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Summary of session: Ecology of early benthic juveniles

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SUMMARY OF SESSION: ECOLOGY OF EARLY BENTHIC JUVENILES

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Session Overview

The unifying theme of the presentations in the session on the ecology of early benthic juveniles reflected a general research thrust in marine ecology and a major emphasis in blue crab ecology, specifically that the roles of dispersal and mortality in determining habitat-specific distribution patterns of young juveniles remain largely unknown. As a consequence, presentations on the ecology of postlarvae and early benthic juveniles focused on four major processes—recruitment, predation, movements, and habitat relationships, with most of the presentations integrating two or more of these processes. Two of the presentations examined recruitment and habitat relationships of young juveniles (Spitzer et al., 2001; Rakocinski et al., 2001), two dealt with dispersal of postlarvae and young juveniles in relation to habitat (Blackmon and Eggleston, 2001; Stockhausen and Lipcius, 2001), one examined predation upon young juveniles (van Montfrans et al., 2001), and one discussed mortality and movements of young juveniles (Etherington et al., 2001). The last four presentations emphasized processes in seagrass beds, whereas the others related work in systems with and without seagrass as a major habitat.

The importance of alternative nursery habitats, other than seagrass beds, has recently been recognized in various geographic locations, as exemplified by the work of Rakocinski et al. (2001). In their field investigation of young juvenile habitat use in Mississippi Sound, Rakocinski et al. (2001) demonstrated the common occurrence of juveniles in shallow unvegetated, soft-sediment habitats. The authors suggested that mortality in these habitats may be low, and that juveniles from these habitats may serve as a pool of additional recruits to structured habitats. Rakocinski et al. (2001) further demonstrated that postlarval settlement on artificial settlement substrates was correlated with abundance of young juveniles in natural substrates, providing yet another example of the utility of artificial settlement substrates in serving as a proxy for recruitment. However, artificial settlement substrates do not always serve as a consistent index for recruitment, as noted by Spitzer et al. (2001), who established that in some time periods (1990–1991) young juvenile abundance in Mobile Bay was positively correlated with settlement on artificial settlement substrates, whereas at other times (1997–1998) there was a negative correlation. Whether this difference was due to post-settlement processes in the benthos or to alterations in the effectiveness of artificial settlement substrates in measuring settlement and recruitment was not determined. The collective evidence from these and previous studies indicates that artificial settlement substrates are a valuable tool in measuring recruitment, but that their use needs verification in each system under investigation.

The work of Blackmon and Eggleston (2001) in North Carolina estuaries, and that of Stockhausen and Lipcius (2001) in the York River, Chesapeake Bay show the pervasive influence of transport processes in mediating habitat utilization by postlarvae and young juveniles. Third through fifth benthic juvenile instars apparently move about more readily in the plankton than their younger first-second instar counterparts, and their planktonic meanders reflect active behavioral responses to increasing flow conditions (Blackmon and Eggleston, 2001). Such

behavior might underlie redistribution within seagrass beds or emigration from seagrass beds to surrounding alternative nursery habitats. The spatial configuration of habitats and flow to these habitats determine settlement and recruitment patterns, which can be modified by juvenile behavior, and therefore the importance of various habitats in juvenile ecology. In a modeling study, Stockhausen and Lipcius (2001) demonstrated that the detrimental effects of seagrass loss and benefits of seagrass restoration for postlarval settlement and juvenile recruitment depend critically on the interaction between planktonic behavior, spatial distribution of seagrass beds, and flow patterns. Specifically, the value of a particular location in enhancing postlarval settlement and juvenile recruitment through seagrass restoration depends on the specific location and relevant hydrodynamics. Although it has been recognized that recruitment and transport processes are important, these investigations provide concrete examples of the major role played by planktonic migration, currents, and habitat characteristics in driving recruitment success of the blue crab.

The remaining two studies in seagrass beds, Etherington et al. (2001) in North Carolina, and van Montfrans et al. (2001) in Chesapeake Bay, were unique in elucidating patterns and processes producing juvenile loss in nursery habitats. Etherington et al. (2001) offer one of the only examples of the joint measurement of mortality and emigration of juveniles in the field. Using a relatively simple field mark-recapture technique, they showed that emigration and mortality rates of young juveniles are extremely high, approaching or exceeding 50% in less than a day. These high loss rates point out that young juveniles move about frequently, either within or out of seagrass beds, and that they potentially suffer high mortality rates. Though these results were not unexpected, the direct field measurement of these rates is unique, and worthy of further research.

Given that mortality rates of juveniles are high in the nursery grounds, as also noted by Spitzer et al. (2001) in the Gulf of Mexico, who are the culprits? van Montfrans et al. (2001) offered convincing evidence from field studies of stomach contents that striped bass, red drum, and Atlantic croaker prey heavily on young juveniles in seagrass beds. Such mortality is in addition to the likely high cannibalism rates experienced by young juveniles in the nursery grounds. Despite the high predation rates, the fraction of all juveniles consumed by finfish predators was relatively low (approximately 5–10% over the fall recruitment period), casting doubt on the assertion that the impact of these predators has a major role in driving population fluctuation of the blue crab. Nonetheless, the high frequency of occurrence of juvenile crabs in the guts of these transient seagrass predators is worthy of future investigations into their role in the decline of the blue crab in Chesapeake Bay and other estuarine ecosystems.

Future Research Directions

Collectively, the studies of blue crab postlarvae and young juveniles revealed several meritorious lines of investigation and perplexing research issues. First, and in no order of priority, the role of alternative nursery habitats in population dynamics remains unresolved. The relative importance of seagrass beds, marsh systems, other structured habitats, and unvegetated habitats should be further investigated because they may independently harbor substantial fractions of the juvenile segment of the population. Second, the landscape should be defined so as to identify the interactions between alternative nursery habitats. For instance, do systems with seagrass beds linked to productive unvegetated, soft-sediment habitats serve as better nurseries for growth and survival than unstructured hab-

itats alone? Third, transport processes must not only be acknowledged, but also studied intensively to illuminate their role in driving recruitment patterns. Such information is particularly crucial to investigations dealing with marine conservation biology, as the impact of habitat loss and restoration on blue crab populations depends to a large extent on hydrodynamic conditions. Fourth, further attempts to measure mortality and migration rates of juveniles in the field are warranted. Knowledge of these rates is important not only for an understanding of juvenile ecology, but it is a foundation for stock assessments and management strategies aimed at conservation and sustainable exploitation of blue crab populations. Finally, we commend modeling efforts that use the best available ecological information to provide insights into processes whose ecological impact is difficult to measure. As long as modelers and ecologists communicate effectively, such collaborative efforts will serve as a valuable heuristic tool for understanding the dynamics of blue crab postlarvae and young juveniles in the natural environment.

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