New England Lobster Settlement Index: *Update 2004*

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This is the fourth annual update of the New England lobster settlement index, a monitoring program independently supported by Rhode Island, Massachusetts, Maine, and New Brunswick. Its aim is to evaluate the strength of lobster year classes when they first settle to the sea floor in near-shore nurseries where they spend their first few years of life. The data are being used to better understand the role of environmental factors that determine regional population trends, a potentially valuable tool in lobster stock assessment and forecasting. This year's update briefly summarizes the 2004 settlement index and features a promising development in our effort to use the index in forecasting.

Settlement in 2004 continued a string of generally strong settlement years across New England since 2001. The spatial pattern of high densities in New Brunswick and from mid-coast Maine to Salem, Massachusetts, and low densities in eastern Maine and Buzzards Bay are now familiar patterns (Fig. 2).

As with previous updates, we present an ongoing analysis with the time series to illustrate how the data are used. In this update we show how the settlement survey can be used together with nearshore trawl survey data collected at nearby stations to evaluate the predictive power of the settlement index, as well as to measure the impact of natural mortality, such as disease.

Earlier studies have demonstrated that annual differences in the abundance of newly settled young-of-year lobsters reliably foretell the number of 1-year-olds in the nurseries a year later (Wahle and Incze 1997, Wahle et al. 2003). Until now we have been uncertain whether it would be possible to forecast the number of lobsters entering the fishery anywhere from 5 to 9 years later depending on the region. It comes as no surprise that our first evidence of that link comes from southern New England where lobsters grow relatively quickly.

Mark Gibson, one of Rhode Island's senior fishery scientists, assessed the predictive power of the settlement index by testing its ability to forecast the abundance of pre-recruit lobsters caught in Rhode Island's nearshore trawl survey; a survey that has been conducted every fall and spring since the late 1970's. Pre-recruits in this analysis comprised lobsters with a carapace length between 55-72 mm which were deemed likely to be 3-years-old, and about a molt or two away from legal size (83 mm). Figure 3 illustrates that during the early 1990's the number of pre-recruits reached a peak in 1993 after which their numbers began to falter somewhat. But after 1997 the lobster count in the trawl survey dropped precipitously, a trend coincident

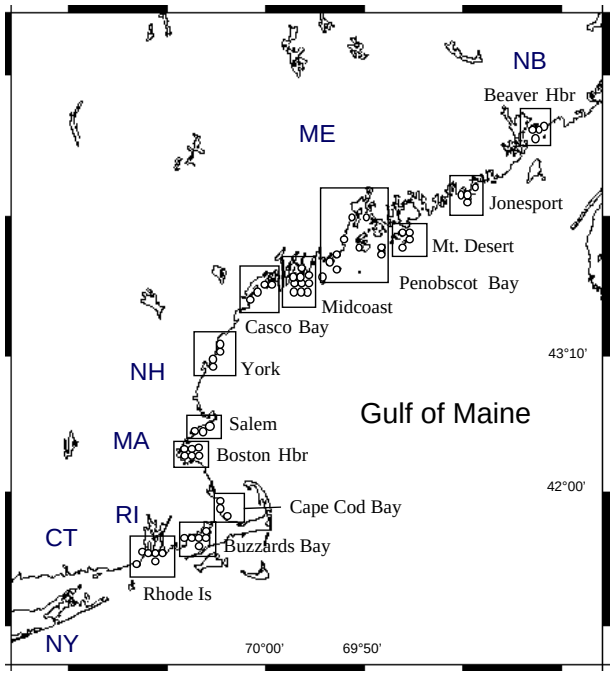

Fig. 1. Sampling sites of the New England lobster settlement index. Initiated at a few sites in Maine and Rhode Island in 1989-90, the survey now spans some 65 sites from RI to New Brunswick. Boxes surround sites used for regional averages shown in Fig. 2. Surveys are conducted by divers using suction samplers in shallow cobble-boulder.

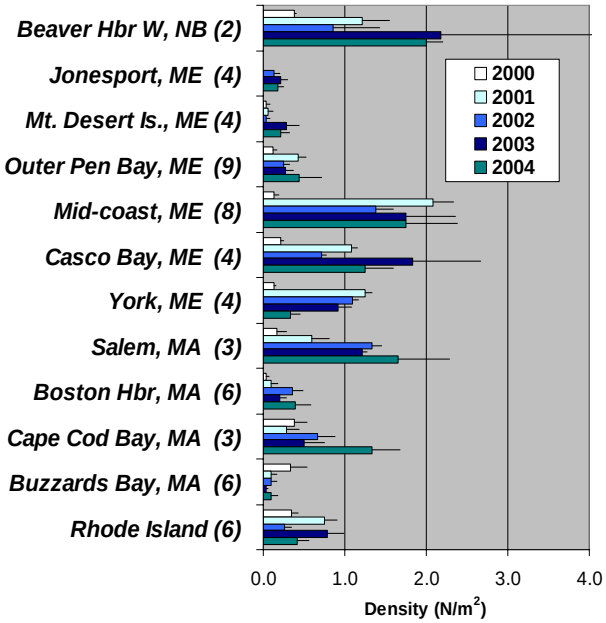

Fig. 2. Regional average lobster settlement throughout New England from 2000 to 2004. Number of sites averaged for a region in parentheses. Some sampling sites in Jonesport, Mt Desert and Penobscot Bay have changed in the past 3 years, so time trends may not be reliable.

with the onset and spread of shell disease. Importantly though, the settlement data suggest that not all of the decline in pre-recruits during the late 1990's can be attributed to shell disease. An initial correlation analysis indicated that fully 88% of the variation in pre-recruit numbers prior to 1997 can be explained by settlement alone. But once shell disease became prevalent, an additional "disease severity" term needed to be included in the model to fully explain the decline in pre-recruits. When the joint effects of settlement and disease were included in a modified form of a standard stock-recruitment equation called a Ricker model, Gibson was able to reproduce the time course of pre-recruit catch with reasonable accuracy (Figure 4). It is noteworthy that as the disease took its toll on the adult population from 1997 onward, settlement continued to be strong, suggesting a larval subsidy to coastal Rhode Island from outside the affected area that continues to repopulate Rhode Island nurseries.

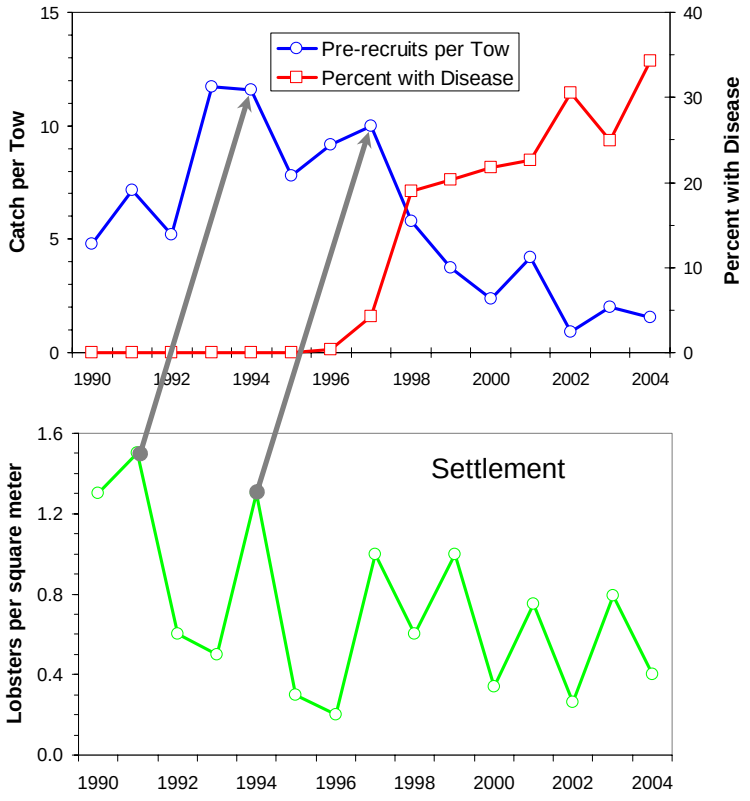

Fig. 3. Time series of the abundance of pre-recruit lobsters and the prevalence of shell disease among them (top panel) and the settlement index (bottom panel). Until the onset of shell disease, peaks in settlement were strongly reflected in the pre-recruit catch 3 years later (arrows); afterward disease increasingly masked the continuing settlement.

There are several important messages in this analysis. First, it is a promising sign that the settlement index may be a useful forecasting tool in other parts of New England. Second, it is clear that a new agent of natural mortality affecting post-settlement lobsters has entered the picture, and must be accounted for in the settler-to-pre-recruit relationship. Third, the parallel settlement and trawl surveys help us distinguish disease effects from larval supply effects on changes in lobster populations. This is a prime example of how the two surveys can be used hand-in-hand to assess the health of the resource. Following year classes through time in this way enables us to evaluate changes in natural mortality before lobsters enter the harvest. Moreover, we can take from this the lesson that it is not safe to assume that natural mortality is constant, either in time or space, as has been practiced in previous stock assessments (ASMFC 2000). Finally, the relative stability of the settlement signal to date - despite declining catches - implies that a substantial portion of coastal Rhode Island's lobster fishery is dependent on egg and larval production occurring elsewhere, suggesting an effective breeding population in offshore waters. The appropriate management response to this recent crisis will benefit from a better understanding of the source-sink linkages among regions.

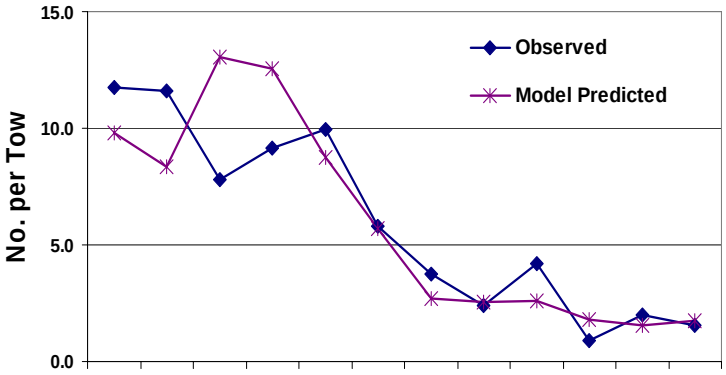

Fig. 4. Observed time series of pre-recruits from 1993 onward compared to the time series predicted by the model using terms for settlement and disease.

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