American Lobster Settlement Index | Update 2015

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http://umaine.edu/wahlelab/current-projects/american-lobster-settlement-index/

The question on everyone's mind in the lobster industry is: *How long will this boom last?* As 2015's lobster landings are still being tallied, it's shaping up to be another all-time record for the US and Canada. That is, in dollar value. But for Maine, the state dominating US landings, volume has fallen off the 2013 peak for the second year running. Indeed, while Maine's landings shot up by 23% in value in 2014, volume was down 3%. In 2015 value surged again by another 8%, masking a 2.4% decline in volume from 2014. This ***ALSI Update*** adds the 2015 settlement numbers to our accumulating time series from diver-based and collector-based sampling in New England and Atlantic Canada. We also include updates on our regional ALSI-based forecasts, which suggest that if settlement is of any use as a predictive tool, some areas may be in for a longer term slide from their astronomical highs.

Settlement 2015: Young-of-year lobster densities in 2015 were down from 2014 in most areas (Fig. 1). In the Gulf of Maine, most monitoring sites from Jonesport, Maine to Cape Cod Bay reported some of the lowest settlement on record. Declines were less steep in southwest Nova Scotia, and settlement was even slightly up in Beaver Harbour, New Brunswick. But northeast Nova Scotia – Cape Breton and Canso – have had a weak couple of years. Even the southern Gulf of St. Lawrence, where juvenile lobster numbers and subsequent landings have surged upward in recent years, reported a downturn in settlement in 2015. In southern New England, south of Cape Cod, settlement remains at historic lows under a siege of still prevalent shell disease.

Forecast validation: Over the past year we have made strides in developing ALSI as an early warning system for future trends in lobster landings. These forecasting models start with the premise that settlement strength is an accurate indicator of year-class strength, and in turn, a key determinant of subsequent recruitment to the fishery. Because the lion's share of the catch consists of lobsters that have just crossed the threshold to legal size, we also consider landings to be a solid indicator of recruitment to the fishery. It would be easy to say how old a legal-size lobster is if it had growth rings we could count, such as those in fish bones and scales, but there is currently no fool-proof way to age a lobster. So, we

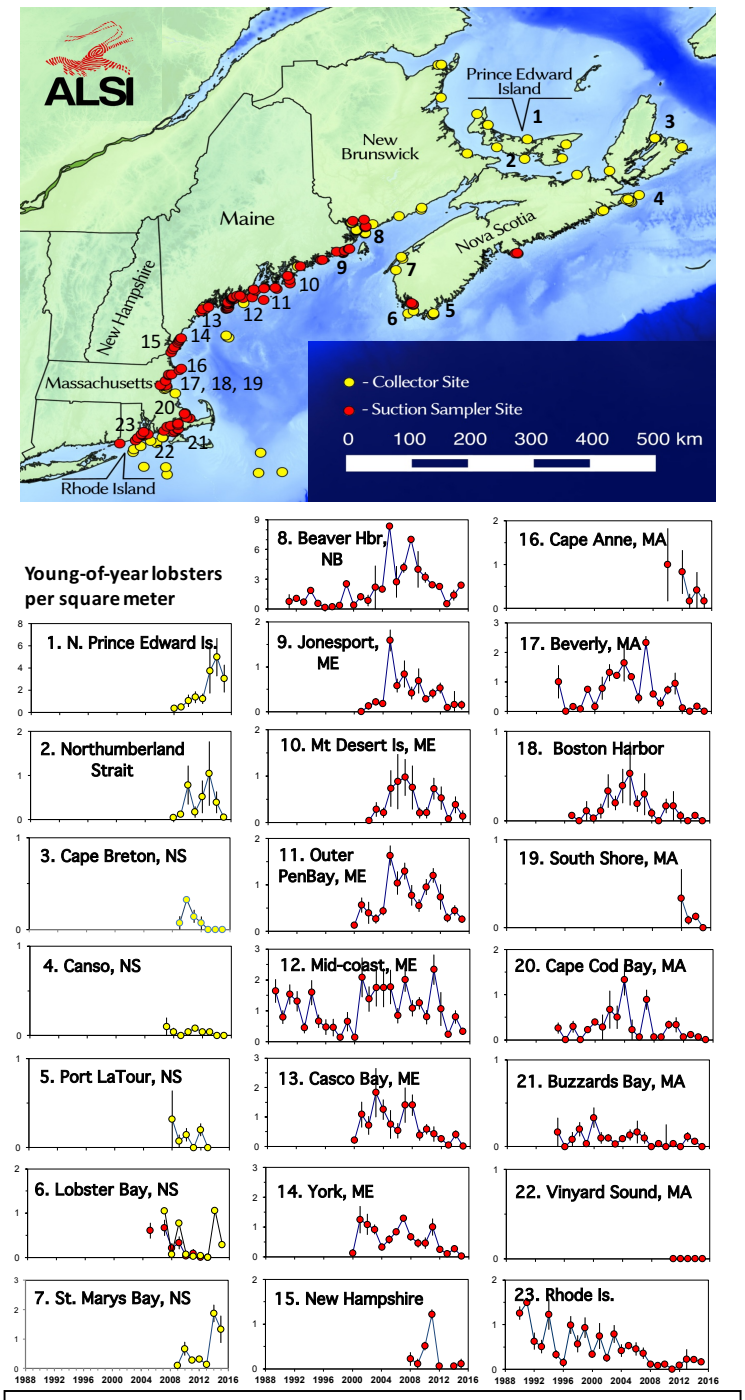

Figure 1. ALSI sampling in New England and Atlantic Canada. Diver-based suction sampling (red) and vessel-deployed collector (yellow). Corresponding time series for groups of sites in study areas numbered on the map.

must go by our best estimate of how fast a lobster grows. We know a year class does not arrive at the fishery all at once, and we account for the fact that some lobsters grow faster than others based on previous growth and tagging studies up and down the coast. It can take anywhere from 5 to 10 years after settlement for a lobster to reach legal size, depending on both individual differences and regional temperature regimes. We also know that mortality rates are not the same for juveniles in time or space, and our forecasting model accommodates changes in natural mortality over time. For example, in southern New England, incorporating changes in shell disease prevalence into our model has significantly improved its forecasting power. We end up with a series of regionally customized models that incorporate our best estimates of local differences in growth and mortality to produce a relative index of recruitment to the fishery. The next step is to test how well the time trend in the recruitment index correlates with the time series of landings for the same area. This validation step is called "hindcasting" because it looks back in time as we compare the observed landings to the model-generated index. If there is a statistically significant correlation, we can proceed with some confidence that the model we've developed for the area will be useful in forecasting future landings. Some models simply do not pass this validation step.

Figure 2 gives forecasts for 10 study areas that have passed our hindcasting validation step. These are study areas with long enough settlement time series to generate at least five years of hindcasts (in blue) against which we have compared observed landings (black line) with favorable correlations. Forecasts beyond the observed landings are shown in orange. In short, if ALSI - adjusted for variable growth and mortality - is a good predictor of landings, we may expect to see more precipitous declines in the coming years, especially for eastern Maine and the Bay of Fundy. ALSI time series are not yet long enough to be evaluated as a predictive tool for most Canadian waters, but the upward trend in the southern Gulf of St. Lawrence bodes well for future landings in that region.

To be sure, forecasting is an inherently uncertain business. For starters, it's fair to ask how confident we can be that young-of-year densities are representative of year class strength. Are we missing an important settlement signal, such as in deep water, outside the range of our monitoring? An increase in lobster settlement outside our sampling domain could offset the declines we currently predict. Did we get the variability in growth rates right, particularly the effect of changing temperature? As for mortality rates, we think we have captured the effect of shell disease, but what about predators? The abundance and composition of predatory groundfish is always changing, but we have not yet accounted for it as a factor in our models. And finally, how sure can we be that landings data, our reality check on model-predicted trends in recruitment, represent an accurate indicator of fishery recruitment? Some questions are easier to address than others. Research is under way on both sides of the border to address these uncertainties - to better understand deep water settlement, the impacts of a warming ocean, movements among sub-population, and even to test new ways to age lobsters. Hopes are these forecasting tools help fishermen, dealers, managers, and policy makers realize the benefits of having a several year lead on the ups and downs in the region's most valuable and iconic fishery. **θ**

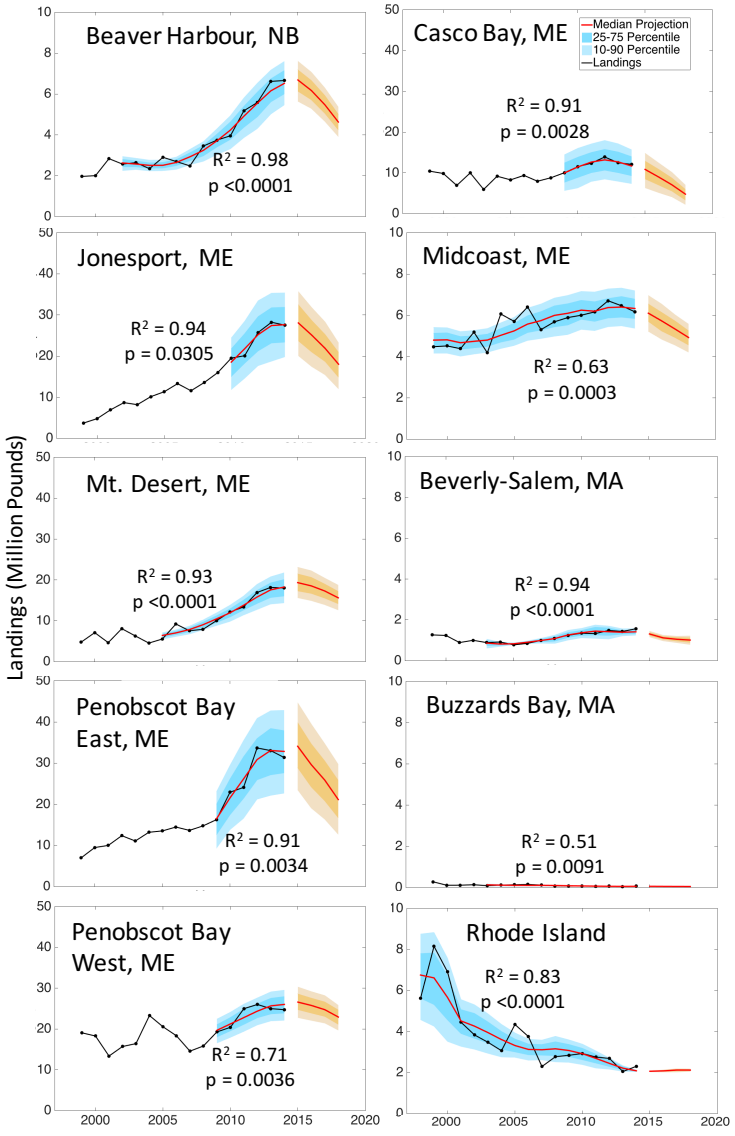

Figure 2. ALSI-based landings hindcasts and forecasts to 2018. Model hindcasts, shown in blue, were correlated against observed landings (black line) to test model performance through 2014. Note landings scale varies. The model did a good job of explaining time trends in landings for 10 of the 12 areas we analyzed. For example, the R^2 value of 0.98 at Beaver Harbour, NB, means that the model explained 98% of the variability in lobster landings there. Based on the strength of that relationship and settlement in more recent years, forecasts are made for future years (in orange). Time will tell whether the forecasts