American Lobster Settlement Index | Update 2024

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Lobster Settlement 2024:

Research teams from the ALSI collaborative successfully monitored 62 suction sampling and 36 collector sampling sites for newly settled young-of-year lobsters (**Fig. 1**). Southern regions continued to show low rates of settlement, although northern Gulf of Maine regions have experienced a slight uptick since the all-time lows seen in the 2010s. Northern-most regions continue to have recruitment higher than their long-term average. Prince Edward Island experienced some of the highest recruitment rates ever observed, with one site recording the highest ever abundance; nearly 32 settling lobsters per square meter, compared to the long-term average of 1-2 in the Gulf of Maine.

Highlights on Recent Research:

Climate change is likely to impact lobster settlement by affecting larval quality and prey availability in the environment. As the Gulf of Maine experiences rapid change in temperature attributable to large-scale ocean processes, investigating the relationships between climate and larval lobster health will be critical in advancing our understanding of how the lobster resource has, and will, respond to changes within the environment. Two recent studies highlight how warming in this region may impact settlement at both a population- and individual-level, suggesting that warmer conditions add multiple pressures to lobster larvae, affecting both the quality and quantity of annual recruits (Ascher et al. 2024, Shank et al. 2024).

Lobster larvae hatched into the water column must rely on their diet of zooplankton and leftover maternal resources to survive until competent to settle to the seafloor. The abundance of a specific zooplankton, *Calanus finmarchicus*, may help reveal why recruitment rates have changed in the Gulf of Maine, as first described by Carloni et al. (2018, 2024). Years with higher *Calanus* abundance tend to mirror years of higher lobster recruitment, and vice versa (**Fig. 2**), suggesting that this species is critical to the survival of lobster larvae. Changing oceanographic conditions in the Gulf of Maine have increased the amount of warm Gulf Stream entering the Gulf of Maine from the Southwest, thereby causing fewer *Calanus finmarchicus* to overlap with lobster larvae during warm years (Shank et al., 2024). Lobster larvae feeding from a diminished prey supply may face heightened competition for resources, and in warmer years with low food

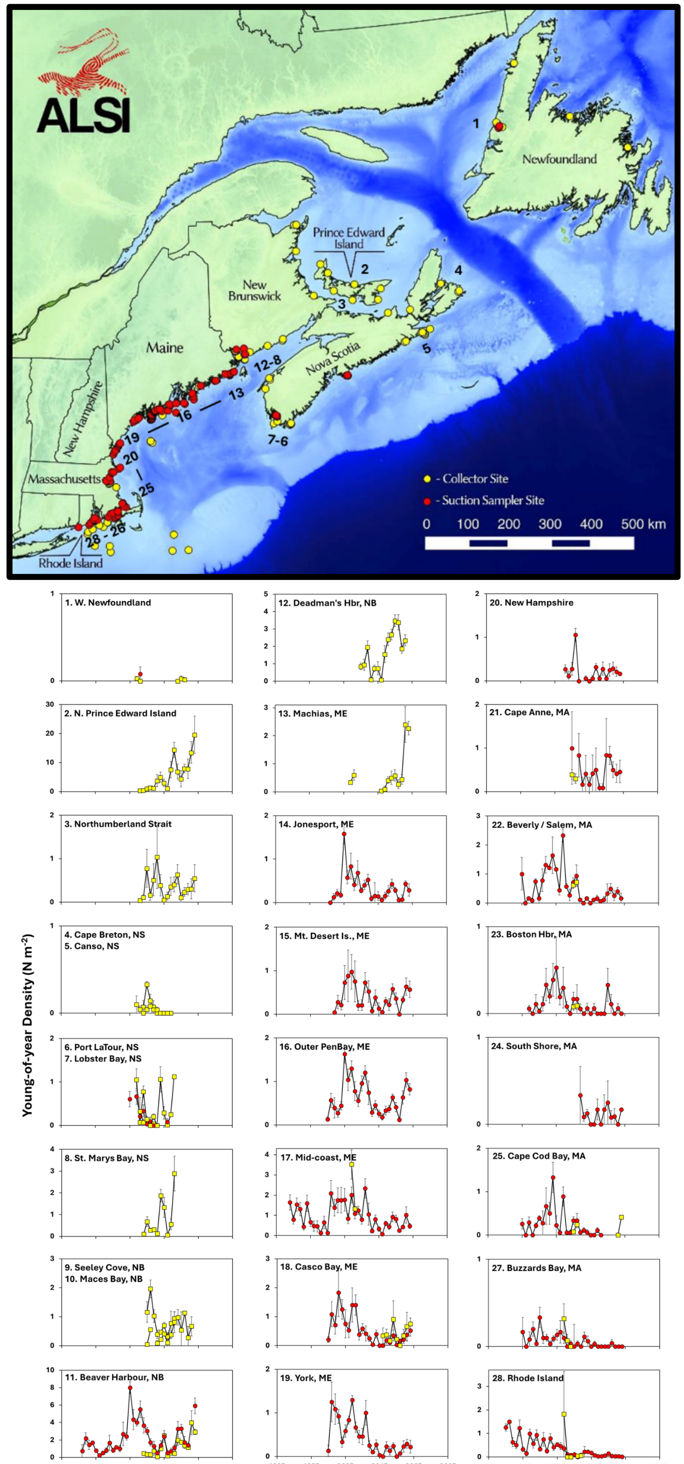

Figure 1. Diver-based suction (red) and vessel-deployed bio-collector (yellow) sampling locations and corresponding young-of-year lobster abundance.

availability there may be a lower chance that larvae will survive to settlement.

To survive in a warmer environment with a reduced prey supply, larval lobsters may rely more heavily on internally stored nutritional resources to avoid starvation. These resources primarily come from energy invested into eggs by their mother, but the amount of energy invested is reflective of the conditions experienced by the ovigerous female. Warmer conditions, therefore, may affect the annual quality of larvae and their ability to withstand stress. Ascher et al. (2024) demonstrated that ovigerous lobsters tend to hatch fewer eggs at smaller body sizes, and that eggs produced by those smaller females are consequently smaller and contain fewer lipid (fat) resources. Consequently, larvae produced by these smaller ovigerous females showed lower rates of survival compared to their larger counterparts. Overall, this suggests that large larval size is favorable for overcoming natural challenges to settlement, and that ocean warming may negatively affect settlement as smaller, nutrient-depleted larvae are released that have a lower chance of survival and recruitment to the seafloor.

With lobster larvae being hatched at smaller sizes and into an environment with more limited prey availability, the implications may be dire. Smaller, nutrient-deplete larvae may be less equipped to survive stress in early life, potentially diminishing the chance of survival before settlement to the seafloor. Tracking the health of this vulnerable subset of lobster populations, therefore, necessitates an approach that considers the influence of various ocean changes on the entire ecosystem. Fortunately, warming within the Gulf of Maine has slowed in recent years as cold, Arctic waters have increasingly entered the Gulf, coinciding with the recent settlement rebounding along coastal Maine (**Fig. 1)**. It is unclear how long these beneficial conditions will persist, and what impact they will have on lobster populations over the long term. Monitoring newly settled postlarvae and studying early life history processes, therefore, remain an essential tool in tracking the health of current, and upcoming American lobster populations, ensuring that we keep a finger on the pulse of this resource in the face of climate changes.

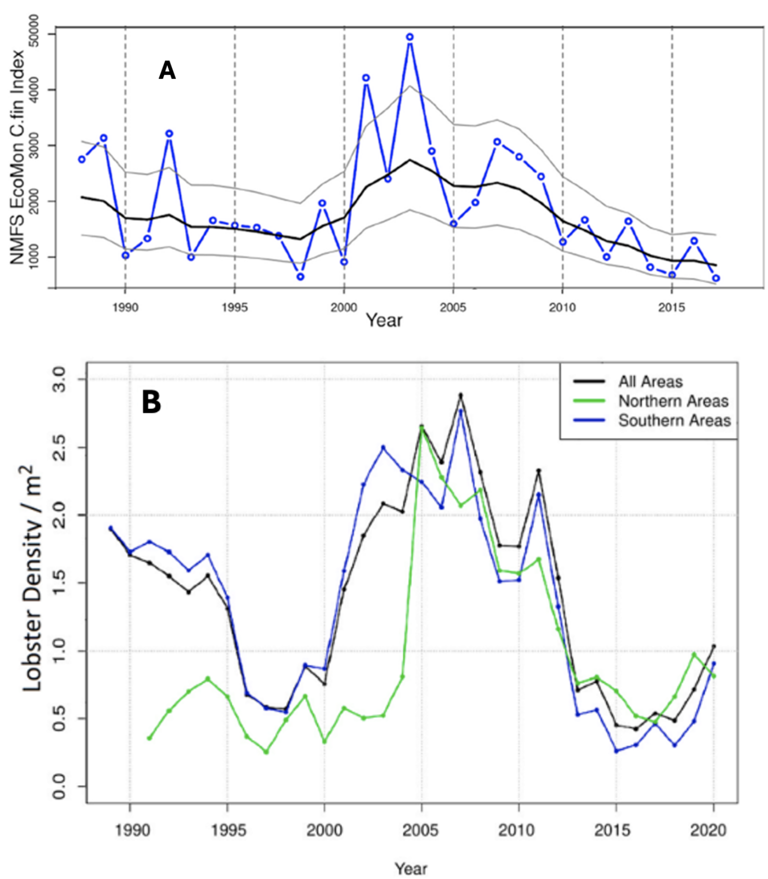

Figure 2. Changes in Gulf of Maine lobster recruitment and zooplankton prey. **A)** Gulf-wide *Calanus finmarchicus* abundance from NOAA EcoMon Survey. **B)** Modeled ALSI settlement trends from the southwest and northeast Gulf of Maine. Adapted from Shank et al. (2024)