EXECUTIVE SUMMARY

In the fall of 1999, an unusual mortality event was observed in lobsters from Long Island Sound (LIS), resulting in a reduction of greater than 90% in landings in western LIS and 60-80% in central LIS. The Connecticut Department of Environmental Protection (CTDEP) annual spring and fall trawl survey data indicate declining lobster abundance indices from historic highs beginning in the fall of 1998 and continuing to the spring and fall of 1999. Lobster trawl surveys have continued to indicate declines in lobster populations with reported lowest index rank (fall 2002 standard Long Island Sound Trawl Survey (LISTS) of 6.31 lobsters per tow; fall 1983 LISTS of 19.6 lobsters per tow) (Semi-annual performance report, May 1, 2002 – October 31, 2002, CTDEP, U.S. DOC, NOAA, NMFS).

Common in the media are reports that there may be an association between the 1999 lobster die-off in he western LIS and the aerial application of the mosquito adulticide malathion or the use of methoprene in catch basins. However, timelines and historical data indicate that while the lobster die-off peaked in the fall of 1999, it began in 1998, the summer before pesticide spraying began. During the same time period, there were unexplained mortalities of blue crabs and spider crabs in the sound. Notably, a continuing loss of sea urchins ranging from Massachusetts to Nova Scotia had been documented since 1995 and a major lobster mortality was noted in Maine in 1997-98. In all, a number of potential factors and/or events had been implicated in the cause of lobster mortalities in LIS. These are: 1) pollution form dredging materials (PCB's, heavy metals, nitrates); 2) pesticide applications (West Nile virus mosquito control practices); 3) sewage treatment plant effluents; 4) agent released from Plum Island Animal Disease Center, USDA; 5) introduction of an agent (i.e., ship ballast, bait fish, new species invasion, intentional); 6) nutritional conditions (bait fish and stock cultivation); 7) lobster population density and associated natural disease; 8) anomalous regional climatic conditions (hurricane Floyd, 09/15/99; drought 1998-1999); 9) thermal stress; 10) low dissolved oxygen levels (and associated elevated hydrogen sulfide) and 11) a newly identified marine parasite.

The following report summaries data collected over and approximate 2-year period. The project involved a comprehensive review of the health of lobster in LIS, which includes the signalment and pathology, microbiology, parasitology, toxicology, immunology and hematology of random catch (trawl or trapped) lobsters in LIS. In brief:

- Paramoeba sp. continues to be found and is consistently associated with reported and observed morbidity and mortality.
- Paramoeba sp. has been found as far east as the Niantic area
- Paramoeba isolates have been partially characterized by molecular methods and electron microscopy (Publication submitted and revised 09/03).
- No consistent findings have been found with bacterial pathogens including Vibrio spp., and Aerococcus (Gaffkemia agent). This finding is significant as lobstermen consistently report red-tail (clinical Gaffkemia) but this is not the case. Gaffkemia, based on our results is uncommon in LIS.
- No viral pathogens have been identified
- No significant mycotic pathogens have been identified
- Shell disease is a continued and significant problem in the eastern LIS.
- Transmission electron microscopy of shell disease reveals characteristics of a pathogen other than bacteria. This finding is significant as shell disease is classically described and reported of bacterial etiology.
- Scanning electron microscopy of shell disease reveals classical chitinolytic bacterial cocci. Further studies are ongoing.
- Immunologic data indicates a significant difference is hemocyte counts and

phagocytic activity relative to inshore and offshore animals and specific zones. No association with contaminants, water temperature and/or seasons is indicated.

- Micronodular hemocytic aggregates and foci of melanization and/or mineralization are common histopathologic findings and involve primarily the antennal glands and gills. The cause is undetermined but similar lesions are associated with paramoebiasis and have been reported by others (New Lobster Mortality in Long Island Sound. Commercial Fisheries News, 33:12, December 2003). It should also be noted that this type of pathology is not uncommon in lower vertebrates and invertebrates and reflects the basic innate immune functions.
- Other known lobster disease pathogens (*Anophryoides haemophila*) have not been identified.
- Contaminants are identified and tabulated. No correlation can be drawn to other disease pathogens, histopathology or other parameters measured.`
- Primary contaminants identified are heavy metals and variable PCB's
- No pesticides, specifically the mosquito control agents (Resmethrin, Malathion, and Methoprene) are detected.

After an extensive monitoring program in Connecticut and New York waters of Long Island Sound, which involved the testing of lobster tissue for bacteria, parasites and toxins, investigators from the Department of Pathobiology at the University of Connecticut identified a parasite as a possible cause of the lobster mortalities. It was not and still has been yet to be determined if the parasite, a protozoan known as a *Paramoeba spp.*, is the primary cause of the mortalities or is the result of lobsters stressed from other factors. One of the more controversial theories regarding the mortality event was the role of pesticides used in the control of West Nile Virus (WNV) and their effect upon LIS lobsters. Starting in September 1999, New York used the adulticide Malathion, with Connecticut and New York both using the adulticide Resmethrin and larvicides (Methoprene- trade name Altosid) for the control of mosquito populations along the shores of Long Island Sound (Sea Grant, 2001).

Note, to determine correlation between the application of mosquito control agents, contaminant body burdens, and the health of the lobsters a parallel project involving the analysis of water and sediment collected by the investigators and lobsters and crabs, collected by CTDEP or their representatives, from five locations (harbors or embayments) within LIS was conducted (Final Project Report submitted to CT DEP, July 20, 2003. "Investigation of Mosquito Control Agents in Long Island Sound Water, Sediment and Lobsters and Their Effects on Lobster Health"). These studies were unable to detect the three target compounds, Resmethrin, Malathion, and Methoprene (RMM), in any of the water, sediment, or tissue samples analyzed for this study. Samples were collected as near to the source as possible to estimate worst-case scenarios, however, no compounds were detected. There were no known applications of Malathion at the locations during this study or the EPA-LISS study reported here.

There was a tendency towards a difference in the immune function of lobsters collected from inshore location when compared to offshore. In all cases for which lobsters were sampled inshore and offshore on the same day and location, hemocyte phagocytic index of lobsters at offshore were always higher than that of inshore lobsters. Also, mean phagocytosis was significantly higher in the control Niantic (Eastern LIS) lobsters than in those from pooled locations in Western LIS. Although there is no correlation with the pesticides analyzed, this could possibly reflect sub-acute to chronic effects of past pesticide exposure. There are many other factors that could explain this difference, including environmental variables such as water temperature and salinity and stress due to potentially higher lobster populations. Unfortunately there is minimal baseline immunological datasets for the American lobster, thus it is difficult to make assumptions regarding a "normal" immune function. Gross and histopathologic examination revealed no

differences between inshore and offshore lobsters or time of collection. There was no statistically significant East-West trend in the data for histopathology.

Because of the inability to detect RMM in any of the water, sediment, or tissue samples, it is impossible to draw conclusions regarding the immunological and histopathological results as they relate to the RMM pesticides. It must be noted that the lobsters and blue crabs collected in this study represented a random collection and sick/moribund animals were not specifically targeted. Personnel utilized a very rigorous method in the chemical analysis of the samples and the techniques utilized the best available technology. The method detection limits for this study were below published lethal concentration values for many aquatic organisms, which lends some credence to the theory that the pesticides used to control for the WNV outbreak were not causes of direct mortality.

As a final note, the animals represented in this study are a random collection. Sick/moribund and/or dead animals, or animals associated with identified mortality events were not specifically targeted. Therefore, the data does not necessarily reflect events, agents or factors specifically associated with morbidity and mortality events. The data reported here best reflects the general health status (background disease and contaminants) of the American lobster (*Homarus americanus)* in Long Island Sound.

To best manage unexpected events such as disease, mortalities and population declines in LIS lobster populations a continuous surveillance system needs to be in place as is with any other cultured or farmed species. This system should include routine sampling of lobsters and should include lobstermen whenever possible.

- All data and summaries are provided in appendices.
- All files can be provided in electronic format as requested.