"The Trouble with Eelgrass"

A Complex Environmental Habitat History for Zostera marina in New England Coastal Waters

The Habitat Value of Zostera Marina Must be Indexed for Climate and Temperature

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Note from Tim Visel

This paper follows a series of Long Island Sound Study papers beginning in 2006 which raises several questions about the habitat classification of Zostera marina in New England coastal waters. Although the reports date to 2006 the questions about eelgrass do not – many go back to the early 1970s.

I have spent much time in small boats in Connecticut lobstering and oystering and later with other small boat fishers. In the middle 1970s, a disconnect between historic observations of fisheries and those contained in more recent research for eelgrass became so wide they could not fully explained. During some NOAA Sea Grant workshops in the 1980s the full impact of these differences introduced me to a field that is just beginning to be recognized, environmental fisheries history or the long term impacts of climate and energy upon fisheries habitat quality. I know that many will dismiss this report and perhaps ignore it. Others have said it was both disturbing and disappointing. I ask that you read the entire report as the habitat value assigned to eelgrass is severely compromised by a failure to include many long term observations and historic United States Fisheries Commission reports. Only when these reports and fishery observations are included with current research will the trouble with eelgrass and environmental policies attached to it end.

Preface

Much has been written the past three decades about eelgrass Zostera marina in New England coastal waters and many articles have documented the relationship between bay scallops Argopecten irradians and eelgrass.[1]
That association needs to be reviewed, most appropriately by a review committee not connected to funding or research dependent employment. I feel that is an important first step to more fully understand the long term habitat history of Zostera to published habitat or "ecosystem services." This article was first written for the Habitat Working Group of the EPA Long Island Sound Study last September and edited for a regional audience and as such most of the specific site references to Connecticut have been taken out of the original article.[2]

Eelgrass abundance as a nitrogen indicator of estuarine health is now an area of much controversy and possible scientific misconduct. Eelgrass should as many other habitat types be viewed as part of a complex long term environmental habitat history. A long term look at eelgrass sees it as an aggressive, successive marine plant. The natural law of habitat succession is beyond most regulatory policy decision processes and that includes eelgrass. Short term observations of habitats are often inconclusive and unsuitable upon which to base long term public policy decisions.

That is the trouble with eelgrass and in my opinion is that we do not have the complete "habitat history" for Zostera in New England. The habitat history we do have may be flawed by a bias that focused upon creating environmental policy rather than on objective research practices. This view does not reflect the Long Island Sound Study or EPA, they are my own after nearly three decades of historical habitat research. Unfortunately eelgrass is now linked to nitrogen abatement issues, a further complication that is also currently under review.

Statement of The Problem

One of the chief limitations of eelgrass studies since the last warm period (1974 to 2004) is the interpretation of insitu observations. Researchers report on what they presently can observe and measure as the research community dictates assessment protocols. Many of the eelgrass studies respond to grantor agencies or seek to measure environmental conditions in response to regulatory applications or permits. These studies often suffer from, for lack of a better term, "snapshot

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[1] See December 2012 NOAA Conference presentation titled "Do We Have the Correct Scallop Grass" 91 pages available from Susan Weber, Adult Education and Outreach Program Coordinator susan.weber@new-haven.k12.ct.us

[2] Other working papers about eelgrass and bay scallops are available from The Sound School Adult Education and Outreach Program. Views expressed here do not reflect the membership of the Citizen's Advisory Committee (CAC) or Habitat Restoration Working Group of the Long Island Sound Study. Tim Visel can be reached at tim.visel@new-haven.k12.ct.us or The Sound School -60 South Water Street, New Haven, CT 06519 – USA.

ecology" – what appears to be important today may not be important tomorrow or for that matter yesterday. They look and give the appearance of science but lack the long term environmental habitat history viewed over time during different climate and energy periods.

Rarely do eelgrass studies attempt to quantify observations over long periods of time and such long term assessments in marine ecology are relatively rare. The Rhode Island Narragansett Bay species survey is the exception. What is frequently overlooked is the marine form of habitat succession – observable on land but until now, markedly absent from many marine studies. That is the shifting baseline dilemma – brought forward many years ago by Daniel Pauly; at what point do we begin to assess habitat succession and in what capacity? That is the great weakness in most of the eelgrass studies to date, which attempt to provide a representation of habitat value when they are basically merely enhanced presence and absence studies. Habitat benefits should not be described in anything more than random observations over a short time period of which few conclusions can be drawn regarding long term ecological impacts. They are just observations in time that is all. Portrayal beyond that is misleading at best to baseline policy decisions.

The best example of mistakes by assumption is the eelgrass bay scallop association. Although the bay scallops will set heavily upon eelgrass that habitat association now needs a review. The simple fact is bay scallops will set on any clean material, even plastic. The habitat association exists because a species specific habitat "clock" often overlaps. As habitat quality for some organisms decline it is often the case that habitat quality for others improve, the current blue crab lobster reversal in Connecticut is a case in point. The truth of the matter is largely what Nelson Marshall in his initial bay scallop research reported --that Niantic Bay Connecticut fishers claimed that "redweed" was the real scallop grass. Most likely it is.

With the recent research from Europe regarding red macro algae species especially the coralline reds to scallop habitats these fishers were essentially correct. Eelgrass it seems now only outlasted the more cold water tolerant reds, it could exist longer in changing habitat conditions which now contained Sapropel a low pH, high organic content marine compost which forms in high heat low energy periods. As the alkaline preferring coralline reds died off they were quickly replaced by aggressive eelgrass and the overlapping habitat clock of bay scallops made it seem as though eelgrass was significant when in fact habitat wise it was not. This habitat "reversal" is very clear with the deep water bay scallop fisheries of Narragansett Bay during the late 1870s. Here the deep water bay scallop beds and essential spawning and setting habitats were covered by dense beds of eelgrass in response to changing climate cycles. This long term change in habitat quality for bay scallops needs to be addressed. A look at Southern New England bay scallop landings data all follow a cold and energy prevalent habitat and that bay scallop production is much higher during colder and energy filled periods. When eelgrass died out and then was washed out of Niantic Bay, bay scallop production soared – in the absence of eelgrass. The Narragansett Bay deep water bay scallop fisheries declined from changing habitat conditions, largely an increase in warmth and decrease in storm intensity following the 1870s. Bay scallops and eelgrass follow cycles in climate and energy patterns and should be addressed as such. No longer can it be considered a mistake at best, at worst it is an attempt to ignore observations and published reports during long term climate and energy cycles[3]. These climate and energy "cycles" can last decades even hundreds of years.

H.G. Wells gave us a wonderful example of habitat succession in his famous book The Time Machine. Imagine the opportunity to sit back and watch marine habitat succession as fast the land was portrayed in the book and later in the movie. Here we could see an acorn fall to the ground, sprout, proceed to sapling, grow to adults, shed mature acorns and repeat the process again in just a few seconds. Unfortunately, we do not have a time machine for the marine environment, but we do have a record of past habitat successions, a habitat history locked away in the cores of coastal coves.

Since the last large global meltdown that ended the Wisconsin Ice Sheet over North America, we have had several habitat reversals, governed by temperature and energy, a marine habitat succession history. It has become warm, than colder, stormier and then quiet, all producing different habitat scenarios. Imagine if you can, we did have that time machine and could go back and see for ourselves what habitat conditions prevailed during those different periods. During certain conditions some species benefit while others decline – the Bay Scallop responds best to cold and stormy periods.

We can try to restore bay scallops in times of high heat and low energy but with little chance of success, we can look for blue crabs after a brutally cold New England winter, again with poor results. The link to habitat quality often has a direct energy and temperature connection and over time, and these conditions guide species abundance. That is why it is so important that the Long Island Sound Study support a long term habitat history for living marine organisms.

When Ecology Became Policy

The failure to take into account environmental fishery history for eelgrass may have been one of the costliest environmental mistakes of all time. We may have spent

[3] The absence of published work that lacks significant habitat references is a type of scientific misconduct – it is called citation amnesia or citation negligence. Historic efforts to control eelgrass from damaging shellfish habitats included cutters, drag chains, underwater mowing machines, herbicides and explosives. Efforts to mitigate eelgrass impacts were published in numerous New England and Canadian reports in the 1950s and 1960s.

millions of dollars on studies that answered few questions, enacted policies that could not or never will yield expected results, and deflected economic opportunities from which that we may never recover the financial losses, apparently over one concept – the choosing of eelgrass as an environmental policy "winner." Eelgrass is a significant ecological facet of a constantly changing, habitat spectrum and was chosen as a "best" habitat condition. When the "time machine" stopped, eelgrass was under it; that is all our environmental timeline shows. What made it so special? Eelgrass fits several environmental policy objectives that highlighted the "negative" impacts of bottom disturbance; and nitrogen levels, it could be mapped; it could be connected to coastal processes; it had ecological service habitat benefits. Those ecological benefits now need to be fully explored and discussed[4]. Policy decisions (no net loss including past, present and future eelgrass population projections) can no longer be pushed down the road for others to sort out. Some of the more serious research questions/concerns remain unanswered about eelgrass and they include,

1) The eelgrass habitat history is incomplete, especially for the bay scallop association. In fact, the Great Heat (1880-1920) and the return of eelgrass (thick meadows) ended the deep water bay scallop fishery in Connecticut and Rhode Island. Eelgrass meadows hurts bay scallop habitat, not helps it.

2) Eelgrass is not the preferred algae for scallop sets. Red Macroalgae and Coralline reds worldwide have this scallop grass distinction for stimulating setting and spawning chemicals. My research indicates that eelgrass does not contain these chemicals.

3) Civic groups have been encouraged to plant eelgrass as restoration attempts to help restore bay scallops. They have planted it in oxygen depleted, sulfide-rich marine soils (Sapropel) where there is little chance of success, it is a waste of public funds and no doubt disappointing to the volunteers. Restoration attempts have been made that conflict with its life cycle biology.

4) Various groups have promoted eelgrass as an estuarine health indicator for nitrogen contamination. High nitrogen levels are natural during periods of high heat and low energy. During cold periods, nitrogen, mostly a result of leaf and organic matter decomposition and not from people in sluggish or poorly flushed areas is reduced by oxygen, not sulfur. During cold and high energy periods, nitrogen often is limiting in shallow seas and sounds. It is simply washed out of

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[4] See comments sent to Philip Trowbridge, New Hampshire State Dept of Environmental Services, July 17, 2008 observations of the Niantic Bay Scallop Fishery – negative impacts of nitrogen enriched eelgrass upon bay scallop populations. Eelgrass populations declined and bay scallop productivity increased in Niantic Bay. Eelgrass growths in the 1890s have now been linked to declines in the bay scallop deep water fisheries of Narragansett Bay, RI.

them by storms, but that also is natural. Nitrogen needs a habitat history of its residence time also, especially if it is connected to eelgrass habitat services under different climate and energy conditions.

5) The biological reproduction capacity of eelgrass resembles that of Phragmites; eelgrass moves into recently cultivated marine soils and displaces other organisms as it tends to form dense monocultures just as Phragmites does. It is a habitat succession plant, and subject to natural die-offs as all monocultures are. Again, a long-term view or a habitat history of this naturally occurring process is needed. It is similar to the first cover plants that grow after a terrestrial forest fire.

6) Our eelgrass strain may be invasive, carried here hundreds of years ago, aboard sailing ships from the Thames River Estuary in England. In addition, west coast fishermen are currently battling an invasive strain of eelgrass from Japan. Numerous shellfish researchers and biologists have noted this invasive characteristic and negative benthic impacts to shellfish populations.

7) Retired oysterman, John Hammond on Cape Cod (1982) felt the spread north of green crabs in the 1950s and 1960s into Maine was facilitated by thick growths of eelgrass. Mr. Hammond believed that green crabs needed to live in this eelgrass habitat as he frequently called it a habitat "bridge" or "cover." He felt that eelgrass and green crabs shared a direct habitat link. This area needs additional research. Habitat indicators from Canada now point to a direct habitat association.

8) Although eelgrass does perform nursery and habitat functions structure for finfish and shellfish species, it is a highly specific and transitory one. It is often "first in" after major recultivation events (cold and storms). In a cold water environment it is "clean and green" but in warmth becomes brown and furry and has direct negative habitat consequences to many organisms. These references are rarely mentioned in current reports.

9) The primary cause of eelgrass declines in eastern CT is severe storms or root atrophy/disease. Following a long period of heat and warm temperatures eelgrass formed meadows and grew to enormous densities following a cold and stormy period in the 1870s. By 1931 it succumbed worldwide to a disease as it did following the storm filled 1950s. In 1981 a similar disease outbreak occurred and continued as temperatures again rose into the 1990s. I feel it is not a coincidence that the stormy periods and die offs are both about 50 years apart.

10) Much credence has been placed upon light availability – water quality for eelgrass and clarity as both negative linkages to septic systems. A better indicator would be temperature – colder water limits algal growths as any beachcomber shore visitor will report. Winter water clarity is much greater, than August, and eelgrass does better in energy prevalent colder conditions – little relationships if any can be tied to coastal septic systems for temperature and energy changes.

Misrepresented Ecological Services

Although much research has been reported that links water clarity as a function of eelgrass ecological services and as an indicator to healthy estuarine habitats this is in opposition to many of the biological attributes of eelgrass itself. During warm periods dense eelgrass meadows traps enormous quantities of organic matter (mentioned as a positive ecological service) and this ability also impacts soil pH and soil oxygen reduction processes. Tides waves and even boat wakes can disturb this organic matter "oatmeal" reducing water clarity releasing fine particles that is trapped between eelgrass blades.

Marine soils are quite susceptible to pore water stagnation and subsequent acidic sulfur reduction processes during the same warm and low energy conditions. In fact the first Sapropel deposits often occur under eelgrass meadows whose root structures effectively seal the oxygen sufficient reduction pathway from a sulfur reducing one below the roots. As currents are slowed by eelgrass blades additional organic matter is then trapped, and fills pore space in soils as the relative elevation of the eelgrass meadows begins to rise. When this occurs tidal flushing is reduced and oxygen levels drop accelerating organic matter build up. Sulfur reduction turns the soil acidic and sulfide rich. This material is highly toxic to bivalves especially steamer clams Mya as newly set veligers shells dissolve. At some point the acidity and sulfide levels cause the eelgrass roots themselves to rot off and atrophy occasionally called rhizome (root) failure or die back. In plain terms the soil even rejects eelgrass itself, destroying its roots. Plants released from the Sapropel then drift away in search of better habitats.

At this point, the mud putrefies and becomes Sapropel, a sulfur rich material that now sheds ammonium ions which fuels brown algal blooms further reducing water transparency. Sapropel has been linked to warm weather hydrogen sulfide toxicity "black water death," a decline in winter flounder habitat viability and reduces then eliminates bivalve sets. Eelgrass is helped by coastal energy storms and dredging projects or basically any energy that will increase tidal flows (oxygen levels) and restore pore water circulation in marine soils will help slow but not stop a eelgrass habitat failure.

Thus the successional aspect of eelgrass is often "first in" after a major recultivation event, such as a strong storm or dredge project. The clean and green eelgrass has structural ecosystem benefits but those habitat benefits are transitional, eventually in warm and storm free periods eelgrass turns in the soft stagnant brown and furry eelgrass that has periodically die offs as in 1931 and 1981 (natural cycles). This process is driven by watershed organic matter not dissolved nitrogen which helps vascular plants[5]. Ammonium however has been shown to favor brown algal blooms HABS harmful to bay scallops also in warm periods.

Summary

Shellfishers at the turn of the century and the 1960s noticed this negative aspect of thick eelgrass and wrote extensively about this ability to strangle or starve shellfish (Bay Scallops), smother and suffocate oyster and clam beds. Inclusion of these references accentuates the negative successional aspects of eelgrass that it is an opportunistic colonizer of disturbed (cultivated) marine soils. But these references are often "missing" from more recent eelgrass studies. Eelgrass is impacted by long periods of heat and low energy – much as other species under long such periods. A nearly complete die off of eelgrass can be expected from successive encroachments of other habitat types immediately following a storm or extended periods without them. Under a high heat condition eelgrass over Sapropel sheds as it reduces ammonium which fuels brown algal growths especially in water bodies with long poorly flushed channels to the sea. In marine core samples taken in New England coves this cycle can be evidenced by sulfur rich layers of organic matter sandwiched between those containing estuarine shell.

It's (eelgrass) linkage or connection to water quality indicators without an energy or temperature review would be therefore misleading. Continued reporting of eelgrass ecological services without the references of the 1890 to 1931 or 1940 to 1981 periods is a manipulation of existing research literature by the omission of these citations[6].

Omitting data or results such that the research is not accurately represented from the available literature is an infraction listed as #65 Fed. Reg 76262/I for federal research misconduct. These research guidelines were changed last year by Congress (HR4078 2011-2012) in response to testimony before the House Committee On Oversight and Government Reform[7].

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[5] The question of nitrogen and eelgrass was the subject of a field meeting of House Committee on Oversight and Government Reform, June 4th 2012. Several exhibits highlight the ecological services of eelgrass and nitrogen and are available online.

[6] See HR4078 Title VIII – Ensuring high standards for agency use of scientific information – SEC. 801. Requirement for final guidelines. "The agency has in place procedures to identify and address instances in which the integrity of scientific information considered by the agency may have been compromised, including instances in which such information may have been the product of a scientific process that was compromised."

[7] See Field Hearing June 4th 2012, Exeter Town Office Building, Exeter New Hampshire "EPA Overreach and the Impact on New Hampshire Communities." House Committee on Oversight and Government and see Reform Staff Report 112th Congress, December 27, 2012 pg 11 & 12. Darrell Issa (CA-49) Chairman.

Eelgrass by its own defined biology slows currents and increases oxygen debts. It traps organic matter that in high heat sheds ammonium a plant nutrient that favors brown algal blooms and reduces water transparency. When organic terrestrial matter or oatmeal (crushed stems leaves and wood debris) enters estuaries and is trapped by eelgrass it starts its own "habitat clock."

Many of the positive habitat "clock" attributes that are mentioned so many times for eelgrass are in fact are the same ones that can end it. Examination below estuarine eelgrass meadows which tend to rise in elevation over time often contain long buried bivalve habitats in many coves. Habitat succession of eelgrass populations is a natural long term condition. It should be viewed as such and snap shots do not show the full eelgrass habitat "movie".

Fishers Picked the Name

One of the few organisms that can withstand the last stage of eelgrass succession in heat and one in particular is suited to this hostile environment is the American eel Anguilla – rostrata. The American eel has robust mucus production that can protect its skin from this sulfur rich and low pH environments. It is also able to breathe sufficient oxygen through specialized skill cells, supplementing gill oxygen exchanges. A century ago these warm eelgrass habitats supported a huge spear fishery and as then a dominant winter fishery habitat type as the place to capture (spear) eels. This habitat type became known as eelgrass named by fishers and a good term.

We could learn much from observations of fishers from the past as we do by the present.

Always willing to exchange ideas/concepts and research notes.

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THE COMMONWEALTH OF MASSACHUSETTS

Department of Natural Resources

BOARD OF NATURAL RESOURCES

Thomas a. Fulham, Chairman

DIVISION OF MARINE FISHERIES
Courtesy of the Massachusetts Coastal Area Management Office

A Study of the Marine Resources of the Westport River is the seventh in a series of monographs initiated by the Division of Marine Fisheries in 1963. These reports relate the extent and value of the marine resources of the major bays and estuaries in Massachusetts. (page 32).

The major factor limiting quahog abundance seems to be lack of favorable bottom. During the past decade eelgrass has been rapidly spreading on bottom areas which were formerly productive in quahogs. Quahogs sampled in eelgrass areas have reflected poor growth suggesting that the dense eelgrass interferes with circulation and food supply to the quahog. Soft bottom and dense eelgrass is especially obvious in the west branch of the river. The tendency toward less forceful ebb and flow of the tide in the west branch may be associated with hydrographic changes which have occurred with the gradual filling in of the lower harbor. Future dredging projects may bring about hydrographic changes which will favor the ecology of the quahog. (page 31).

It has generally been acknowledged that current, or circulation is of major importance to the growth of the scallop, although certain studies in recent years (Cooper and Marshall, 1963) have suggested that current may not necessarily be the main factor accounting for the condition of the scallop. While no extensive sampling was conducted in the Westport River to compare the size of the scallops from areas of good and poor circulation, the shellfish officer and fishermen have reported that scallops growing on the flats among dense growths of eelgrass are considerable smaller in size than those growing on the adjacent relatively clean channel bottoms. On September 23, 1966 biologists made a survey of scallops occurring on an extensive shallow eelgrass flat in the west branch of the river. This sampling occurred about one week before the opening of the scallop fishing season. The average size (dorso-ventral height) of 60 scallops gathered in the area was 54.8mm, or about 2 3/16 inches. The “eyes” were notably small and not of commercial quality. Because of the small size of the scallops and the density of

eelgrass in the area which hampers dredging, fishing during the scallop season was confined to the deeper areas further downstream in the estuary. (page 31)
Eelgrass.

Below mean low water, eelgrass (Zostera marina) is the most prevalent vascular plant growing in the Westport River. In recent years eelgrass has been rapidly spreading in the Westport River just as it has in other protected bays and estuaries of Southern Massachusetts. In moderate density, eelgrass is beneficial to many forms of marine animals. For instance, bait fishes and the juvenile forms of large species find shelter amidst the eelgrass clumps. Young bay scallops, upon reaching the setting stage, anchor themselves to the grass blades. Decomposing eelgrass forms detritus which is fed upon by many mollusks and crustaceans. (page 43).

Detriment to shellfisheries also occurs when dead eelgrass accumulates in dense mats and smothers beds of shellfish. (page 44).

Because of the increasing growth of eelgrass on shellfish beds, considerable research is presently being conducted to find an effective method of control. To date, no attempted methods have proven themselves completely practical. One town on the south shore of Massachusetts has attempted to cut eelgrass with an underwater mower designed for cutting submerged vegetation. At best, this method is only temporary since the plan stalk is cut off above the substrate surface leaving the stems and roots to produce new growth. Experimentation by various agencies with herbicides is presently being conducted. While certain chemicals such as 2, 4-D have effectively destroyed eelgrass, the toxicity of the chemicals to associated fauna is not clearly known. Similarly, it is still not known to what degree herbicide residues may accumulate in the live bodies of shellfish within and adjacent to the treatment are. Further investigation and analysis may pave the way for future practical and safe us of herbicides in the estuarine environment. Until such time, no herbicides should be introduced indiscriminately into our coastal bays and rivers. (page 44).

An experimental attempt was made in 1961 to improve bottom conditions in areas void of shellfish by applying lime. Fifty-two tons of lime were spread over 12 acres of the river. During that same year fishermen were hired to dredge and remove starfish from the river. Similarly, dredges were used tin 1962 to thin out blue mussels which had become a problem by encroachment in mats upon valuable quahog producing bottom. (page 30).

ENVIRONMENTAL ASSESSMENT OF THE USE OF EXPLOSIVES FOR SELECTIVE REMOVAL OF EELGRASS (ZOSTERA MARINA)

Michael Ludwig

Environmental Assessment Division
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
U.S. Department of Commerce
Milford, Connecticut 06460
(1977)

ABSTRACT

Data were obtained regarding the biological and physical impacts associated with using explosives as a herbicide for eelgrass (Zostera marina). Removal of the rooted marine vegetation from an area approximately 122 meter wide and 550 meters long within Niantic Estuary at Waterford, Connecticut has been proposed in an attempt to improve water quality and containment of egg and larval stages of the Bay Scallop (Argopectens irradians). Creation of a channel through dense stands of eelgrass should reestablish a persistent tidal eddy in the inner estuary which would improve dissolved oxygen levels and allow more complete habitation of the embayment. Relying on a physical model and in situa-generated information from both the private and public sectors it has been concluded that such an attempt, with proper constraints should be allowed.

Marshall's 1960 discussion of this situation describes the scallops as setting on red algae in the absence of eelgrass within the estuary. Apparently the algae served as a suitable substitute for the destroyed eelgrass. As eelgrass reestablished itself along the coastline it also re-vegetated the estuary and had, by the early 1960s, extensively reduced the tidally-generated gyre's persistence and mixing capabilities. During this same period bay scallop production suffered a serious decline. Compounding the reduction in numbers of juveniles the area experienced a series of concurrently occurring harsh winters which had caused the almost complete exclusion of bay scallops from the area.

The Works of David L. Belding M.D. Biologist
Early 20th Century Shellfish Research in Massachusetts

Quahaug and Oyster Fisheries
The Scallop Fishery
The Soft Shell Clam Fishery

Re-published by Cape Cod Cooperative Extension
with the permission and cooperation of the Massachusetts
Division of Marine Fisheries
2004

Cape Cod Cooperative Extension is proud to present this re-published collection of reports on the shellfisheries of Massachusetts written by Dr. David L. Belding

"..the Legislatures of 1905 to 1910 directed the Commissioners on Fisheries and Game to conduct a series of investigations and demonstrations to determine methods of developing the shellfisheries."

This publication, The Works of David L. Belding, MD contains three of the volumes of research completed by the Commonwealth's Shellfish Biologist in the early 20th century. His work took place over many years, and was updated and re-printed on several occasions. To this day, Dr. Belding's studies of shellfish have proven to be quite accurate, through, and remain a remarkable and classic pieces of research.

Cape Cod Cooperative Extension is proud to provide the shellfish community and all that love the history of Cape Cod and Massachusetts with this 2004 edition of Belding's work.

Bill Burt, Marine Resources Specialist
Cape Cod Cooperative Extension, an agency of Barnstable County

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FOREWORD OF THE MASSACHUSETTS DIVISION OF MARINE FISHERIES

I take great pleasure in knowing that the public will once again be able to read the research work conducted by Dr. David L. Belding on the shellfisheries of Massachusetts during the first part of the 20th century.

In the preparation of this 2004 edition, the Division of Marine Fisheries (DMF) and Cape Cod Cooperative Extension agreed on an effort to present the material, as far as possible, in the original format of the last published editions of the works printed in 1930.

Dr. David Belding, a medical doctor, was also a fine biologist. He was assigned by what was then called the Massachusetts Commissioners of Fisheries and Game to conduct studies into the shellfisheries of the Commonwealth. These studies began in 1905 and continued through 1910, and during most of those years Belding had but a single assistant. Despite this fact, his work regarding the biology of shellfish remains extraordinary in terms of its accuracy, particularly when you consider the time period when this work was done, and the type of equipment and technology he had available for his research. When one reads this volume, keep in mind the amount of time it must have taken to travel from one location to another, as many of the rural roads at that time were just sand paths. The amount of work, attention to both the experiments and detail makes this a premier piece of shellfish research. Today many of his observations and recommendations are still the basis of shellfish management decisions. Shellfish culture methods, also experimented with by Belding in the early 1900s have developed into a major industry for the coastal region, with more than 300 growers now licensed by local towns to use the tidelands of the Commonwealth to raise shellfish for the marketplace.

Thus, while shellfish research continues, and the tools of the present DMF now include: the computer, internet research, GIS mapping, and sophisticated laboratory equipment; the work of the Shellfish Program remains focused, as it has long bee, to provide a safe and sustainable shellfishery for the Commonwealth of Massachusetts.

I hope you enjoy this reading of Belding!
Sincerely,

September 2004

J. Michael Hickey, Chief Biologist
Shellfish Sanitation and Management Program,
Massachusetts Division of Marine Fisheries

Rekeyed from original version by The Sound School Adult Education and Outreach Program, June 20, 2013

Dr. David L. Belding, Massachusetts Research

On the Growth of Soft shell Clams -

Eelgrass: Eelgrass as we have seen is fatal to a good clam bed. Many productive beds would be quickly spoiled by eelgrass if it were not for constant digging. The grass raises the surface of the bed above the normal level by bringing in silt, which smothers the clams. The reclamation of such flats can be accomplished by destroying the grass and allowing the water to carry away the accumulated muddy deposits. At Newburyport an eelgrass flat with a surface layer of soft mud was converted into a productive hard flat by digging. A strong current removed the loosened material, and a new flat about one foot lower than the original was formed.

A coating of algae often helps to protect the flat from too much shifting and the mud surface furnishes abundant food forms. Eelgrass helps to hold the mud firmly, but as it also catches silt it forms a layer of soft mud which is apt to smother the small clams.

It occasionally happens that parts of a flat which seem similar in every respect exhibit extreme differences in the way they harbor or repel that clam set. It is almost as though an invisible line had been drawn beyond which clams did not grow. Hydrogen sulfide and other organic compounds in the soil may account in part for this condition.

Organic Material: Clams are usually absent from soils containing an abundance of organic material. Even if the slimy surface does not prevent the set, the clams that take lodgment soon perish. Organic acids corrode their shells and interfere with the shell-forming function of the mantle. Such a soil indicates a lack of water circulation within the soil itself as indicated by the foul odor of the lower layers of soil, the presence of hydrogen sulfide, decaying matter, dead eelgrass, shells and worms. If such a soil could be opened by the deep plowing, or resurfaced with fresh soil to sufficient depth, it would probably favor the growth of the clam.

On the Growth of Bay Scallops -

Eelgrass, especially on the shallow flats, occurs either as (1) thick clusters with open spaces intervening, (2) thinly scattered or (3) thick masses. Only in the last case is eelgrass a serious check to growth, as it then cuts off circulation of water, which is the main essential for rapid development. Growth experiments on clear sand bottom and in thick eelgrass, where other conditions were approximately the same, show a greater rapidity of growth in the scallops on the clear bottom than those in the grass.

Soil: The character of the bottom affects the growth but little, as the scallop rests only on the surface and is constantly shifting its position. However, the young scallop would soon perish in soft mud were it not attached to eelgrass during the early period of its life. The best bottom seems to be a tenacious sand (sand with a slight mixture of mud) with thin eelgrass. In the case of the large channel scallop, the soil is either sand, gravel, hard mud, shells, with the little eelgrass.

On the Growth of Quahogs -

Eelgrass – The soil exerts an indirect influence on growth by the abundance or scarcity of eelgrass, which it thick prevents the free circulation of water over the bed. In addition to the examples cited under “Current,” a comparison of experiments Nos. 186 and 187 on Egobert’s Flat, Plymouth harbor, gives an annual growth of 11.73 millimeters for the clear and 7.43 millimeters for the eelgrass, although both beds were near together. The presence of eelgrass is not necessarily an indication of slow growth, as it only becomes a detriment when thick enough to interfere with the circulation.

The results, as will be seen by reference to the general table, were briefly as follows: on Egobert’s the bed in the eelgrass showed a slower growth than the bed on the bare sand, due to difference in circulation of water.

Current – The growth of the quahog depends upon the circulation of water, as the current is the “food carrier,” and therefore, within limits, the more current, the more food. Current also keeps the ground clean, and prevents contamination or disease from spreading. The most important point in choosing the ground is to locate the grant where there is a good current, as growth is directly proportional to the circulation of the water. It is possible, of course, for a place to have so rapid a current that it would cause a shifting of the bottom, and perhaps wash the quahogs from their burrows, but such a current is found in but few localities in which one would think of planting.