Long Island Sound Lobster Health Symposium

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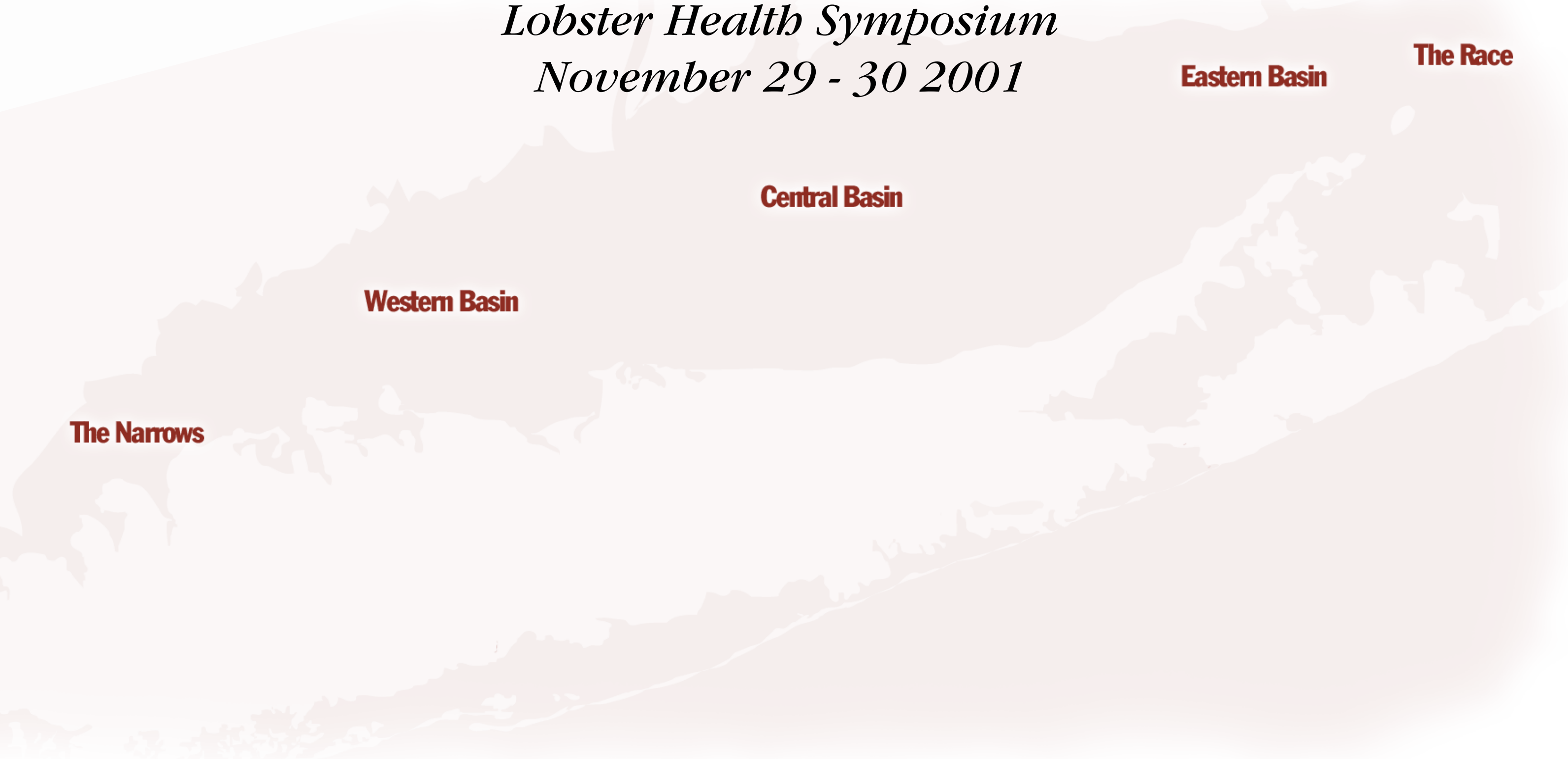

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BACKGROUND MATERIAL

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Assessment of lobster health in Long Island Sound 2000-2001

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Key Words: lobster, disease, pathology, amoeba, paramoeba

Introduction

A large-scale die-off of American lobsters (*Homarus americanus*) in Long Island Sound (LIS) during the autumn of 1999 devastated the multimillion-dollar lobster industry in New York and Connecticut. There are many theories as to the cause of this mass mortality including pesticide applications, effluents from sewage treatment plants, dredging sediment, and ecological and climactic factors. A pathological investigation at the University of Connecticut (UConn) identified a potential cause of the mortality as (presumptively) a parasitic paramoeba species. This discovery launched a full investigation into the health of the American lobster in Long Island Sound. Our goal was to assess the health of lobster and to collect background data on diseases and their prevalence in LIS. The study extended over one full year (May 2000-June 2001) in which animals were collected in groups of 10 from each of five predetermined zones in the Sound on a monthly basis. Upon receipt of these animals at UConn, a full necropsy was performed and samples were taken for histopathology, toxicology, microbiology, hematology/immunology, as well as for archival and collaborative purposes. To date over 500 animals have been collected for analysis. Preliminary findings indicate that there are no significant and/or consistent bacterial pathogens identified in lobsters collected from LIS. However, shell disease is prevalent in eastern LIS, the cause of which is not determined. In addition, there is no evidence of mycotic, viral, or other pathogens with the exception of the parasitic amoeba. There is no quantitative evidence of pesticide toxicity. To date, other data on contaminants and environmental factors remain to be interpreted and correlated with pathology findings. All indications based on pathological evaluations of the American lobster in LIS, suggest that the mass mortality of lobster in 1999 was the effect of a natural disease (paramoebiasis). However, the role of other environmental and anthropogenic factors has not been fully elucidated.

Investigation of mosquito control agents in Long Island Sound water, sediment and lobsters and their effect on lobster health.

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Key Words: Resmethrin, Methoprene, paramoeba, immunotoxicology, and lobster

Introduction

During the summer and fall of 1999, there was a massive die-off of lobsters predominantly in western Long Island Sound. Information from the Connecticut Department of Environmental Protection and New York State Department of Environmental Conservation show that lobster landings in some parts of the western Sound fell virtually 100% in the fall of 1999. One of the potential causes implicated in the die-off has been the use of mosquito control agents, Resmethrin, Malathion and Methoprene, used during the West Nile Virus outbreak.

This study was undertaken to determine the levels of pesticides in Long Island Sound and lobster tissue, as well as an assessment of lobster health. The investigators analyzed lobsters, seawater, and sediment from five locations within Long Island Sound (LIS) to determine correlation between the application of mosquito control agents, contaminant body burdens, and the health of the lobsters. Five locations in LIS were identified; four are harbors or embayments in the towns of Bridgeport, Stamford, Norwalk, and New Haven which were affected. The fifth, (Niantic) served as a "clean" or reference site. This study is ongoing with final collection scheduled for late November 2001. Pathological analyses have not been completed to date. All results should be considered preliminary until all quality assurance data has been examined and the final report is released.

Objectives

- To assess the potential impact of mosquito control agents, Resmethrin, Malathion and Methoprene, on the immunological and histological status of lobsters from five areas of Long Island Sound.
- To assess the presence and distribution of mosquito control agents, primarily Resmethrin, Malathion and Methoprene. Concentrations will be measured in water and sediments from: a baseline; immediately after a storm event; and late in the season from the five areas. Collections from each site consisted of lobsters and water column samples from near and offshore areas.

Methodology

This study was undertaken in two phases.

- Phase 1 encompassed a baseline sampling event during September of 2000, collecting lobster, seawater and sediment from near and offshore sites at each location. For phase 1, a total of 150 lobsters/crabs were examined histologically and immunologically and 105 samples, inclusive of water, sediment, and lobster hepatopancrease, were toxicologically analyzed.
- Phase 2 consisted of three distinct sampling events including a baseline, event-driven, and late season assessment of pesticide concentrations and lobster health, these activities took place between April-November 2001. These events will occur at the same five locations, from near and offshore sites sampled in Phase 1. A total of 225 lobsters/crabs were examined histologically and immunologically and 250 samples, inclusive of water, sediment, and lobster/crab hepatopancrease, were toxicologically analyzed in phase 2.

The field and laboratory methods used include:

- Lobster tissue analysis including necropsies, gross and microscopic examinations of tissues to determine the presence/absence of the paramoeba and other pathological conditions. Lobster immunological analysis included phagocytic index, hemocyte counts, and total proteins.
- Toxicological analysis consisted of a modified US EPA Method 616 for the determination of Resmethrin, Methoprene, and Malathion in lobster hepatopancrease, seawater and sediment. Both *cis*- and *trans*- isomers of Resmethrin were analyzed during this study.

Data

Chemical Analysis

All samples analyzed to date have been below detectable levels for the four target compounds. The analytical detection limits were low, with water analysis at 0.25 ppb, sediment analysis at 1.5 ppb, and tissue analysis at 15 ppb. The literature has estimated that the field concentration of Methoprene in shallow pools at 8 ppb and an LC_{50} in young *Gammarus spp*. at 0.32 ppm (Brown *et al.* 1999; Gradoni *et al.* 1976).

Pathology

There was incidence of paramoeba and other pathological conditions in lobster tissues examined to date. There was also incidence of abnormal levels of total proteins and abnormal coagulation in lobster tissues examined. Preliminary analysis shows no direct correlation between pathological condition and location.

Immunology

There was a significant relative difference in immune function of lobsters from near and offshore sites within Norwalk and Bridgeport, when collected during the same period. Hemocyte cell counts (Figure 1) and phagocytic index were significantly lower in nearshore vs. offshore sites.

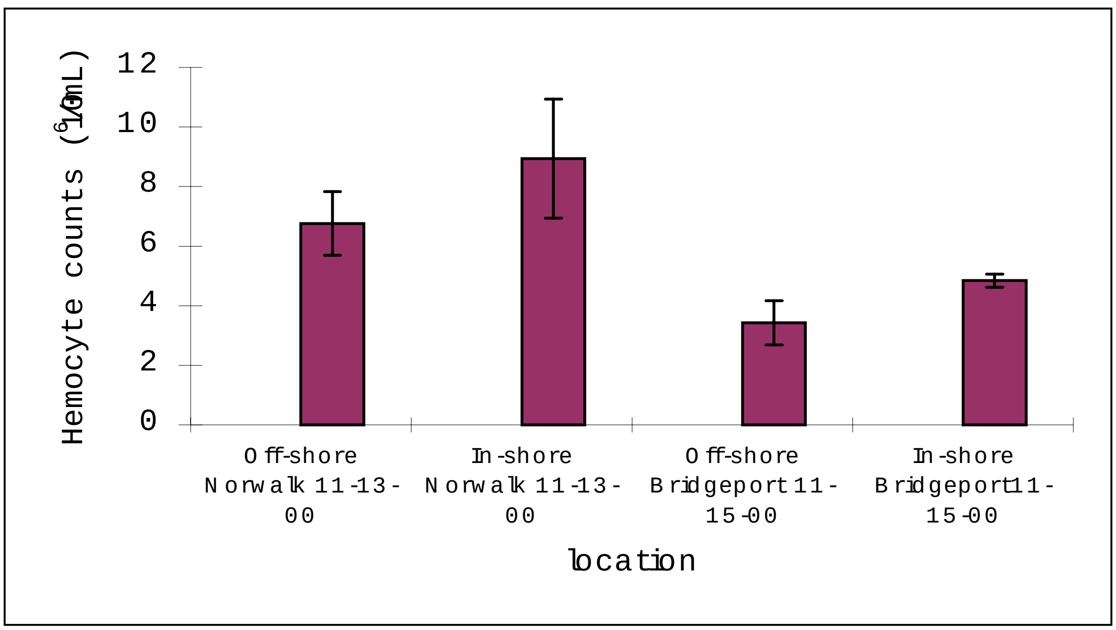

Figure 1. Hemocyte cell counts in lobsters collected from Norwalk and Bridgeport in November of 2000.

Expected Outputs

Although the data from this study is preliminary, it appears that concentrations of the pesticides applied to control the spread of the West Nile Virus, in biologically relevant concentrations in Long Island Sound, as described in the literature. We are seeing an effect on the immune function of lobsters collected from near shore location when compared to offshore, in certain cases, although there is no correlation with the pesticides analyzed. This data should complement the laboratory-based toxicity and sub-lethal studies that were recently initiated to better indicate if ambient concentrations of pesticides are present in biologically relevant concentration as they specifically apply to lobsters.

References

Brown, M.D., D. Thomas, P. Mason,, J.G. Greenwood, and B.H. Kay. 1999. Laboratory ad Field Evaluation of Four Insecticides for *Aedes vigilax* (Diptera:Culicidae) and Toxicity to the Nontarer Shrimp *Leander tenuicornis* (Decapoda: Palamonidae). *J Economic Entomol*. 92(5):1045-1051.

Gradoni, L., S. Bettini, and G. Majori. 1976. Toxicity of Altosid to the Crustacean *Gammarus* a*equicauda*. *Mosquito News*. 36(3):294-297.

Shell disease in southern New England lobsters

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Key words: shell disease, lobsters, chitin

Introduction

Shell disease, the deterioration of the exoskeleton by chitinoclastic microorganisms, occurs in marine and fresh water environments, has been observed on crustaceans since 1900 (Hapitch 1900, cited in Rosen 1970). Gross signs of the disease are similar in all crustacean species; the exoskeleton is pitted and marred with necrotic lesions and, although the disease is not immediately fatal, death may ultimately occur (Fisher *et al.* 1978). For lobsters, the unsightly appearance of the shell can greatly affect marketability. Chitin-digesting bacteria and fungi have been implicated as causative agents and include isolates of *Vibrio* spp., and several other Gram-negative bacilli (Hess 1937; Getchell 1989). A major outbreak of shell disease began in the late 1990s in eastern Long Island Sound, Connecticut and nearshore coastal areas of Rhode Island and Massachusetts (Castro and Angell 2000). In the spring of 2000, lobster biologists from southern New England and New York developed standardized procedures for monitoring the extent of shell disease in wild populations. The goal of developing a uniform protocol was to provide a more comprehensive assessment of the prevalence of shell disease throughout the range of the U.S. lobster resource. The objective of this report is to provide an update on the status of shell disease in southern New England, New York and offshore waters.

Materials and Methods

Prevalence and severity of shell disease in lobsters were monitored during several surveys conducted by state agencies and research groups from Massachusetts to New York. Sea sampling surveys were performed aboard commercial fishing vessels by biologists from Massachusetts Division of Marine Fisheries (MADMF), Rhode Island Department of Environmental Management (RIDEM), Connecticut Department of Environmental Protection (CTDEP) and New York State Department of Environmental Conservation (NYSDEC). Research surveys were conducted by the University of Rhode Island (URI) and the Millstone Environmental Laboratory (MEL). URI conducts weekly bottom trawl surveys at two sites in Narragansett Bay and a covered trap survey in Dutch Harbor, Narragansett Bay. MEL monitors lobster population characteristics at three sites in eastern Long Island Sound (LIS) using unvented research traps from May through October in the vicinity of the Millstone Power Station in Waterford, CT. In addition, CTDEP conducts spring and fall bottom trawl surveys throughout LIS.

The shell disease index developed in 2000 is simple and it is based on the percent shell coverage of disease symptoms (pitting, erosions, lesions) on the total surface area of the lobster. The index includes the following categories: 0 = No shell disease symptoms; 1 = Shell disease symptoms on 1 to 10% of the shell surface; 2 = Shell disease symptoms on 11 to 50% of the shell surface; 3 = Shell disease symptoms on more than 50% of the shell surface; and OLD = New shell shows scars of a shell erosion from the previous shell. The categories are broad to reduce subjectivity when assigning an index and to expedite sampling large numbers of lobster aboard commercial fishing vessels.

Results

Several thousand lobsters were examined each year in surveys conducted by state agencies and research groups from Massachusetts to New York. Shell disease prevalence in all southern New England areas was low in 1996 and 1997 (0-5.6%), but increased in 1998 along the Rhode Island coast (4.3-18.9%) and in 1999 in eastern LIS (9.0-16.2%; Table 1). By 2000, the percentage of lobsters with shell disease approached or exceeded 20% in nearshore coastal areas from southeastern Massachusetts to eastern LIS. Levels remained high (8.7-42.9%) in this region during 2001. Prevalence of shell disease in central and western LIS and in offshore canyon areas never exceeded 5%. Lobsters of all sizes have been observed with shell disease, although larger sized individuals and egg-bearing females had higher incidence and severity of shell disease symptoms. This is most likely due to the molt cycle of large lobsters and egg-bearing females. Smaller lobsters molt more frequently (1-2 times/yr or more) and shed their shells before severe shell disease symptoms occur. Large lobsters and egg-bearing females experience more shell deterioration because they may only molt every two years.

	1996	1997	1998	1999	2000	2001
Massachusetts						
MADMF						
Rhode Island						
RIDEM	0.3	4.3	18.9	20.3	21.8	31.0
URI trawls	0.5	1.3	4.3	2.7	-	-
URI traps	-	5.6	8.9	19.1	32.4	42.9
Long Island Sound						
East						
MEL traps	-	<0.1	1.5	9.0	16.4	21.5
NYSDEC	-	-	-	-	18.6	11.7
CTDEP	1.7	3.2	3.3	16.2	20.8	22.7
Central						
NYSDEC	-	-	-	-	0.3	0.1
CTDEP	-	-	-	-	1.2	1.3
West						
NYSDEC	-	-	-	-	0.1	0.2
CTDEP	2.5	3.1	1.2	1.5	1.0	<0.1
South Shore LIS						
NYSDEC	-	-	-	-	4.0	4.4
Offshore Canyons						
RIDEM	0	<0.1	0.2	0.8	2.1	2.7

Table 1. Population percentages of lobsters with shell disease (all severity indices) collected in southern New England, New York, and offshore waters 1996-2001.

Large seasonal variations were observed in the incidence of shell disease (all severity indices), which closely corresponded to the molt cycle. Prior to the peak molt, which usually occurs in June in southern New England, up to 60% of the lobsters examined had shell disease (Figure 1). Following the major molt in July, only 5 to 20% of the lobsters were afflicted. The percentage of diseased lobsters and levels of severity increased through August and September as new shells quickly became infected. By October 2000 and 2001, population percentages of shell diseased lobsters peaked to between 60% and 75% in areas from Massachusetts to eastern LIS.

In addition to recording the presence and severity of shell disease on each lobster, we also noted the appearance of scars on the exoskeleton due to previous (i.e., premolt) chitinoclasia infections. Again, egg-bearing females had the highest percentage of scarring and secondary infections. The occurrence of secondary infections began in June following the onset of the major molt and increased each month through October when 60% of the catch had shell disease for a second time. These observations indicate that shell disease may not be initially fatal. However, successive infections may cause additional physiological stress to lobsters resulting in decreased locomotion and agonistic behavior that could lead to increased vulnerability to predation.

Discussion & Conclusions

A number of isolated outbreaks of shell disease have been reported in lobster populations along the New England coast in the past century. However, these reports were limited to impounded lobsters in the

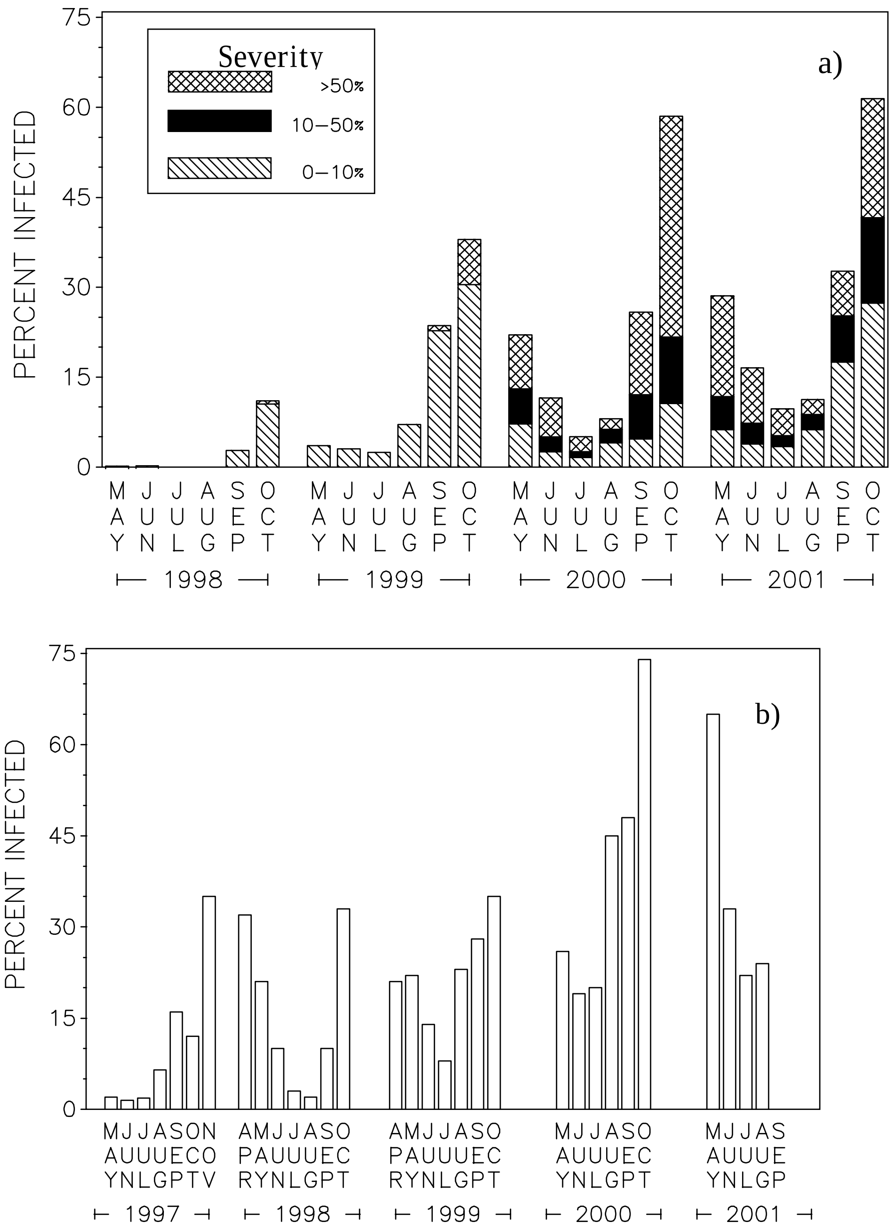

Figure 1. Monthly population percentages of lobsters with shell disease collected in a) eastern LIS waters 1998-2001 and b) Dutch Harbor Rhode Island 1997-2001.

Gulf of Maine during the 1930s (Hess, 1937; Taylor, 1948) and to infrequent occurrences in wild lobsters in the 1980s along Massachusetts coastal waters and the New York Bight (Sinderman *et al.*, 1989; Estrella, 1991). The present epizootic outbreak is clearly different from any other cases reported for American lobster. The cause of the outbreak is unknown; it may be due to water quality degradation along the coast or to natural environmental factors such as warmer seawater temperature. However, it is surprising that the prevalence of shell disease was low in central and western LIS, two areas known to be more polluted with domestic sewage and industrial contaminants than areas to the east. The etiology of shell disease may be enhanced by increased transmission due to crowding as a result of the sharply higher abundance of lobsters in recent years. Most alarming is the prevalence and severity of shell disease in egg-bearing female lobsters. The effect of the disease on lobster recruitment in southern New England may be significant if egg-bearing females suffer higher natural mortality due to shell disease.

References

Castro, K.M., and T.E. Angell. 2000. Prevalence and progression of shell disease in American lobster, *Homarus americanus*, from Rhode Island waters and the Offshore Canyons. *J. Shellfish Res.* 19:691-700.

Estrella, B.T. 1991. Shell disease in American lobster (*Homarus americanus*, H. Milne Edwards, 1837) from Massachusetts coastal waters with consideration for standardizing sampling. *J. Shellfish Res.* 10:483-488.

Fisher, W.S., E.H. Nilson, J.F. Steenbergen, and D.V. Lightner. 1978. Microbial diseases of cultured lobsters: A review. *Aquaculture* 14:115-140.

Getchell, R.G. 1989. Bacterial shell disease in crustaceans: a review. *J. Shellfish Res*. 8:1-6.

Hess, E. 1937. A shell disease in lobsters (*Homarus americanus*) caused by chitinivorous bacteria. *J. Biol.* 3:358-362.

Rosen, B. 1970. Shell disease of aquatic crustaceans. Pages 409-415 *in* S.F. Snieszko (ed.); A Symposium on Diseases of Fishes and Shellfishes. *Am. Fish. Soc. Publ*. No. 5, Washington, D.C.

Sinderman, C.J., F. Csulak, T.K. Sawyer, R.A. Bullis, D.W. Engell, B.T. Estrella, E.J. Noga, J.B. Pearce, J.C. Rugg, R. Runyon, J.A. Tiedemann and R.R. Young. 1989. Shell disease of crustaceans in the New York Bight NOAA *Tech. Rept. Memo*. NMFS-F/NEC-64, 43 pp.

Taylor, C.C. 1948. Shell disease as a mortality factor in the lobster, *Homarus americanus*. State of Maine Dept. of Sea and Shore Fisheries. *Fisheries Circular No. 4*. Boothbay Harbor, ME. 8 pp.

Investigations into the cause of lobster mortality in Long Island Sound: Remots® sediment-profile imaging and bottom water quality monitoring from August to November 2001

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Keywords: sediment-profile imaging, hypoxia, sediments, hydrogen sulfide, ammonia

Introduction

As part of the response by concerned agencies to reports of dead and dying lobsters in western LIS in September 1999, samples of water, sediment and lobster tissue were collected and analyzed for toxic substances and pathogens. These tests generally showed no abnormal conditions, but later testing by the University of Connecticut pathobiology laboratory identified a protozoan parasite (*Paramoeba spp*) as a possible causative agent. Under contract to the NYSDEC, SAIC collected REMOTS® sediment-profile images at 30 stations in western Long Island Sound in late October 1999, to determine if there was anything abnormal occurring at the sediment-water interface to explain the lobster mortality. The sediment surface at most stations was found to be black or dark-colored, and the depth of the apparent Redox Potential Discontinuity (aRPD, a measure of the apparent depth of oxygen penetration into the sediment) was very thin (less than 1 cm) at most stations. It was considered likely that lobsters had been exposed to low dissolved oxygen (DO) concentrations and/or elevated levels of sediment-derived toxicants (e.g., hydrogen sulfide and ammonia) in the months preceding the October 1999 survey. Such conditions, however, are not considered unusual or abnormal for the benthic environment during summer/early fall in western LIS, where seasonal near-bottom hypoxia has been a recurring phenomenon for decades.

Methods & Objectives

SAIC and Dr. Carmela Cuomo of Yale University were funded by US EPA to conduct a series of three follow-up field surveys in August, September and November 2000. During each survey, REMOTS® sediment profile images were collected at 36 stations in western LIS, along with simultaneous measurements of DO concentrations in close proximity to the bottom (10 cm above the seafloor). Concentrations of hydrogen sulfide and ammonia were determined in bottom water samples obtained 2 to 4 cm above the seafloor. Key REMOTS® measurements at each station included aRPD depth and the infaunal successional stage. The objective was to evaluate the role of near-bottom hypoxia/anoxia (and related sulfide and ammonia releases from the sediment) as a potential structuring influence on the benthic environment and communities of western LIS, especially in those areas where lobster mortalities occurred. Long-term exposures to low oxygen and high levels of ammonia/hydrogen sulfide may have induced a physiologically-stressed state in the lobsters that died in 1999, weakening their immune systems and making them more susceptible to infection or disease.

Results

In all three months, average aRPD depths at the majority of stations were shallow (less than 2 cm). In general, a higher proportion of stations in the Western Narrows had aRPD depths less than 2 cm compared to those in the Eastern Narrows. There was a high degree of among-station variability in the aRPD depths. Extremely shallow RPD depths (<1 cm) were observed at stations in both the Western and Eastern Narrows, but interspersed among these were stations having relatively well-developed aRPD depths of 2 cm or more. There were no clear temporal trends of either increasing or decreasing RPD depths across the three surveys.

In all three surveys, the sediment-profile images present showed either reduced (anoxic) sediment at the sediment-water interface, sediment that was very black in appearance (i.e., highly reduced/anoxic), or a combination of both conditions (Figure 1). Sediments having an extremely black appearance are inferred to have a high inventory of sulfides, resulting from bacterially-mediated breakdown of organic matter.

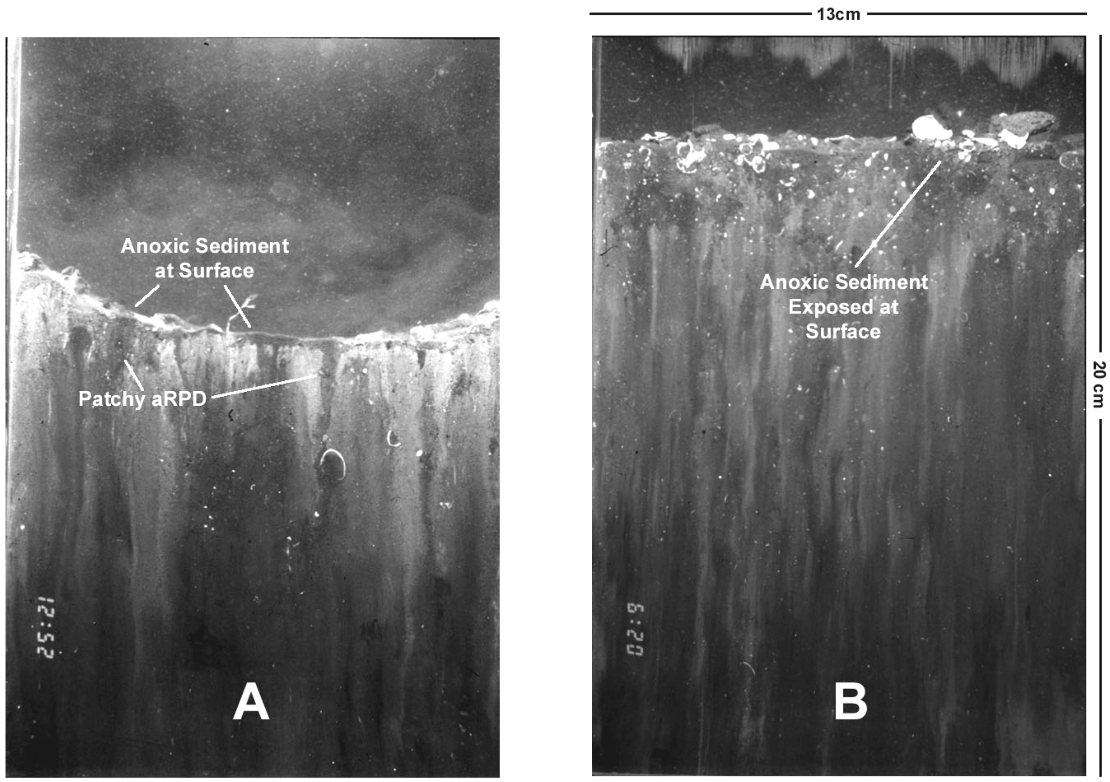

Figure 1. Representative sediment-profile images from western LIS illustrating very shallow aRPD depths, underlying sediment that is extremely black (anoxic), and patches of anoxic sediment occurring at the sediment-water interface.

Surface-dwelling, opportunistic benthic organisms (successional stage = Stage I) were widespread and dominant in all three of the 2000 surveys. This result is not surprising, as this successional stage is comprised of taxa with high population turnover rates that are adapted to persist under stressful hypoxic conditions. In particular, the tube-building, surface-dwelling polychaetes that comprise Stage I in LIS are among the most sulfide-resistant marine invertebrates. Past REMOTS® surveys of 1986 and 1987 also found a dominance of Stage I opportunists during August hypoxia episodes in western LIS.

The average DO concentration measured at a height of 10 cm above the seafloor increased steadily, from 2.97mg/L in August to 5.19 mg/L in September to 8.52 mg/L in November. The widest range of values was observed in August, when minimum values of 0.81 and 0.84 mg/L were measured at two stations in the Western Narrows, while maximum values of >6 mg/L were measured at three stations in the Eastern Narrows. In general, there was a west-to-east gradient of increasing bottom DO concentrations observed in August. The majority of the stations sampled in September had DO concentrations greater than 5 mg/L, while the November DO measurements were uniformly high, ranging between 8.12 and 8.96 mg/L.

Both ammonia and sulfide were detected in bottom water samples in August, September and November. In August, sulfide concentrations generally ranged from 0 to 1 μM/L and ammonia ranged from 0 to 0.2 μg/L. Elevated sulfide concentrations (between 2 and 8 μM/L) were observed at several of the western-most stations during the August survey. Ammonia levels were elevated at two of these stations and at one station in the central Eastern Narrows. In September, sulfide and ammonia levels at most stations were considerably higher than in August. Sulfide ranged between 2 and 6 μM/L, while ammonia ranged between 1 and 3 μg/L. In November, sulfide levels at most stations were somewhat lower than in September, ranging between 2 and 3 μM/L. Ammonia concentrations in November ranged between 0 and 5.5 μg/L; some stations showed a decrease and others an increase relative to September.

Summary

1) Surface sediments that appeared to be highly anoxic were visible in sediment-profile images obtained throughout western LIS in August, September and November 2000. This black sediment was either exposed at the sediment-water interface or present just below a thin surface veneer of oxidized sediment.

2) The observed shallow aRPD depths and the anoxic appearance of the sediments suggest that inventories of organic matter remained high enough to cause build-ups of anaerobic decomposition products (e.g., sulfides) close to the sediment-water interface during the months of August, September, and November of 2000.

3) Sediment-profile imaging surveys conducted previously (10/99, 8/86 and 8/87) likewise found thin aRPD depths and exposed anoxic sediment throughout western LIS, leading to the conclusion that compromised benthic habitat quality is a chronic condition in this region.

4) The 2000 study showed the benthic community was dominated by small, surface-dwelling, opportunists (Stage I) adapted to persist in anoxic/sulfidic sediments. Because of the annual recurrence of hypoxia, the benthic macroinvertebrate community in western LIS appears to be unable to progress beyond early successional stages (I and II) into the more advanced "equilibrium" stage (Stage III) that characterizes undisturbed muddy seafloor environments in central/eastern LIS.

5) Measurements of DO made 10 cm above the seafloor showed that hypoxia persisted in western LIS during summer 2000 for longer than indicated by CTDEP measurements taken 1 meter above the seafloor. DO concentrations indicative of severe to moderately severe hypoxia were observed at stations in the extreme western Sound in late August 2000. Near-bottom DO concentrations increased steadily from August to November 2000, reflecting the break down of thermal stratification and system-wide re-aeration of bottom water.

6) Significant levels of both sulfide and ammonia were measured very close to the seafloor in August, September and November 2000. These results suggest that anaerobic decomposition processes are dominant over aerobic processes on the bottom of western LIS, and illustrate the key role that the organic-rich sediments of this area play in structuring the chemical environment at the sediment-water interface.

7) The water at and near the sediment-water interface in western LIS appears to remain within a functionally hypoxic state for much of late summer and early fall, even after the breakdown of stratification result in a downward mixing of well-oxygenated water to the bottom.

8) Lobsters in western LIS in 1999 and 2000 were likely exposed to both low dissolved oxygen concentrations and elevated levels of hydrogen sulfide and ammonia. These stressors, alone or in

combination, could have served to increase the lobsters' susceptibility to a pathogen-borne disease or other potential causative agent(s) of mortality.

9) Benthic processes are important as an influence on overlying water quality and as an important factor in the overall health of the western LIS ecosystem. Regular benthic and near-bottom water monitoring surveys should be considered as a complement to the on-going water quality monitoring program in LIS.

10) It is recommended that any future surveys of this nature involve either year-round sampling or at least be initiated in spring, well before the onset of thermal stratification and hypoxia. This would provide a more complete picture of seasonal differences and, in particular, help to elucidate the time scales that are suspected to influence the relationships among the different measured parameters (e.g., aRPD depths versus DO versus ammonia/sulfide).

Anomalies in meteorological forcing and water column structure as possible contributors to the 1999 lobster mortalities in Long Island Sound

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Key Words: temperature, anomaly, principal component analysis, heat flux

Introduction

Analyses of long-term records for bottom temperature for both New York State Department of Environmental Conservation (NYSDEC) and Connecticut Department of Environmental Protection (CTDEP) water quality stations in Long Island Sound reveal large positive anomalies of up to 2 °C (from the mean annual cycle) during 1997-2000. This period of elevated bottom temperatures corresponded with increased lobster mortality rates in the Sound. Large anomalies occurred in late summer when bottom temperatures are normally at their highest. Bottom temperatures remained high during fall molting periods. The high bottom temperatures during summer 1999 were apparently precipitated by an early fall overturn during which anomalously high temperature surface waters were mixed downward.

Bottom temperature anomalies over the past decade exhibit coherent long-period fluctuations. Analyses of records from NYSDEC indicate that over the past five decades, there has been a gradual decrease in summertime bottom water temperatures in the western Sound. Accompanying the decrease in summertime bottom temperatures has been an increase in water column stratification and a decline in summertime bottom dissolved oxygen. There have also been very large inter-annual variations in summertime bottom temperatures, which are correlated with inter-annual variations in summertime bottom dissolved oxygen.

Hypothesis

It is our hypothesis that Long Island Sound's lobster mortalities resulted from the convergence of several environmental factors. These conditions may have stressed the animals enough to result in mortality or may have weakened them to the extent that they were vulnerable to opportunistic pathogens. These observed anomalies in bottom temperature described above point to temperature. Our specific hypothesis is that anomalies in water column properties including temperature, dissolved oxygen and salinity are correlated with anomalies in lobster mortality rates within the Sound. We hypothesize that covarying fluctuations in these water column properties may violate lobster habitat requirements and thereby contribute directly to an increase in lobster mortality rates. The apparently elevated salinities during the 1999 mortality events would lead us to focus primarily on covariations in temperature and dissolved oxygen.

The overall goal of the proposed research is to test our hypothesis that anomalies in water column conditions are a causative factor for anomalies in lobster mortality rate throughout the Sound. To achieve this goal we identified four specific objectives to:

(1) Define the spatial patterns and time varying amplitudes that characterize dominant covariations in water column properties: temperature, dissolved oxygen, and perhaps salinity.
(2) Determine the relative contributions of local meteorological forcing and non-local forcing in producing the dominant modes of variability defined under objective (1).

(3) Interpret the modes of water column variability defined under objective (1) during lobster mortality periods to determine the extent to which parameters or their rates of change approach lethal limits.
(4) Establish statistical relationships between the time variations in dominant modes characterizing the spatial patterns of water column anomalies and the time variations in patterns of lobster mortality rate anomalies.

Methods

Under objective (1) we propose to use principal component analysis (PCA) to examine the spatial-temporal relationships associated with covariations in temperature (T), dissolved oxygen (DO), and salinity (S) in the Sound. Available data sets include NYSDEC data for stations E09 and E10 in the western Sound, and CTDEP monitoring and hydrographic data collected throughout the Sound.

For objective (2), we propose to describe the mechanisms by which anomalies in local meteorological forcing produce observed anomalies in water column structure. Specifically we propose to use a simple mixed layer model to describe the response to anomalies in surface heat flux and surface wind stress.

To achieve objectives (3) we propose to use a response model such as that developed by McLeese (1956) for percent mortality in response to variations to T, DO and S. We propose to use this model to evaluate the potential mortality associated with PCA modes defined under objective (1). We propose to evaluate the response for an individual mode during periods when that mode dominates, and for combined modes during those periods when both must be considered. We propose finally to develop statistical relationships between PCA time series and lobster abundance and catch per unit effort time series available from historical CTDEP trawl and catch data to address objective (4).

Conclusions

Preliminary results have been obtained for PCA analysis applied to longer term records for T, DO and S at axial CTDEP that extend back to 1994. The first mode represents covarying fluctuations whereby T and S are anomalously low (high) when DO is anomalously high (low). Moreover, this mode shows very little spatial variability in the along-axis direction, and thus appears to depict covarying basin-wide fluctuations in T, S, and DO. The second mode exhibits more spatial homogeneity depicts variability whereby T is anomalously high (low) when S and DO are anomalously high (low). Mode 3 shows increased spatial structure.

Corresponding to the above spatial patterns of variability are the PCA time series for each mode. During most of the 1994-2000 period, for example, the variations in mode 1 tend to cancel mode 2, except during two periods when they tend to reinforce each other. The first is during early 1996 when the values of mode 1 and mode 2 would indicate conditions particularly favorable for lobsters [i.e. anomalously low T (~2^o) and elevated DO (~2mg/L)]. The second is during early 1998 when the values of these two modes would indicate conditions particularly unfavorable for lobsters [i.e. anomalously elevated T (~2^o) and low DO (~2mg/L)]. Mode 3 is characterized by relatively short-lived (~2 months) events. Two of these events are evident during the period 1994-2000, the strongest of which occurred during 1999.

Preliminary results have also been obtained for PCA analysis applied to longer term records for T, DO and S at CTDEP axial stations F3,I3 and M3 extending back to 1991. The spatial structure for each of the first 3 modes exhibits a very similar structure to that described above for the 6 stations for the period 1994-2000. Also, the amplitude time series obtained for these longer records are consistent with the time series from the shorter analyses during the period of overlap. This would indicate that both PCA results are robust. Examination of these longer series shows one additional period, early

1994, when mode 1 and mode 2 acted in concert to produce particularly favorable conditions. There were no periods before 1994 where the two modes tended to act in concert to produce unfavorable conditions in the manner they appeared to in early 1998. Interestingly, the extension of mode 3 back to 1991 shows that there were no other "peak" events associated with this mode in the first five years of the decade, such as those that occurred in the late 1990's. This preliminary analysis shows that the late 1990's may have been unique within the last decade with regard to the environmental conditions affecting lobsters.

Both 1998 and 1999 were characterized by an early fall overturn. Figure 1 provides a comparison of observed surface and bottom temperatures at CTDEP station D3 during 1999 with climatology for the decade. The early overturn lead to high bottom temperatures that persisted through the fall molt period. Both 1998 and 1999 also exhibited high SST beginning in the previous winter.

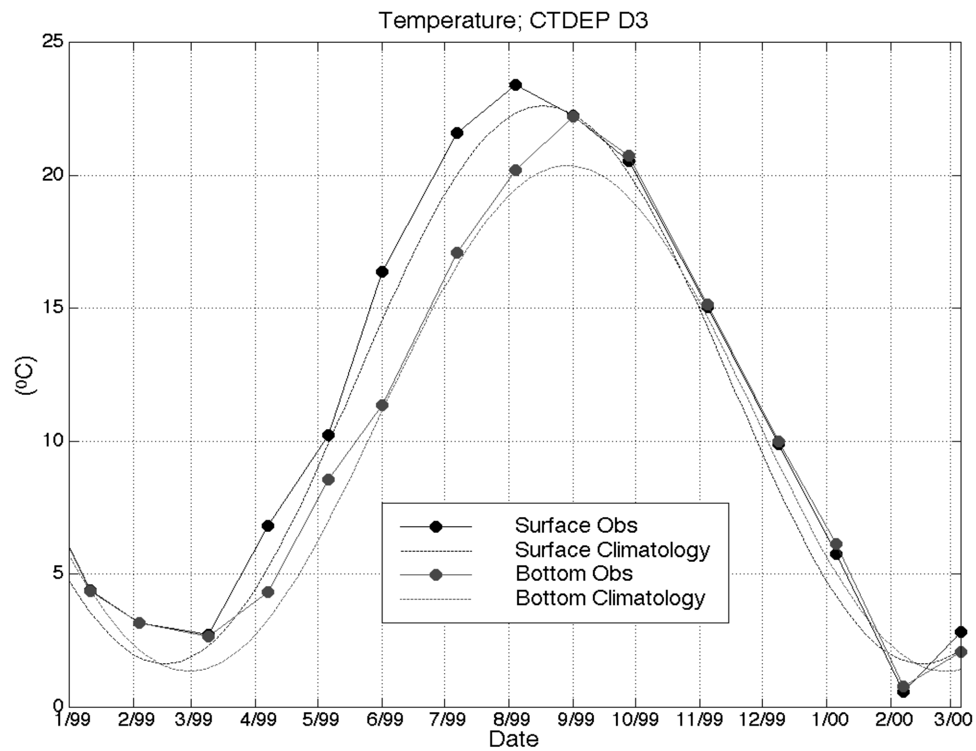

Figure 1. Observed surface and bottom temperatures at Station D3

Analyses of available meteorological observations show that the high winter SST was associated with high sensible heat flux. Secondly, analyses indicate that the early overturn during 1999 was associated with anomalous wind stirring and associated high latent heat loss before the end of August. It appears especially significant that the early overturn occurred before SST had begun to drop. Generally, it appears that anomalous meterorological conditions contributed directly to large bottom temperature anomalies in late summer and fall 1999.

Reference

McLeese, D. W. 1956. Effects of temperature, salinity and oxygen on the survival of the American lobster. *J. Fish. Res. Bd. Canada* 13 (2): 247-272.

Human impacts of a natural resource disaster: The 1999 lobster die-off in western Long Island Sound

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Key Words: social, economic, capital, post-disaster, die-off

In 1999, the die-off of lobsters in western Long Island Sound resulted in significant dislocations of the human ecosystem, particularly in the lobster fishery. Lobster fishers were often engaged in a singular economic activity characterized by little occupational or capital diversification, making them highly vulnerable to disruptions of lobster stocks. The sudden and unexpected collapse of the lobster stocks amounted to a natural resource disaster for lobster fishers and their families. Because of the high degree of specialization in the industry, the adaptive flexibility of the production sector of fishers and their linked capital networks was low. This resulted in significant social, economic, and psychological impacts to the lobster fishing populations. This paper documents these disruptions, and suggests strategies to modify the culture of response to such natural resource disasters to improve adaptive flexibility in the human ecosystem and expedite social, psychological ,and economic post-disaster aid in response to future natural resource disasters in the Long Island Sound Natural Resource Region.

This study was funded by the Economic Development Administration, U.S. Department of Commerce.

Fishery dependant monitoring of the American lobster (*Homarus americanus*) in Long Island Sound

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Key Words: lobster, monitoring, fishery, Long Island Sound

Introduction
Staff of New York State Department of Environmental Conservation (NYSDEC) and Connecticut Department of Environmental Protection (CTDEP) conducts routine monitoring on many of their shared marine resources of Long Island Sound. Although the focus and intensity of the lobster monitoring in Long Island Sound (LIS) changes periodically, both states have a consistent commitment to collect fishery dependant information from licensed lobstermen. This information is a critical component to assess the status of LIS lobster fishery and the lobster population.

Methods
New York State has maintained catch records from licensed commercial lobstermen since 1977 through an annual recall survey that is completed as part of the lobster license renewal application. The State of Connecticut has maintained a comprehensive logbook system for all of their commercial lobstermen since 1979. Unlike the annual recall data, the Connecticut logbook data contains detailed information that can highlight subtle changes in catch and effort commercial fishery characteristics.

In addition to harvest data, both NYSDEC and CTDEP have conducted various levels of commercial sea-sampling since the mid 1970s. This sampling is conducted aboard vessels of cooperating commercial lobstermen. Typically one or two observers are sent aboard a vessel to record biological information such as size, sex, and condition of the entire catch. Since 1999, New York has increased the frequency of sea-sampling trips to gather information concerning the general health of lobsters in Long Island Sound. In June of 2000, the agencies conducting lobster monitoring projects in southern New England developed a uniform criteria for assessing the prevalence and severity of Shell Disease Syndrome as part of the routine sampling. Temporal and areal peaks in the mortality of lobsters were identified through conversations with lobstermen and by monitoring the number of dead lobsters caught in traps.

Results
Commercial fishermen harvest over 99% of all the lobsters taken from Long Island Sound. In New York virtually all harvests are from traps. Lobsters are heavily exploited throughout much of their range, including LIS. Recently over 95% of harvested lobsters measured by NYS DEC observers were in the first molt group above the legal size limit. Thus lobster landings are directly dependant on the number of lobsters growing to legal size each season. Since lobsters tend to molt in mass during summer and again in late fall, the fishery tends to have two peak harvest periods referred to as the summer and fall runs. The downturn in lobster harvest since 1999 has resulted in the largest decrease in the number of traps reported to NYS DEC since data collection began in 1977.

Lobster harvest in New York was relatively stable through the late 70’s and early 80’s. Beginning in the late 1980’s and continuing through to 1997, there was a tremendous increase in the commercial lobster landings. The highest landings on record occurred in 1997 when CT and NY residents harvested approximately 11 million pounds of lobster from LIS. In New York, there was a decrease from 1997 to 1998 of almost 1 million pounds, mostly from LIS. The 1999 lobster landings showed a 15.7 % decrease from the 1998 landings, mostly from the western Sound. Analyses of the CT DEP logbooks indicate that virtually all of this decrease came after the summer run was over. Total NYS landings then fell by over 3.5 million lbs (55%) in 2000 compared to 1999. This drop is presumed to be the result of a decrease in lobster abundance after the mortality event that occurred late 1999. Figure 1 shows New York State's lobster landings by area over the past three years. The lobster harvest in the western Sound showed the most dramatic decrease while the eastern Sound harvest was cut by over 41%.

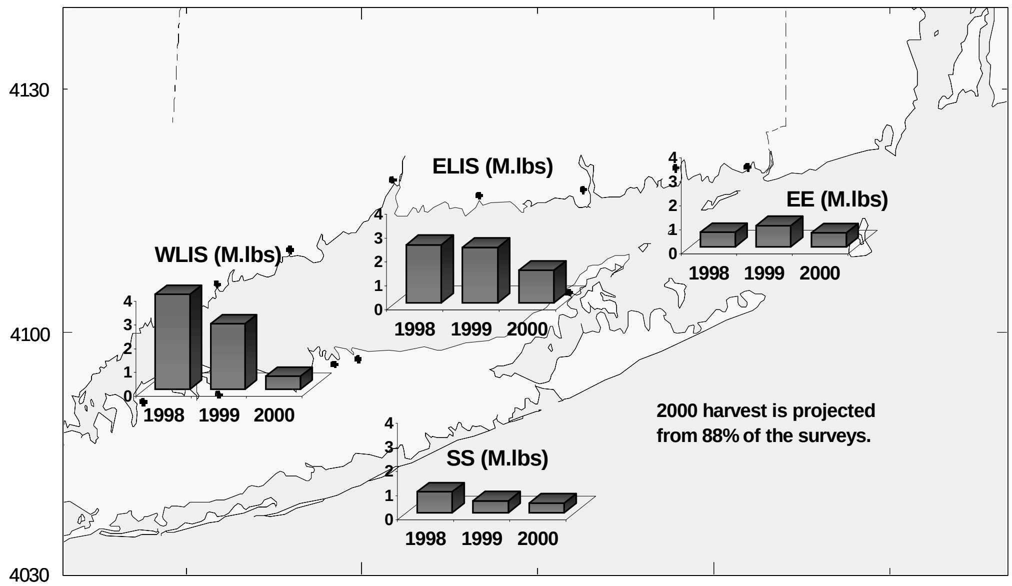

Figure 1: NY resident commercial lobster harvest (millions of lbs) by area from 98-00

The lobster sea-sampling program in New York State has recorded biological information from approximately 20,000 lobsters per year since 1999. The Connecticut Department of Environmental Protection conducts similar sampling for about 10,000 lobsters per year. Most of these lobsters are caught in the waters of Long Island Sound. Recently the number of dead and weak lobsters has been of particular interest because observations of where and when dead lobsters are found could be useful in identifying the cause of the mortalities. Figure 2 shows the percentage of dead lobsters caught in western Long Island Sound as recorded by NYSDEC observers.

Traditionally the percentage of lobsters found dead in commercial lobster traps in LIS has been less than 0.5 %, although higher percentages are sometimes observed. The higher percentages are sometimes observed when traps have been set for long periods without being hauled, which has become common practice when catches are slow. Fishermen have indicated that it is not uncommon to find more dead lobsters in their traps during the lull between the summer and fall runs. Although sampling coverage was lower in 1998, the sole trip in WLIS in November indicated a percentage of dead lobsters above the usual expected background level. That trip was made in response to reports that western Sound lobsters had been showing up dead during October of that year. Mortalities resumed to usual levels until the late summer and fall of 1999 when they increased. Although mortalities were reported throughout the Sound, the highest concentrations were in the western-most Sound. The percent of dead lobsters in traps decreased again in the spring of 2000 and generally remained less than 1% of the catch through the summer of 2001. Although no increase in mortalities was observed in the fall of 2000, there was an increase in mortalities in the fall of 2001. Several lobstermen reported an increase in the number of dead lobsters observed in traps beginning in September 2001. However sampling trips were difficult to schedule and the two trips made in October had soak times longer than two weeks making comparisons with shorter soak times difficult.

The proportion of weak lobsters was also recorded. However, the subjectivity of the criteria for differentiating weak lobsters has been problematic. The proportion and severity of shell disease syndrome in lobsters sampled by NYS DEC and CT DEP are included in the presentation titled *Status of Lobster Shell Disease in Southern New England* presented by Don Landers at this symposium.

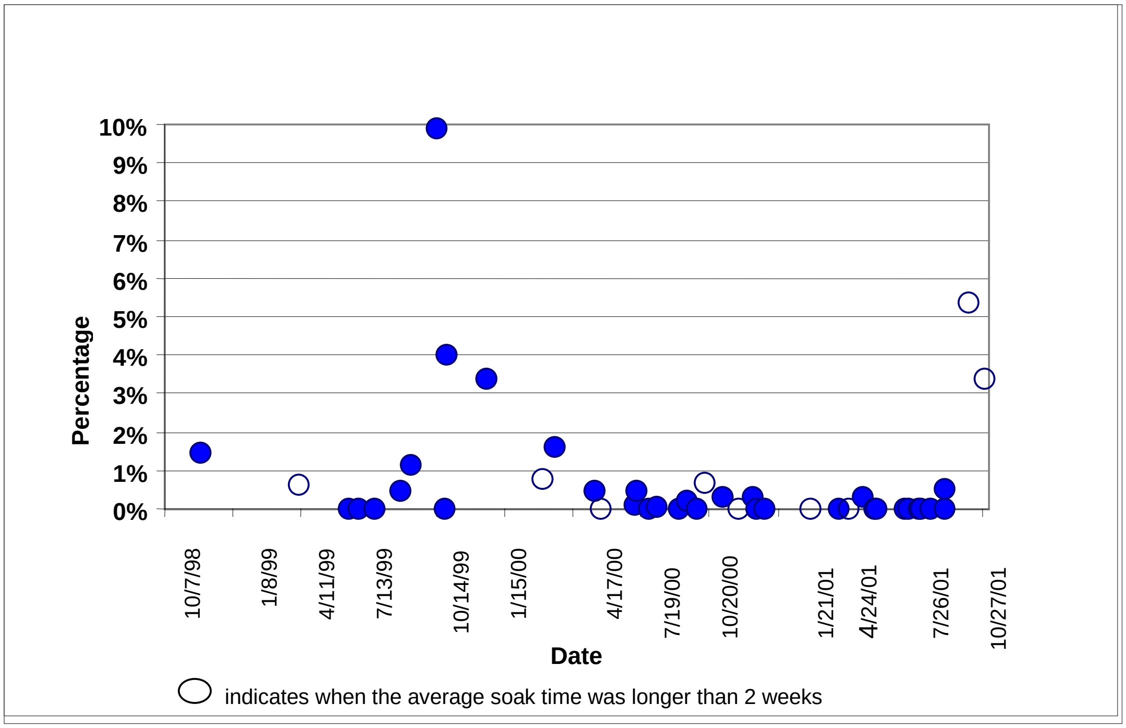

Figure 2: Percentage of lobsters that were caught dead in traps on sampling trips in WLIS 1998-2001

Conclusions

It appears from the harvest and catch/effort data that the number of lobsters in Long Island Sound, particularly the western Sound, has been reduced significantly since the lobster die-off in 1999. This is confirmed with fishery independent data collected by CT DEP (Gottschall *et al.* 2000[a], 2000[b] and presented by Dave Simpson at this symposium). The sea sampling data suggests that the lobster mortalities have appeared periodically in late summer and fall. However, the severity of the events varies from year to year with 1999 being the most severe on record in terms of number of animals affected. The abundance of lobsters in LIS prior to 1999 was the highest on record, which may have contributed to the magnitude of the mortality event.

The LIS lobster fishery was over capitalized at the time of the mortality event in 1999. Although the number of traps in the water was at the highest level on record, the number of fishermen had been decreasing for several years, thus many of LIS lobstermen were heavily invested in the fishery. The overexploited status of other fisheries, in combination with a prohibitive regulatory structure, made it impossible or impractical for lobstermen to easily switch target species when the availability of lobsters decreased. The LIS fishery comprises a small portion of the North American harvest, thus the price of lobsters has remained fairly stable despite the decreased availability from LIS. Therefore, lobstermen's revenues dropped proportionally to the reduced catch. This has resulted in divestment in the fishery by many participants rather then a scrambling to catch the last lobster.

Despite the drop in effort, exploitation rates remain high and the fishery still relies on the availability of new recruits each season. Timely analyses of fishery dependant and fishery independent monitoring of LIS lobsters is critical to identify changes in the abundance and mortality rates of lobsters that could lead to further stock depletion.

References

Gottschall, K., C. Giannini, D. Simpson, V. Crecco. 2000[a]. Connecticut Lobster (*Homarus americanus*) Population Studies. Completion Report for Project Period 4/1/97 – 3/31/00. IJF Act (PL 99-659) CT Project 3-IJ-130. Award Number NA76FIO167

Gottschall, K., C. Giannini, D. 2000[b]. Connecticut Lobster (*Homarus americanus*) Semi Annual Report. Semi-Annual report for Project Period 4/1/00-9/30/00. IJF Act (PL 99-659) CT Project 3-IJ-168. Award Number NA06FI0208

Update on lobster abundance and distribution from the Long Island Sound Trawl Survey

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Key Words: trawl survey, abundance indices

Introduction

The Long Island Sound Trawl Survey was initiated in 1984. The primary objective of the survey was to support state level fishery management by providing trends in abundance of marine finfish species and collecting information on size and age composition of five finfish species important to marine recreational anglers (bluefish, scup, summer flounder, winter flounder, and tautog). Recognizing the importance of the commercial fishery for American lobster, abundance, size composition and detailed biological data were also collected for this species. The survey was initially designed to be conducted at 40 sites monthly (35 in 1984) from April through November covering the area between Groton and Greenwich, CT in New York and Connecticut. However, little sampling was done in waters west of Norwalk due to the density of lobster gear and the frequent practice of setting gear "blind" i.e. without surface marker buoys, due to heavy tug and barge traffic in the area known as the Narrows.

In 1986, concerns about hypoxia prompted a renewed effort to survey the Narrows where low oxygen problem was often most severe. Four fixed stations were eventually added north of Hempstead Harbor, NY where monthly sampling using standard Long Island Sound Trawl Survey (LISTS) sampling protocol continued through 1990. These four years of data provide a limited historical context for sampling in the Narrows during 2000 and 2001.

In 1991, LISTS was modified to a spring/fall survey and the additional LISTS sampling in the Narrows was discontinued. Suspending sampling in the summer freed the research vessel to conduct a three-year study specifically designed to evaluate the impacts of low oxygen on finfish, squid and large crustaceans including lobsters, in the western two-thirds of LIS from Hempstead Harbor to Mattituck, NY. The study design included the use of a smaller mesh net, and decreased tow duration (15 vs. 30 min) and speed (2.5 kts *vs* 3.5 kts). This approach was effective in retaining smaller fish, crabs and lobsters and improved access to the more congested areas of the Sound. Overall catch rates were sufficiently different to preclude direct comparison with LISTS time series.

Supplemental LISTS sampling resumed in the Narrows in 2000 following the massive lobster die-off that occurred in the fall of 1999. Ten sites were sampled in May and June of 2000 (two in April), and by the fall, six fixed sites distributed in pairs were established along an east-west gradient off Darien, Greenwich and Hempstead Harbor. Monthly sampling at these sites continued in 2001 during the spring (April-June) and fall (Sept-Oct) trawl survey.

Although Long Island Sound Trawl Survey's initial objectives were largely limited to trends in abundance of migratory recreational finfish species on a Sound-wide basis, issues such as the lobster die-off have demanded that these survey data be examined on a finer scale. In this report we present traditional Sound-wide trends in lobster abundance, but we also present initial results of abundance indices developed for three areas within the Sound.

Methods

Long Island Sound Trawl Survey employs a stratified-random sampling design with samples taken at 40 stations each month during spring (April-June) and fall (Sept-Oct). Sampling is stratified across three sediment types (mud, sand and transitional) and four depth intervals in 9.1 m intervals from

<9.1 m to >27.4 m. At each site, the catch is sorted by species and weighed (since 1992); finfish, lobsters and other large invertebrates are counted and lengths recorded for selected species. Lobsters taken in each tow are measured (mm), and detailed biological data recorded (sex, egg status, shell condition, damage). Temperature and salinity are recorded at each site and a 14 m bottom trawl is towed for 30 min at 3.5 kts from the 15.2 m on Research Vessel *John Dempsey*.

In 2000 and 2001, survey coverage was expanded to the Narrows between Norwalk, CT and Hempstead Harbor, NY to examine the impacts of the massive die-off that reportedly began in Fall, 1998, but intensified in Fall of 1999. Previous sampling using standard trawl survey protocol was conducted in this area from 1986-1990, providing some basis for comparing present conditions to those observed 10-15 years ago.

Sound-wide abundance trends and size composition were developed using all standard spring trawl survey sites. Basin (Central, Western Basin, Narrows) specific indices were developed excluding sand strata. Recent (2000, 2001) tows in the Narrows south of Darien were also excluded from the area sampled from 1986-1990 for consistency. Indices for individual basins were normalized for variations in catch rates associated with depth/sediment type strata using least square means from a general linear model procedure in SAS.

A fishery dependent abundance index (catch per trap haul) was also developed for comparison with survey abundance trends by basin (Central, Western/Narrows) using CTDEP logbook data. Catch per trap haul was calculated from trips with soak times up to 14 days and normalized for set over days, and logbook area fished (NY or CT waters of each basin), using the procedure described above.

Results & Conclusions

The spring trawl survey index of lobster abundance (n=120 sites) declined for the third consecutive year in 2001. The 2001 index (7.56 lobsters/tow) fell 31% from the 2000 index of 11.0 lobsters/tow. This index varied between 6.7 and 8.3 lobster/tow in most years from 1991 to 1997 (the index fell briefly in 1994 to 4.1 lobsters/tow) before peaking abruptly in 1998 at 18.52 lobsters/tow. Although the 2001 index has fallen almost 60% since 1998, the index remains above the 18 year time series median (6.9 lobster/tow), ranking 8th overall and is at a level comparable to that observed in 1997 (7.7 lobsters/tow).

Lobster size composition reflects both selectivity of the trawl and the effects of the fishery after lobsters reach harvest size. Abundance gradually increases with size peaking between 60 and 75 mm for both sexes, then declines precipitously at about 82 mm (harvest size). Cohorts, or year classes, are not readily distinguished as it appears growth rates vary widely causing a smearing of the age structure across a wide range in length. Nevertheless, fewer lobsters under 50 mm were present in 2001 than during the 1999 or 2000 spring surveys.

LISTS spring indices (1984-2001) developed for the Central and Western Basins were significantly correlated with catch-per-trap-haul (CPTH) from the commercial fishery during July-August of the same year (Central Basin: P=0.019, r^2=0.26 Western Basin: P=0.029, r^2=0.22). Survey indices in the Central Basin which consist primarily of pre-recruit sizes were below 10 lobsters/tow (geometric mean) from 1984 to 1997, peaked at 28.5 lobsters/tow in 1998 and have since fallen into the range of 12 to 13.6 lobsters/tow in 1999-2001. CPTH, which reflects abundance of harvest size lobsters, varied between 0.6 and 0.86 pounds per trap haul from 1984 to 1994, rising over 0.9 pounds in 1995 and 1996. CPTH rose above 1 pound from 1997 through 1999 before falling to 0.83 pounds in 2000, then to 0.71 pounds in 2001.

In the Western Basin, LISTS spring indices rose above 40 lobsters/tow for the first time in 1995, increased to about 80 lobsters/tow in 1996 and peaked in 1997 at 125 lobsters/tow. Catch per tow remained at or above 100 in 1998 and 1999 before falling to 57 lobsters/tow in 2000 and 27 lobsters/tow in 2001, the lowest level since 1990. Commercial CPTH in the Western Basin rose from about 0.6 pounds in 1984-1985 to 0.98 pounds in 1991. CPTH declined slightly from 1992-1994 (0.8 to 0.65 pounds) then rose above 1 pound per trap haul from 1995 to 1998. CPTH fell to 0.76 pounds in 1999, then dropped to a low level of 0.43 pounds in 2000, declining further in 2001 to 0.36 pounds.

LISTS survey indices for the Central Basin indicate lobster abundance (principally below harvest size) has fallen from its peak in 1998, but remains well above the 18 year time series average. Catch per trap haul in the commercial fishery has fallen from high levels observed between 1995 and 1999 to slightly below average levels comparable to the 1984-1986 period.

LISTS survey indices for the Western Basin in 2001 were within the range observed between 1984 and 1994, and well below the high levels observed in the late 1990's. CPTH in the commercial fishery in the Western Basin is currently at record low levels.

Comparison of 2000 and 2001 trawl surveys in the Narrows with historical data for that area is more tenuous due to lower sample sizes and discontinues in the time series. However, the abundance index developed for this comparison in 2001 is the lowest observed at 0.7 lobsters/tow.

Coordinating lobster research in Long Island Sound

Emory D. Anderson
National Sea Grant Office

The purpose of this presentation is to review the events of the past two years beginning with the massive mortality of lobsters in western Long Island Sound in autumn 1999, the subsequent response by state and Federal researchers, agencies, and politicians to address this crisis, and culminating in this Second Annual Long Island Sound Lobster Health Symposium.

Lobsters in western Long Island Sound suffered a sudden, massive die-off during the autumn and winter of 1999/2000 ranging from 10% to almost 100%, depending on the specific area. Mortality, although less severe, also occurred elsewhere in the Sound. An estimated 11 million lobsters died, causing serious financial repercussions to more than 1,300 lobster fishers and dealers in Connecticut and New York and crippling a commercial fishery whose landings in 1998 were valued at over $42 million. In addition, the increased prevalence of lobster shell disease throughout the eastern portions of the Sound, which adversely impacted marketability, contributed further to significant financial losses to the two-state lobster fishery.

In October 1999 and again in January 2000, the New York State Department of Environmental Conservation (NYSDEC) and the Connecticut Department of Environmental Protection (CTDEP) conducted a mail survey to collect observations from lobster fishers on events surrounding the mass mortality and increased incidence of shell disease. This information was later used to help develop a strategic research and monitoring program. In November 1999, Dr. Richard French at the University of Connecticut Department of Pathobiology, with funding support from the Connecticut Sea Grant Program, identified a microscopic parasite, *Paramoeba spp.* in dead and dying lobsters, but was unable to conclude that the parasite caused the deaths of the lobsters.

An *ad hoc* Planning Committee consisting of representatives from NYSDEC, CTDEP, National Marine Fisheries Service (NMFS), US Environmental Protection Agency (EPA), Connecticut Sea Grant (CTSG), New York Sea Grant (NYSG), University of Connecticut, and State University of New York (SUNY) was organized in January 2000 to begin to develop a strategic plan of action to respond to the mass mortality event and the shell disease problem in Long Island Sound, and to plan a Long Island Sound Lobster Health Symposium.

On January 26, 2000, in response to requests submitted by both states, Secretary of Commerce William Daley declared the Long Island Sound lobster fishery a marine resource disaster under the Magnuson-Stevens Act.

More than 250 researchers, resource managers, and lobsters fishers met April 17-18, 2000 in Stamford, CT at the First Annual Long Island Sound Lobster Health Symposium. Presentations were given on the current knowledge of the lobster die-off and disease problems. Five working groups focusing on socioeconomics, pathology, oceanographic/environmental processes, anthropogenic inputs, and resource assessment met to develop the framework for a research plan of action to address the significant health issues affecting Long Island Sound’s lobster resource. The groups identified key problems, developed goals and objectives, and listed priority tasks to be addressed.

On May 25, 2000, a follow-up meeting was convened by NYSG, NYSDEC, and the SUNY Marine Sciences Research Center in Stony Brook to review the results of the Stamford Symposium for fishers who had been unable to attend.

The *ad hoc* Planning Committee met in June and July 2000 to develop work plans to address the research priorities identified at the Stamford Symposium.

In July 2000, Congress approved an emergency appropriation of $13.9 million for economic assistance for Long Island Sound fishers affected by the mass mortality and for research funds to investigate the cause(s) of the mortality. Of this amount, $7.3 million was authorized for financial assistance to fishers and $6.6 million was authorized for NOAA (to be administered by NMFS) for research.

The *ad hoc* Planning Committee prepared and submitted a spending plan for the $6.6 million in lobster research funds by the end of July 2000. Following review by NMFS, NOAA, and the Department of Commerce, it was finally approved by the Office of Management and Budget and Congress in early November 2000. The spending plan specified that $2.6 million would go to CTDEP and NYSDEC for resource assessment and monitoring, $2.5 million would go to the National Sea Grant Office (for subsequent awarding to CTSG and NYSG) for research, with an additional $0.33 million for communication and outreach, and $1.17 million would go to NMFS for research and administration.

Additional funds made available to assist in investigating the causes of the lobster mortality included $1 million from the State of Connecticut Bond Commission through the CTDEP Long Island Sound Research Fund, appropriations in the State of New York's budget to support development and initial operation of a Marine Disease and Pathology Consortium to be located at SUNY Stony Brook, a $250,000 appropriation in FY 2001 to ASMFC, a $125,000 EPA RARE grant, EPA Coastal 2000 grants of over $300,000 each to New York and Connecticut for chemical, physical, and biological monitoring in Long Island Sound during the summer and fall of 2000 and 2001, and about $100,000 to the University of Connecticut from the EPA Long Island Sound Study and CT Sea Grant to assess the health of lobsters.

On August 24, 2000, the *ad hoc* Planning Committee was formally established by the Atlantic States Marine Fisheries Commission (ASMFC) and its American Lobster Management Board and renamed the "ASMFC Steering Committee for Lobster Disease Research"(Lobster Steering Committee). The Steering Committee was charged with 1) providing oversight and accountability for the expenditure of funds appropriated for research into the causes of the Long Island Sound lobster fishery disaster; 2) monitoring research on lobster health, providing ASMFC Lobster Management Board with periodic reports on research results, and assessing the implications for the ASMFC American Lobster Management Program; and 3) recommending Board action/support for future lobster health research needs. The Steering Committee consists of representatives from the CTDEP, NYSDEC, CTSG, NYSG, NMFS Northeast Regional Office, NMFS Northeast Fisheries Science Center, National Sea Grant Office, EPA Long Island Sound Project Office, New York lobster industry, Connecticut lobster industry, and ASMFC.

A joint Request for Proposals (RFP) was issued by CTSG, NYSG, and CTDEP in late September 2000 announcing the availability of $3.5 million to support research projects of up to $150,000 per year for two years that seek to reveal the causes, consequences, and possible future predictors of the mass lobster mortality event of 1999, the abnormal molting patterns observed in the Long Island Sound lobster resource, and the extensive shell disease observed in lobsters. Research priorities were combined into three primary areas: pathology/toxicology, anthropogenic inputs/water quality, and environmental oceanographic conditions. Fifty preliminary proposals were received by late October 2000 and were reviewed and rated by the Steering Committee in early November 2000. Of this number, 30 were invited to be submitted as full proposals. A total of 27 full proposals were subsequently received by the December 22, 2000 deadline. Following peer review, the full proposals were evaluated and rated by an international scientific advisory committee in February 2001. Based on this evaluation, the Steering Committee then identified the projects to be funded.

A total of 15 projects were selected from the CTSG–NYSG–CTDEP competition. The $2.5 million allocated to the National Sea Grant Office for research was, in turn, awarded to CTSG and NYSG in late June 2001 to allow each of these programs to fund and administer six of these projects. The remaining three projects were funded and administered by the CTDEP. In addition to the 15 projects, NMFS Northeast Fisheries Science Center selected two projects for immediate funding at its Milford, CT and Sandy Hook, NJ laboratories, with one additional NMFS project to be selected and funded later. Of the 17 research projects currently being conducted over the next two years by teams of investigators in seven states, five pertain to immunology and endocrinology, four to shell disease and *Paramoeba*, four to pesticides, and four to the physical and chemical environment.

The $300,000 allocated to the National Sea Grant Office for communication and outreach, and subsequently awarded to CTSG and NYSG, is being used to communicate the results of the research projects to lobster fishers, resource managers, and the public. One important element of this effort is the series of Long Island Sound Lobster Health Symposia. The general planning and oversight for the present Symposium was provided by the Lobster Steering Committee, but all of the detailed work and arrangements was handled and coordinated by staff from the NYSG and CTSG Extension Programs.

The substantial lobster assessment and monitoring efforts being conducted by NYSDEC and CTDEP as part of the multi-agency initiative on lobsters were described and summarized during the previous session at this Symposium.

The overall research and communication program on Long Island Sound lobster resource summarized above is the product of a unique collaboration of various state and Federal agencies and the fishing industry. This partnership has been extremely successful and serves as an excellent model for future endeavors that call for the expertise and resources of multiple entities to be combined to address a problem of local, regional, or even national importance. Certainly within the Sea Grant community, and hopefully within the other partnering agencies as well, Long Island Sound Lobster Initiative should be viewed as a Best Management Practice and represents the preferred way of doing business with other agencies and organizations that share overlapping responsibilities and mandates.

Connecticut Department of Environmental Protection Lobster Tagging Study

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Keywords: American lobster, tagging

Introduction

The CT DEP Marine Fisheries Division initiated a three-year lobster tagging program in Long Island Sound in August, 2001. The tagging program is designed to complement newly expanded lobster research and monitoring programs in the Sound, as well as ongoing tagging programs in Rhode Island by RIDEM and in eastern Long Island Sound by Millstone Environmental Laboratory (Millstone Power Station, Waterford, CT). The goal of the tagging program is to clarify lobster movement and migration within Long Island Sound as well as between the Sound and adjacent waters. Tag return data will be used to determine the ability of the present lobster stock to repopulate areas hardest hit by the 1999 die-off, as well as determine a "re-population strategy" for areas affected by large-scale mortalities should they happen again. This information will also be used to analyze the effect of movement on the Sound's commercial lobster fishery and harvest rates. Finally, patterns in return data will be used to more clearly map progression of shell disease in terms of sex, size class, maturity, molt stage, season, and its relative impact on survival, growth and egg production.

Methods

A total of 5,000 lobsters will be tagged annually for two years using Floy T-tags inserted in the dorsal muscle under the carapace edge, right of center. Lobsters were captured for tagging in otter trawl catches made during CTDEP Long Island Sound Trawl Survey in spring (March-June) and fall (September-October), and from commercial fishing vessels during routine sea-sampling trips throughout the fishing season. Data on carapace length (CL), sex, egg color and complement, shell damage and shell disease are recorded for each tagged lobster. Soft and 'crack-back' lobsters will not be tagged to prevent injury and improve tag retention. All lobsters have been released within a few miles of their capture location.

The target sample size is 100-200 lobsters in each of three size groups (full recruits <82.6 mm CL, recruits 72 to <82.6 mm CL, and pre-recruit 60 to <72 mm CL), both sexes and egg-bearing females, and five north-south geographic zones (Figure 1). Recaptures received by November of 2003 will be incorporated in the analyses for the final project report.

To enhance returns, all license holders in CT and NY were mailed two notices describing the tagging study, including a postage-paid form to record recapture information. License holders were instructed to record tag number and related information before releasing the lobster with the tag in place to increase time at large. To collect size at recapture information, Connecticut resident commercial license holders were provided with an interval gauge and instructions on use. This gauge measures size in one-centimeter intervals between 5 and 14 cm.

A two-tiered tag recapture reward system is being used to enhance and evaluate recapture rates. The standard reward for most tags is $5.00. However, to enhance reporting rates, a subset of 99 tag returns selected at random each year will have a $100 reward and one with a reward of $1,000.

These tags will be identical in appearance to the $5.00 tag and will serve as an added incentive to report tags, as a single tag may have a value as high as $1,000. A second set of 100 tags with a reward of $100 has also been deployed. These tags are distinguishable by color and their higher value is printed on the tag. The ratio of return rates for these higher value tags and standard tags will be a measure of cooperation, or non-reporting, for the standard tags and will be used to adjust return rates for the standard tags. Pre-recruit lobsters will not be tagged with high value tags because they are below the selection size for the escape vents in commercial traps and would therefore be expected to have a lower recapture rate in the first year.

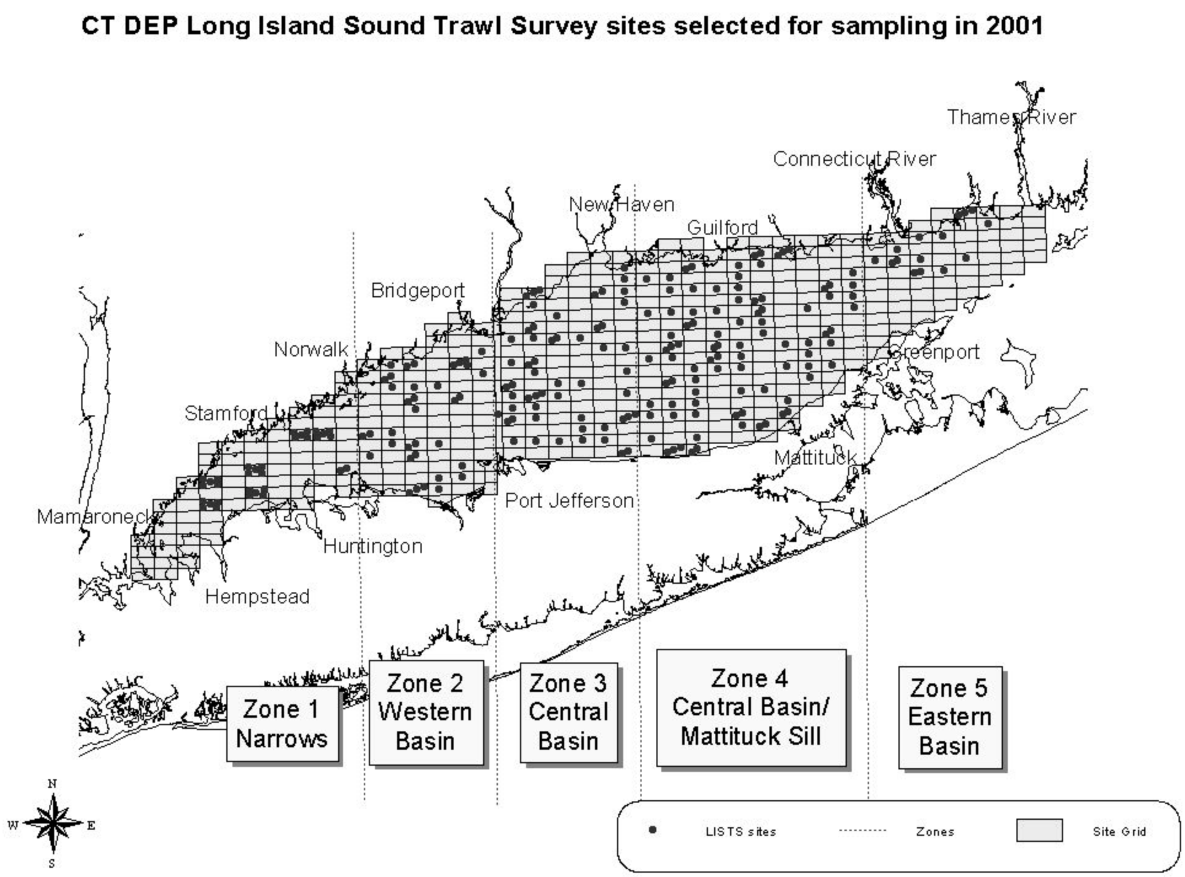

Figure 1: Five tagging zones with the CTDEP Long Island Sound Survey sampling grid and sampling sites chosen for 2001.

Results

As of October 10, 2001 approximately 3500 lobsters have been tagged and released in all five zones (Figure 2), with a fairly equal distribution in each zone. Two-thirds (2,376) have been tagged from commercial vessels, and the remainder from the CTDEP Trawl Survey. Cooperation from commercial and personal-use license holders has been good. Return data from more than 100 tags, including multiple returns, have been received.

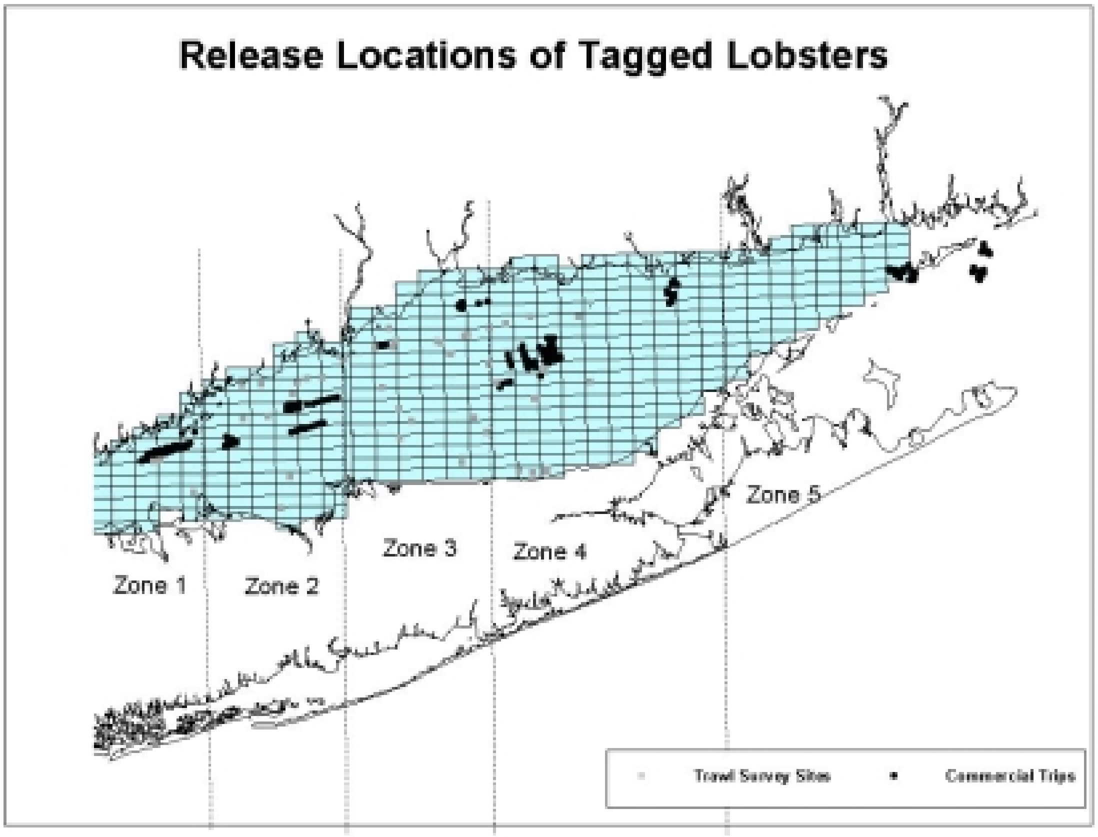

Figure 2: Release locations for tagged lobsters throughout Long Island Sound, August-October, 2001.

An evaluation of juvenile lobster (*Homarus americanus*) distributions in western Long Island Sound

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Key Words: Juvenile lobsters, monitoring, acoustic tracking

Introduction

We initiated a research and monitoring program for American lobsters (*Homarus americanus*) to determine abundance, distribution and habitat preference of juveniles and ovigerous females in western Long Island Sound[*]. These particular life history stages are important to the lobster fishery as they represent future recruitment potential of the stock, and are of even greater importance given the recent losses that resulted from the severe lobster mortalities in western LIS in 1999.

Presently, what is known about lobsters in western Long Island Sound (LIS) is mainly derived from observations of the commercial trap fishery and the Connecticut Department of Environmental Protection's Bottom Trawl Survey (e.g. Briggs and Mushacke 1979, Briggs 1992, CT DEP, 2000). However, neither of these surveys specifically targets juvenile lobsters (defined as < 45 mm carapace length). The goal of our initial experiments is to build on existing studies to achieve a greater understanding of juvenile lobster ecology in western Long Island Sound. It is hoped that the data collected will assist the lobster industry by providing guidance in predicting recruitment, identifying important recruitment sites, determining habitat preference, and provide an independent assessment of lobster recoveries in western LIS.

A fundamental problem with studying juvenile lobsters in the field is that they are difficult to capture, especially when they are in the pre-emergent developmental stages (< 15 mm carapace length, Lawton and Lavalli, 1995). We reviewed a suite of sampling options used to capture juvenile lobsters. SCUBA surveys such as those employed in more northern regions were judged to be of limited value when applied to the deeper (> 45 m) mud-bottom waters of the Sound where higher abundances of juveniles were expected. Bottom trawl surveys were also ruled out since they do not effectively sample lobsters < 40 mm in carapace length (CL), and can be difficult to use in heavily fished areas (e.g. CT DEP trawl surveys). Hence, we elected to test modified commercial traps. The initial focus of our pilot study this year was to determine the types of traps that will most reliably capture juvenile lobsters in western LIS. However, our sampling design is also arranged to collect adults since we intend to monitor the widest possible size distribution of lobsters in the surveys next year.

Methods

In September 2001, we deployed several different trap types on trap-strings (trawls). Traps varied in mesh size and entrance diameter, as well as overall size and shape. Each trawl (n= 6) consisted of 10 traps that included two standardized commercial traps lined with small mesh (0.64 cm mesh, 15.2 cm entrance), two reduced-size lobster traps (1.3 cm mesh, 6 cm entrance, no parlor), two eel traps (1.3 cm mesh, 6.2 cm entrance), two eel traps with reduced diameter entrances (1.3 cm mesh, 3.5 cm entrance), one standardized commercial style lobster trap with an open vent (3.2 cm mesh, 15.2 cm entrance), and one standardized commercial trap with a closed vent (3.2 cm mesh, 15.2 cm entrance). Traps were set approximately 15 m apart and baited with fish — typically Atlantic menhaden (*Brevoortia tyrannus*). The trawls were deployed at six different deep-water (> 140 m) stations between Lloyd Neck and Eatons Neck, Huntington, NY, and allowed to soak for one week. Recent reports by CT DEP bottom trawl survey and by local lobster fishers suggest that juveniles can be found in these selected deep-water areas. We chartered a local lobster fisher to deploy and retrieve the traps on a weekly basis. Upon retrieval we recorded numbers, carapace length (mm), sex, weight (g), eggs, color of eggs, and incidence of shell disease or other signs of poor health for lobsters in each trap. We intend to run this pilot survey through November 2001.

Results

While these investigations are still underway, preliminary examination of the data showed a significant difference in the average size captured in the traps (ANOVA: $p < 0.05$). In general, eel traps contained the greatest average abundance of lobsters < 45 mm CL (Avg.= 5 per trap), and consistently captured the smallest sizes of lobsters (Avg. CL= 39.7 mm, range= 19-65 mm). Although the eel traps consistently captured more juvenile lobsters than all other traps, the standardized commercial traps with small mesh caught the widest size range (i.e. = 13.5 – 85 mm) of lobsters and the smallest individual captured (CL= 13.5 mm). The commercial traps with closed vents also caught the greatest abundance of lobsters between the sizes of (60-85 mm) as well as a variety of other crustaceans such as spider (*Libinia emarginata*) and Jonah crabs (*Cancer borealis*). A general analysis of length, weight and sex composition of lobsters will be performed and discussed accordingly.

Conclusions

Overall, these initial gear calibrations suggest that it is necessary to employ several trap types in order to attain the widest possible variation in size when sampling lobsters in the deeper waters of western LIS. It appears that a trawl combining eel traps and standardized commercial traps with closed vents will catch higher numbers and a wider size range of lobsters than other configurations of the traps tested. This combination of traps also has the advantage of capturing large numbers of other common crustacea, and is easy to manipulate in the field. We will use such an arrangement of traps in our full experimental design next year where we will deploy our trawls in shallow and deep-water stations from May through December.

We intend to use the data in conjunction with other research and monitoring efforts to provide a more comprehensive assessment of changes in abundance and spatial distribution for all size classes of lobster in western Long Island Sound. We are also interested in developing a juvenile recruitment index for LIS lobsters. Our data will also be of value for elucidating habitat and locations that may be significant with respect to juvenile recruitment (e.g. mud vs. cobble habitat) and therefore, lead to improved protection from dredging, or other human activities that could adversely affect lobsters or their habitats.

We would also like to note that the overall project has benefited from the expertise of a local lobster fisher whose services we have contracted with respect to lobster fishing, gear construction and a working knowledge of the sampling area. We plan to expand our survey a to include additional lobster fishers who are interested in participating in these efforts. Finally, in addition to this study, we are also evaluating the potential to track individual lobsters with acoustic telemetry methods. We hope that these studies will allow us to track movement of individual egg-bearing females, evaluate their home range, and determine if there are preferred geographic areas where they aggregate to hatch their eggs in western LIS.

References

Briggs, P.T., Mushacke, F.M. (1979) The American Lobster in Western Long Island Sound. *N.Y. FishGame J*. 26: 59-86.

Briggs, P.T., (1992) Lobster Monitoring on Long Island Sound, 1991, An In-House Report, April 1992. New York State Department of Environmental Conservation.

Connecticut State Department of Environmental Protection (2000) Long Island Sound Lobster Survey Summary Report, Spring 2000.

Lawton, P., Lavalli, K.L. (1995) Postlarval, juvenile, adolescent, and adult ecology. In: “Biology of the lobster *Homarus americanus*” (J.R. Factor, ed.), pp. 47-88. Academic Press, New York.

Economic impacts of the 1999 lobster die-off: Dealer and Market Survey

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Key Words: lobster disaster, market, shell disease, retail, dealer

The 1999 die-off of lobsters in western Long Island Sound was a *natural resource disaster* that spawned *secondary disasters* in the human ecosystem associated with the Sound. One of these *secondary disasters* was disruption of the marketing of lobsters. When the disaster struck, supply of lobsters from the Sound declined dramatically, and public concern over the safety of lobsters rose as uncertainty to the cause of the die-off circulated. Uncertainty lead to changes in consumer confidence, while the interruption of supply of local lobsters forced dealers and retail/wholesale outlets to stop selling lobsters or bring them in from out-of-state, primarily Maine. Marketability of lobsters caught in eastern Long Island Sound is also of significance, because the lobsters are prone to a high incidence of Shell Disease Syndrome. Lobsters that suffer from this disease are often aesthetically unappealing. This paper describes initial perceptions of impacts to dealers and the lobster markets in the region, and outlines plans for a comprehensive survey to determine the nature of market response to the die-off and shifts in wholesale and retail marketing strategy as outcomes of this natural resource disaster.

There are no detailed reports that describe the marketing and distribution component of Long Island Sound lobster fishery prior to the 1999 die-off. However, anecdotal information implied dealers' reluctance to stock LIS lobsters during these periods owing to the high mortality rates that were observed in the holding tanks. There also were unsubstantiated claims of lobster fishers loosing access to formal distribution channels, since the dealers were forced to secure alternative sources for purchasing lobsters. Numerous inquiries were handled by New York State Health Department concerning the safety in consuming LIS lobsters during the mortality event.

Possible long-term impacts (if any) that may have arisen from these changes in the marketing and distribution channels should be evaluated. In order to achieve this objective, it is necessary to develop a base-line definition of these conditions prior to the 1999 die-off, and compare them to present time. Where there is evidence of adverse impacts, there should be a strategic approach to mitigate these effects.

Objectives

Sea Grant will liaise with industry groups involved in both the harvest and post-harvest stages of lobster production (lobster fishers, dealers, retailers, seafood council) in order to assess the perceived impacts of the 1999 die-offs and shell disease on LIS lobster marketability. The proposed research will be comprised of a dealer and market study that seeks to quantify the changes resulting from the 1999 lobster die-off with emphasis on the retail and distribution sector. It will also seek to document consumers' general perception regarding LIS lobster stocks, and recommend approaches to regain market conditions in future.

Methodology

<u>Scoping Meeting</u>

This will be arranged to bring together Sea Grant, industry representatives, resource managers, and researchers. It will also be the avenue to identify specific issues that are relevant to the named stakeholder groups, and constitute the basis for developing research procedures.

Study Design & Field Data Collection

Key respondents will be drawn from stakeholder groups including dealers, restaurateurs, wholesalers, and consumers, to administer survey instrument. Data collection will be comprised of mail, telephone and face-to-face interviews. A desk study also will be undertaken to supplement the information generated by the survey. For example relevant information will be drawn from research funded by the US Economic Development Administration on the impact of the lobster die- off on lobster fishers and their communities.

Expected Outputs

A detailed marketing report for LIS lobsters that will also result in peer-reviewed publications. The report also will contain recommendations to address constraining issues that resulted from the 1999 die-off and the persistence of shell disease in affected areas. This information will be used to develop educational programming and materials (e.g., brochures, posters).

RESEARCH SYNOPSES

PHYSICAL & CHEMICAL ENVIRONMENTAL PARAMETERS

Exposure of Lobsters to the Varied Chemical and Biological Environment of LIS

Andrew F. J. Draxler, NOAA Fisheries, Howard Laboratory, Sandy Hook, NJ
Ashok Deshpande, NOAA Fisheries, Howard Laboratory, Sandy Hook, NJ

Draxler and Deshpande will document lobster responses to the chemical and biological conditions of Long Island Sound in an attempt to uncover any direct relationship between lobster health and their environment. The experiment will examine the health of lobsters under ambient conditions in Long Island Sound during the time period when lobsters are believed to be most susceptible. Lobsters taken from outside the affected areas will be evaluated, and then placed in cages at six sites around western and central Long Island Sound. The sites will be chosen to span a variety of environmental conditions. Scientists will monitor the cages for four weeks, and routinely recover lobsters from each site to evaluate them for changes that may be the result of exposure to naturally occurring biogeochemicals (such as ammonia and sulfide) as well as contaminants. Lobster health will be assessed by bacterial determinations, and physiological condition.
Administrator: NOAA National Marine Fisheries Service

Environmental Change in LIS in the Recent Past

Johan Varekamp, Wesleyan University, CT, et al.

This project is building on an ongoing study, where the researchers will evaluate sediment core samples to develop a detailed time-line that summarize the environmental changes in Long Island Sound over the last decade. Evaluation of sediment will generate information on water temperatures, organisms within the food chain, Dissolved Oxygen, pollution and salinity. This study will help to ascertain whether the lobster die-off is more strongly linked to global climate change or local contamination with pollutants or nutrients.
Administrator: Connecticut Department of Environmental Protection

Relationship Between American Lobster Mortality in LIS and Prevailing Water Column Conditions

Robert E. Wilson, R. Lawrence Swanson and Duane E. Waliser, Marine Sciences Research Center, Stony Brook University, NY

Wilson, Swanson and Waliser will examine water quality factors such as temperature, salinity, dissolved oxygen, and pollutants with respect to the lobster mortalities. Lobsters are vulnerable to stress and sometimes die when exposed to unfavorable environmental conditions, especially during the molt cycle when they are most vulnerable. Environmental factors can act singularly or in combination to cause sublethal stress that increases sensitivity to events that would normally be tolerated. Significantly elevated bottom temperatures during the summer and fall of 1999 led the researchers to focus primarily on co-variations in temperature and dissolved oxygen.
Administrator: New York Sea Grant

Effects of Temperature and Body Size on Metabolic Stress in LIS Lobsters
Glenn Lopez and Robert M. Cerrato, Marine Sciences Research Center, Stony Brook University

Lopez and Cerrato will try to determine how high summer temperatures in Long Island Sound's bottom waters may have negative impacts on lobsters, and if larger lobsters are more susceptible to temperature stress than smaller ones. The results of their lab studies may be used to predict the effects of long-term changes in summer temperatures on the health of Long Island Sound lobster population. The study will shed light on normal patterns of lobster stress and mortality as well as the extraordinary mortality event of fall 1999.
Administrator: New York Sea Grant

PESTICIDES

Effects of Pesticides of Lobster Health: Trace Level Measurements and Toxicological Assessment at Environmentally Realistic Concentrations
Anne E. McElroy, Marine Sciences Research Center, Stony Brook University, NY.
Co-investigator: Bruce J. Brownawell, Marine Sciences Research Center, Stony Brook University, NY

McElroy and Brownawell will address the potential link between pesticide use and lobster mortality. They will measure mortality and immune response in larval and juvenile lobsters exposed to levels of pesticides (Malathion, Methoprene, and selected pyrethroids such as Anvil and Scourge) that are likely to occur in the environment. The team will also develop ways to measure levels of these pesticides and their breakdown products in seawater, sediment, and possibly lobster tissues. They are particularly interested in sampling water after storm events when concentrations may be highest. The results of this study should provide a strong indication whether or not pesticide use is likely to contribute to degraded lobster health in Long Island Sound. This study will also shed light on the effects of temperature on the immune response of young lobsters.
Administrator: New York Sea Grant

Determination of the toxicity and sublethal effects of selected pesticides on the American Lobster (*Homarus americanus*)
Sylvain De Guise, University of Connecticut, Storrs, CT. Co-investigators: Richard A. French, University of Connecticut, CT, and Christopher Perkins, Environmental Research Institute, UConn.

The research team will expose lobsters to Malathion, Resmethrin, and Methoprene, three pesticides used in the region to control mosquitoes after West Nile virus was found. The subtle effects of low levels of pesticide exposures on lobster immune system will be measured, in addition to high-level exposures, to determine toxicity.
Administrator: Connecticut Sea Grant

Acute Effects of Methoprene on Survival, Cuticular Morphogenesis and Shell Biosynthesis in the American Lobster, *Homarus americanus*
Michael N. Horst, Mercer University School of Medicine, Macon GA, et al.

This study will include participation from researchers at universities in four states. Horst has hypothesized that Methoprene could kill lobsters and cause biochemical changes in juvenile and adult lobsters. His team will study the effects a range of doses of the chemical have on nerve, skin, pancreatic cells, and shell formation.
Administrator: Connecticut Sea Grant

Hormonal Responses of Lobsters to Stresses of Western LIS
Hans Laufer, Department of Molecular & Cell Biology, University of Connecticut, Storrs, CT, et al.

This multi-disciplinary research team led by Laufer will assess the effects of long-term stresses (including heat, Methoprene, and infection) on the growth, maturation and reproduction processes of lobsters. Lobsters from Western Long Island Sound exposed to known stress factors, as well as those infected by the paramoeba will be compared to field collected lobsters. The hypothesis is that elevated temperature and pesticide levels can alter lobster endocrinology leading to adverse effects on growth, molting and ultimately, survival. This project will measure several endocrine levels in response to laboratory manipulation of temperature and pesticide levels.
Administrator: Connecticut Department of Environmental Protection

IMMUNOLOGY & ENDOCRINOLOGY SYSTEMS RESPONSE FAILURE

Development of an Assay for Phagocytic Activity in the Immune System of Lobsters
Jan Factor, Division of Natural Sciences, SUNY Purchase, NY
Factor will look at how lobsters defend themselves against infection and disease. He will seek to develop methods that will allow the assessment of cellular defenses against infection and disease after sublethal exposure to environmental stresses and toxic substances. Research may lead to an explanation of the recent mortalities by enabling assessment of impacts on the immune system that may lead to lethal infections. **Administrator: New York Sea Grant**

Immunological Health of Lobsters: Assays and Applications
Robert S. Anderson, Chesapeake Biological Laboratory, Center for Environmental Sciences, University of Maryland, MD.

Anderson will use biotechnology tools to measure the blood cell-related defense system of the lobster against disease. This research will lay the groundwork for discerning changes in immune response due to toxicity or other environmental stressors. **Administrator: New York Sea Grant**

Stress Indicators in Lobsters: Hormones and Heat Shock Proteins
Ernest S. Chang, Bodega Marine Laboratory, University of California, Davis, CA
Chang will investigate the relative impacts of stresses from environmental factors (such as temperature and salinity), biological factors (including bacteria and protozoa), and human-caused stresses (pesticides). Lobsters exposed to these stresses will be examined for changes in stress proteins and steroid molting hormones. **Administrator: Connecticut Sea Grant**

Development of assays for the evaluation of immune functions of the American Lobster (*Homarus americanus*) as a tool for health assessment
Sylvain DeGuise, Department of Pathobiology, University of Connecticut, Storrs, CT.
Co-investigators: Richard A. French and Salvatore Frasca, Jr. University of Connecticut, CT

The University of Connecticut Pathobiology team will develop new tools to use in evaluating how immune systems work in both sick and healthy lobsters. They will expose lobsters to various chemicals and other stressors and measure the response of the immune system in each case.
Administrator: Connecticut Sea Grant

Effects of Environmental Stressors on Disease Susceptibility in Lobsters: A Controlled Laboratory Story
Richard Robohm, NOAA Fisheries Laboratory, Milford, CT, and Andrew F.J. Draxler, NOAA Fisheries, Howard Laboratory, Sandy Hook, NJ

Robohm and Draxler will investigate the effects of environmental stressors on the susceptibility of lobsters to pathogens. The work will test whether depressed habitat quality may have compromised lobster immune systems and contributed to the die-off. The researchers will expose healthy lobsters to two bacterial pathogens in the presence of varying levels of environmentally relevant biogeochemicals such as sulfide and ammonia as well as environmental conditions such as low oxygen and increased temperatures. Changes in bacterial numbers and five lobster immune-system indices will be measured after the exposures. The method will also test how stressors affect growth of parasitic amoeba in lobsters, which will be useful observations for researchers who are able to successfully culture the amoeba.
Administrator: NOAA National Marine Fisheries Service

SHELL DISEASE & PARAMOEBA

Shell Disease

Bacterial Assemblages Involved in the Development and Progression of Shell Disease in the American Lobster, *Homarus americanus*

Andrei Chistoserdov, Marine Sciences Research Center, Stony Brook University, NY. University. Co-investigator: Roxanna Smolowitz, Marine Biological Laboratory, Woods Hole, MA.

By comparing shell disease in lobsters from Eastern Long Island Sound with those from Buzzards Bay, Massachusetts, Chistoserdov and Smolowitz will seek to identify the types of bacteria that cause lobster shell disease. The team will also design a set of specific probes that will be used to test for such pathogens.

Administrator: New York Sea Grant

Paramoeba

Phenotypic and Molecular Identification of Environmental Specimens of the Genus Paramoeba Associated with Lobster Mortality Events

Patrick M. Gillevet, George Mason University, Fairfax VA. Co-investigators: Charles J. O'Kelly, Bigelow Laboratory for Ocean Sciences, West Boothbay Harbor, ME; Thomas A. Nerad, American Type Culture Collection, Mannassas, VA; Thomas K. Sawyer, Rescon Associates, Inc. Turtle Cove. Royal Oak, MD

Gillevet will use a combination of methods to isolate and characterize the paramoeba that has been identified in Long Island Sound lobsters. Gillevet and O'Kelly hope to develop a sensitive "fingerprinting" tool that will detect this paramoeba in the environment.

Administrator: Connecticut Sea Grant

Oligonucleotide-based Detection of Pathogenic Paramoeba Species

Rebecca J. Gast, Woods Hole Oceanographic Institution, Woods Hole, MA

This research will seek to develop a method to facilitate the detection of paramoeba in animal tissues, water, and sediment samples. Using the new method, the researchers will sample Long Island Sound for one year to analyze the paramoeba's natural fluctuation and distribution.

Administrator: Connecticut Sea Grant

Development of polymerase chain reaction and *in situ* hybridization-based tests for the specific detection of the paramoeba associated with epizootic lobster mortality by determination of the molecular systematics of the genus *Paramoeba*

Salvatore Frasca, Jr., Dept. of Pathobiology, University of Connecticut, CT, Co-investigators: Richard French, University of Connecticut, CT; Sylvain De Guise, University of Connecticut, CT.

The purpose of this project is to produce and analyze gene sequences of a number of *Paramoeba* species and to develop a molecular diagnostic assay (a kind of "fingerprinting" technique) for the *Paramoeba*species that occurs in Long Island Sound lobsters.

Administrator: Connecticut Department of Environmental Protection

APPENDIX I

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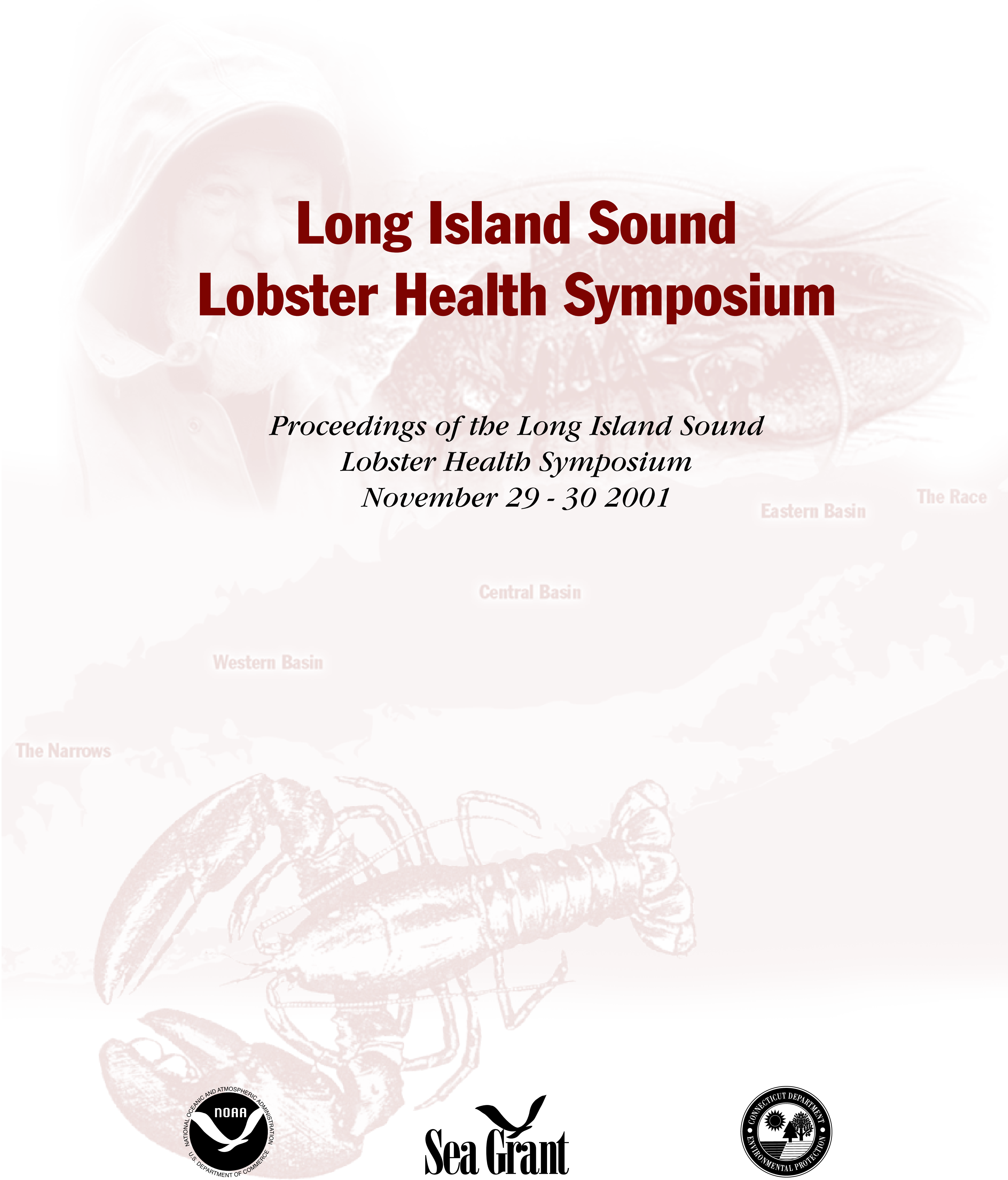

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