 hours worth of Connecticut River non point source impact? With on site residential vegetation uptake it might be far less and considering other inputs from watershed sources and the atmosphere, human direct impact is rather small, even miniscule from Old Saybrook's inhabitants. Natural resource use or impacts to them was not explained.

The bottom line is other than regulatory or analytical measures nitrogen abatement fails to make the case for enhanced natural resources. It may be hard for some to accept but historically climate, temperature and energy levels may have a far greater influence here than nitrogen with coastal embayments and tidal rivers. Nitrogen enhancement is a concern, but to base entire environmental policies on it and to link it to increase resource abundance, is in my opinion misleading. A proper procedure is to consider a broader long term view at least in terms of habitat/resource restoration coupled with environmental studies. In that way an environmental resource history can begin to be ascertained.

For Old Saybrook the only water quality information I was able to locate came from a 1976 US Army Corps of Engineers study of the Connecticut River[1]. In summation no data could be found to link natural resource abundance to declines in water quality nitrogen/bacteria in all three communities. In fact it is reported that the oyster populations in the Hammonasset River (Clinton) and Oyster River (Old Saybrook) are at high levels. In the case of Chatham historical data supports fluctuations in shellfish abundance were more determined by climate and energy (storms) than water quality.

Species diversity remains an elusive but a valuable measure in linking water quality to bacteria and nitrogen levels but those studies have not occurred in either Old Saybrook or Clinton. Without that information the link between marine natural resources and water quality is difficult if not impossible to make. The last overall Connecticut fish census occurred in the 1950s. Public policy discussions or expectations about the value of natural resources linked to water quality improvements needs to be reexamined. Surveys and studies need to be approved for these important fish and shellfish habitat areas. To only focus upon water quality as a key resource indicator may not yield anticipated results.

[1]Environmental Assessment – Proposed Maintenance Dredging of North Cove, Old Saybrook, Connecticut and Brockway Bar and Essex Shoal, Connecticut River State of Connecticut. Prepared by New England Division, U.S. Army Corps of Engineers, Waltham, Massachusetts - May 1976

Water Quality – Water quality in North Cove has been designated Class Scc which is suitable for fish, shellfish, and wildlife, recreational boating and industrial cooling. It has good aesthetic quality. Bacteria such as coli form are present in North Cove. The 1975 Bathing Beach Study (Conn. State Department of Health) shows that no coliform organisms are present in sufficient quantities to classify the Cove water as good to fair (70-400 organisms/100ml). The entire Connecticut River mouth is classified as fair, with an average coliform counts of 353 organisms/100 ml.

Sapropel and Winter Flounder - A Habitat Reversal

Incidence of Fin Necrosis in Winter Flounder Pseudopleuronectes americanus from New Haven Harbor

Peter J. Auster – Schooner Inc 1981

Results and Discussion 1980 Data – Habitat Failure begins in 1974-75

Timothy C. Visel, The Sound School, New Haven, CT

Sulfide Levels in Marine Soils Suspected

Fin Rot is mentioned in Winter Flounder Fishery beginning in 1975; Morris Cove Study Area. This is a 1980 study and significant as it occurred at the beginning of the region wide (Southern New England) habitat failure for winter flounder.

Peter Auster, then working out of the University of Connecticut Marine Science Institute, Marine Research laboratory P.O Box 278 Noank, CT. (Today the Noank Shellfish Cooperative and formerly a CT Fish and Game Lobster Hatchery) surveyed New Haven Harbor winter flounder populations specifically for the fin necrosis (fin rot or flesh rot) in New Haven Harbor from April 17 to November 9, 1980. Of the four stations surveyed, Morris Cove, West Breakwater, Middle Breakwater and a Nun navigational Buoy southeast of the harbor, the inside station Morris Cove contained the greatest number of sampled fish.

Station location/Depth	Bottom/chart classification
Morris Cove 9 foot contour	Smooth/mud rocks nearby
West breakwater 26 ft	Hard
Middle breakwater 18 feet	Hard
N "36" – southeast of Round Rock 20 foot contour	Hard

Morris Cove – site – Peter Auster Study

# fish surveyed	#fish-normal	# fish with Necrotic fins	% Occurrence
2,744	2,137	607	22.12%

Summary and Discussion – Tim Visel

The Morris Cove site had by far the highest incidence of fin rot and the smallest fish in general. This finding agrees with known predatory/prey zonations, the smallest most vulnerable sizes are in shallow water habitats avoiding prey relationships. It is these same habitats however, that became eutrophic and acidic and eventually unsuitable for winter flounder nursery functions. These areas protected from coastal energy pathways are the ones fisheries noticed first as the buildup of organic matter and lack of flushing (storm energy) transitioned these habitats from the colder and storm filled 1950s-1960s.

The transition from alkaline hard bottom sandy habitats often containing estuarine shell to compost filled acidic bottoms in coastal areas took thirty five years or more. The incidence of fin rot was an early sign of massive habitats change for winter flounder and it is now possible to index these near shore areas for temperature and energy profiles.

In areas of reduced tidal circulation these soft organic filled bottoms and in high heat putrefied and became Sapropelic, low pH, high organic and sulfide rich muds. When this occurred these essential shallow water habits failed for winter flounder. In the strictest sense of the word, the fishery was not overfished, but sustained a region wide habitat failure which then created a fishery failure. Traditional fisheries management methods (creel limits, seasons and minimum sizes) are ineffective with such profound habitat reversals.

The 1970s and 1980s habitat reversals were significant in Niantic Bay and noticed by fishers as early as 1969 (personal communication Robert Porter 1983). Residents of Niantic Bay noticed enormous increases in eelgrass growths Zostera marina and warm temperatures produced severe pungent sulfur smells. It was also widely known that on hot summer nights fog with sulfur compounds dripped off street lights and damaged the finishes of cars parked below. These reports are very similar to these reported to me while investigating the Narrow River in Rhode Island in 1981-82. Here residents complained of newly painted houses stained by similar fog/sulfur damage.

As warmer temperatures continued into the 1990s the winter flounder habitat in Niantic Bay became muck filled and unsuitable. Bay scallopers were the first ones to notice diminished habitat capacity as once clear areas, filled with oak leaves. Eelgrass meadows trapped oak leaves and by 1974 circulation patterns in Niantic Bay (River) north of the road and railroad causeway were impacted. Niantic Bay (River) would be an important site to study habitat succession in the near future.

Tim Visel 2009 – The Sound School – Appendix to the Nitrogen Study

STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS

ANNUAL REPORT

Of The

Commissioners of Shell Fisheries,

MADE TO THE

GENERAL ASSEMBLY

AT ITS

MAY SESSION, 1900.

PROVIDENCE:

E.L. FREEMAN & SONS, PRINTERS TO THE STATE. 1900.

STATEMENT OF DR. G. W. FIELD,

OF THE R.I. EXPERIMENT STATION, WHICH HE KINDLY FURNISHES THE COMMISSIONERS OF SHELL FISHERIES, AT THEIR REQUEST, FOR PUBLICATION

The biological department of the R.I. Agricultural Experiment Station, under the direction of Dr. G. W. Field, began in July, 1896, the investigation of the cause of the decline of the oyster fisheries in Point Judith pond. Within the past twenty years, the supply of oysters, previously so bountiful, has rapidly diminished, and at present they have all but disappeared. The details of the investigation are published in the 9th Annual Report of the R.I. Agricultural Experiment Station, Kingston, R.I., 1896.

In brief, the cause of the decline was found to be the deposition of sediment upon the oyster beds; a condition brought about by the repeated closure of the breach, thus making the pond a settling basin for the silt brought down by the Saugatucket River. The silt and detritus, settling upon the oyster beds, kill the oysters by smothering. As a remedy for this a permanent breach was recommended.

The later work upon the conditions in Point Judith pond upon the general economic value of the pond as a source of food supply. Experiments were carried on for determining the amount of food in the water available for shell-fish and for economic food-fishes, for the purpose of ascertaining the quantity of fish and shell-fish which could live there. The comparisons by chemical and planktological methods showed that the food conditions in the pond compare favorably with those in Great South bay, Long Island, N.Y. (the native home of the Blue Point oysters.)

Experiments upon artificial fertilization of the water, analogous to the method of chemically fertilizing the land for crops, demonstrated that it was feasible to increase the growth of plants in the water through the addition of chemical plant-foods, and thus render the water capable of supporting a greater quantity of animal life. These experiments were subsequently suspended, and have not been carried to the conclusion of demonstrating the feasibility from an economic point.

In addition to the above, considerable work has been done on the economic fauna and flora of the pond, and upon the physical conditions governing marine life in the pond. An accurate survey of the bottom has been made, giving depths of water and of mud, among other details of currents, temperatures, specific gravity, tidal influences, etc.

The biological department has published and will send to any resident upon application, the following, bearing directly upon questions connected with the shellfisheries of the State:

1. Oysters in Point Judith Pond, 9th Annual Report of R.I. Agricultural Experiment Station, 1896, pp.173-186.

2. Point Judith Pond, 10th Annual Report, 1897, pp. 117-165.

3. Methods in Planktology, 10th Annual Report, 1897, pp. 117-165.

4. The Star-fish in Narragansett Bay, 10th Annual Report, 1897, pp. 117-165.

5. Report of Biological Division, 11th Annual Report, 1898, pp.94-96.

6. Report of Biological Division, 12th Annual Report, 1899, pp.123-124.

7. The Nitrogen Problem. Bulletin No. 50.

8. The clam. The Cultivation of Tidal Mud Flats. Bulletin No. 51.

Appendix 13 Marine Fisheries

Review Vol. 64, No. 2 2002
Excerpt by: Clyde L. MacKenzie., Jr., Allan Morrison, David L. Taylor, Victor G. Burrell, Jr., William S. Arnold, and Armando T. Wakida-Kusunoki

Quahogs in Eastern North America; Part 1, Biology, Ecology, and Historical Uses

Page 8 Large Bay and Ocean Water Exchange Attributes

In the northeastern United States from Massachusetts through New Jersey, the bays that have a large exchange of their waters with ocean waters now have relatively large stocks of northern quahogs, while those with poor exchanges have small quahog stocks. The areas with large exchange are Buzzards Bay, mass.; Greenwich Bay and Point Judith Pond, R.I.; Long Island Sound, Conn.; and Raritan Bay, N.Y. and N.J.. The bays were the exchange is poor are Great South Bay, N.Y., and new Jersey's coastal bays (Barnegat bay, Little Egg Harbor, and Great Bay). The water in the zones of Great South Bay farthest from the bay inlets exchanges with ocean water only once every several weeks (Nuzzi).

Great South Bay once had large stocks of quahogs, McHugh (1991) reported the opening of an inlet between the Atlantic Ocean and Moriches Bay (which connects with Great South Bay) on Long Island, N.Y., made by a hurricane in 1931, led to a large increase in salinity in Great South Bay. The higher salinity allowed oyster drills to increase in abundance and activity, and they substantially reduced the numbers of remaining oyster (MSX might have also been responsible, (Usinger), but dense quahog sets occurred throughout the bay and a substantial quahog fishery developed. Moriches Inlet eventually closed, but a hurricane in 1953 reopened it. By 1957 it began to close again. In 1958 it was widened and deepened by dredging and subsequently protected by a seawall. Jeffrey Kassner believes this 1958 opening may have set the environmental state for the boom in quahog production in Great South Bay in the 1960's and 1970's.

Ingersoll (1877), who surveyed the mollusk fisheries in 1877-78, reported that Barnegat Bay was called “Clam Bay” and yielded 150,000 bushels of quahogs/year. The area now yields barely 1,000 bushels of quahogs/year. Charts from 1878 (Woolman and Rose, 1878) and 1997 (NOAA Nautical chart 12324) show the amount of housing on the shores, the bay itself, the location of Barnegat lighthouse (wide, open arrows on both charts), and widths of the inlets (Fig.12). Little housing is shown in the 1878 chart, but a considerable amount of housing is suggested by the canalization of the shorelines shown in the 1997 chart (houses crowd the shores of all canals). The buildup of housing took place in the 1960’s and 1970’s (Collins and Russell, 1988). The width of Barnegat Inlet in 1878 was 4 times its width in 1997. There likely was considerable exchange of bay and ocean waters and little eutrophication of bay waters in the 1870’s. This contrasts with limited water exchange and considerable eutrophication of bay waters in the late 1990’s.

Inlets that have been opened by hurricanes seem to have had beneficial effects on quahog populations in North Carolina. Chestnut (1951) stated increased quahog abundance in northern Core Sound during the mid-1930’s appeared to be associated with the opening of Drum Inlet by a 1933 hurricane. Godwin et al, (1971) reported a similar occurrence related to Hurricane Hazel in 1954. Hurricanes do not exert negative effects on quahogs in North Carolina, although the closing of an inlet by a storm has a negative effect. When any North Carolina inlets closed, nearby quahog stocks declined (Taylor, 1995).

Sapropel and Climate Change

Jim Turek, NOAA Habitat Restoration Center, December 16, 2009

- Response to Timothy Visel Questions Regarding -

Energy Pathways Impacting Chemical and Biological Habitat Parameters

1. Bottom habitat degradation is occurring in Southern New England (SNE) due to lack of tidal flow due to anthropogenic activities, thereby increasing the percentage of fine, mostly organic particles. - Yes without question, I would agree with you on these conditions, and NOAA routinely works on restoring tidal restrictions. We completed the Gooseneck Cove restoration (Newport, RI) in May 2009, and we are currently working on one at Bride Brook in East Lyme, CT (Rocky Neck State Park); and we have many more examples. These restrictions clearly result in soft bottom, hypoxic conditions.

3. Eelgrass effects on circulation and bottom particle changes - I would agree that this is occurring in our SNE coastal systems. In our RI South County coastal ponds (my general observations at Ninigret, Potter and Quonnie Ponds), most of the remaining eelgrass beds are situated in bottom types consisting of very soft, sticky sediments (sometimes referred to "black mayonnaise") and in rather deeper waters (~4-6 ft, MTL). I'm amazed that these eelgrass beds can withstand these anoxic, soft bottoms and limited line penetration depths (very long blades on these plants). I surmise that as you said, that few macrobenthics are

found in these eelgrass habitats with such harsh conditions. I am not aware of studies on the eelgrass bottom and macrobenethic conditions, but they may exist. Without question, we have ample anecdotal evidence for the RI coastal salt ponds.

5. Acid or sour bottom conditions - I had not thought extensively about pH as being a problem condition, but I surmise you are correct. In situations where lower DO may not the primary problem, I would guess that pH could become a problem. Certainly sulfides are released in reducing conditions in the sediments, and that may be at least a secondary problem. If you are suggesting that with sandy bottom, groundwater release sites are places of refuge, it may be due to the fact that higher DO levels exist in the groundwater discharge, colder temperatures help sustain better DO levels, the release of groundwater affords at least some mixing, and mixing and DO helps minimize sulfide release. Seems like a compounding effect to me, but I would guess you are correct in that this is why we have lost winter flounder year classes in SNE, and shellfish populations are being affected, also. - I am not aware of studies that have been completed to evaluate this condition. Certainly, storms would help to force out at least some of these organic, sour sediment sinks.