Spiny Lobster recruitment in Florida Bay, Florida

For ecological and economic reasons, *P. argus* is an important component of the south Florida ecosystem. The species is distributed from Bermuda to Brazil and the long-lived (~ 9-12 mo.) oceanic larvae are subject to widespread dispersal. Both the offshore distribution of larvae and genetic evidence indicate that Florida lobsters are part of a pan-Caribbean population. Postlarval *P. argus* move onshore year round at night in monthly pulses during new moon flood tides. Postlarvae that encounter structurally complex vegetation, particularly red macroalgae and to a lesser extent seagrass, settle and metamorphose into the first benthic juvenile stage.

After metamorphosis, the “algal-stage” juveniles remain in vegetation for several months, where they are sheltered from predators and have abundant food. Once they reach approximately 15 mm carapace length (CL), the juveniles begin to emerge from vegetation and take up daytime refuge in crevices provided mainly by sponge interstices (approximately 70% of shelters) and other small crevices. These “postalgal-stage” juveniles are exposed to many piscine and invertebrate predators; mortality during their first benthic year is estimated at 96-99%. Postalgal juveniles initially occupy relatively small home ranges, but at 45 mm CL (~ 1 yr postsettlement) they become nomadic, entering the fishery a year or two later. Despite extremely heavy fishing over the last two decades (> 90% of the legal-size lobsters are caught annually), adult population abundance has not declined and is undoubtedly sustained by the supply of postlarvae from outside the system.

Shallow, vegetated areas near the Florida Keys and in Florida Bay are the lobster’s nursery habitat and the structure of the macroalgal settlement habitat is naturally dynamic. But the region has experienced a cascade of environmental disturbances over the last few years that threatens to alter the entire ecosystem. Water quality is declining and many hectares of seagrass have disappeared. From 1991-1993, extensive blooms of cyanobacteria swept over Florida Bay near the Middle Keys. Those blooms sparked a massive die-off of the sponge community, and coincident shifts in the abundance and shelter use of juvenile spiny lobsters. Remarkably, the availability of alternative shelters (mostly solution holes) for juvenile lobsters, a large healthy nursery elsewhere in the Keys, and unusually high postlarval supply in recent years have boosted Florida’s lobster population, although lobster densities in the region affected by the sponge die-off (~ 20% of the total nursery) have declined by > 50%.

However, the loss of shelter for lobsters will be long lasting because the sponges are recovering slowly and postlarval abundances have declined the past several years.

The recruitment of clawed lobsters in New England and spiny lobsters in Florida are thought to be governed by a combination of variable postlarval supply and post-settlement mortality, driven principally by the availability of suitable shelter for protection from predators. The prevailing hypothesis for these species is that recruitment of juveniles is limited in a density-dependent manner by shelter-imposed thresholds, but below them the population fluctuates in response to larval supply. Our initial evidence in support of this hypothesis came from observations of postlarval supply and subsequent recruitment of juvenile lobsters at sites differing in habitat structure. The availability of potential shelters for juvenile lobsters at Fiesta Key were among the highest we recorded at nearly 200 sites. At this site, where the carrying (shelter) capacity for young lobsters is unsurpassed, there is a significant positive relationship between postlarval supply and recruitment of postalgal-stage juvenile lobsters (30-35 mm CL) eight months later. In contrast, postlarval supply and postalgal juvenile abundance were uncorrelated at a nearby but low structure site (Old Dan Bank) only 2 km away during the same time period. Thus, small-scale spatial heterogeneity in nursery habitat structure produced dramatically different recruitment dynamics.

Results from two experimental studies also support this general hypothesis. 1) We artificially enhanced postlarval settlement and shelter for juvenile lobsters on six 0.05 ha hard bottom sites and followed juvenile recruitment for 15 months on those manipulated sites versus three unmanipulated control sites with typical natural shelter densities. Juvenile abundance increased where shelter was enhanced and tag returns confirm that the increase was due to higher local recruitment, not immigration into the area. 2) We followed this with a more ambitious study in 1991-1993, where we manipulated the density of microwire-tagged settlers and shelter density with concrete structures in a 3 x 3 factorial design on 27 separate hard bottom sites. Once again, local recruitment increased in direct proportion to the density of suitable nursery habitat structures and seasonal fluctuations in postlarval supply were only reflected in recruitment on habitat-rich sites. Recovery of microwire-tagged settlers furthermore suggested that survival of stocked postlarvae was greatest on the sites with dense shelters (six times greater than on sites with the lowest density of structure).

Presently, we seek to link, through modeling (Spatially Explicit Individual Based Model) and region-wide field studies of postlarval supply and juvenile abundance, the large-scale processes affecting postlarval supply and environmental quality with local ecological interactions in order to predict population-level consequences. We wish to know how much postlarval supply varies along the Florida Keys archipelago, what oceanographic features affect it, and how it interacts with nursery habitat structure on a regional scale to determine recruitment.

Reference

Herrnkind, W., M. J. Butler IV and J. H. Hunt. 1999. Acase for shelter replacement in a disturbed spiny lobster nursery in Florida: why basic research had to come first. American Fisheries Society Symposium 22:421-437. (*This paper gives a chronology of research from ~1983-1998 and cites relevant publications.*)