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# The Nursery Role of Seagrass Beds

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## COMMENTARY

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**THE NURSERY ROLE OF SEAGRASS BEDS.**—Seagrass meadows are usually thought to serve as essential “nursery grounds” for a wide variety of species in coastal waters, including many economically important finfish and shellfish (see, for example, reviews by Thayer et al., 1984; Zieman and Zieman, 1989; Bell and Pollard, 1989). Many of these fish and invertebrate species are spawned offshore and pass through a series of larval stages on the shelf before moving into coastal waters as larvae or postlarvae. They then make the transition from a planktonic to a benthic existence by settling into seagrass habitats.

Seagrass species are among the most productive plants known, and they frequently support animal densities many times those on nearby unvegetated substrates (Virstein et al., 1983; Orth et al., 1984; Summerson and Peterson, 1984; Williams et al., 1990; Hutchings et al., 1991; Kirkman et al., 1991; and the reviews cited above). Textbooks and review articles commonly report that the great amount of food potentially available to juveniles, usually thought to be in the form of seagrass detritus and epiphytic algae, together with the protection from predators provided by seagrasses, explains why such large numbers of animals are typically associated with seagrass habitats (e.g., Thayer et al., 1984; Zieman and Zieman, 1989).

However, the database that would allow an evaluation of whether seagrass meadows actually provide more available food for juvenile fish and shellfish is actually quite small. One simple way to evaluate this proposition is to compare the growth rates of individuals inhabiting vegetated and nearby unvegetated substrates. The expectation is that growth rates will be highest in seagrass, owing to the greater food supply available there. We are aware of only a relatively small number of studies that have experimentally tested this hypothesis. They frequently employ the use of field enclosures, and include studies of fish (Sogard, 1992; Nadeau, 1991; Nadeau and Heck, unpubl. data), shrimp (Heck et al., unpubl. data), brachyuran crab (Perkins-Visser et al., 1996), bivalve mollusk (Peterson et al., 1984; Peterson and Beal, 1989; Coen and Heck, 1991; Irlandi and Peterson, 1991; Irlandi and Mehlich, 1996), and gastropod mollusk (Ray and Stoner,

1995) growth. These studies have frequently come to different conclusions regarding the effect of seagrass on growth rates.

There are, however, many studies that have investigated the protection that seagrasses might provide various species of invertebrate prey from their predators (e.g., Nelson, 1979a; Coen et al., 1981; Heck and Thoman, 1981; Stoner, 1979, 1982; Summerson and Peterson, 1984; Leber, 1985; Heck and Wilson, 1987; Main, 1987; Ryer, 1987). There are few studies using small fish as prey (e.g., Lascara, 1981), although there are many reports of the protective role of vegetation for freshwater fish species (cf. the review in Heck and Crowder, 1991). These studies, in contrast to those of the effect of seagrass on growth rates, have usually come to very similar conclusions regarding the role of submerged aquatic vegetation (SAV) as protection from predators, although there are a small number of exceptions.

Below, we search for some generalities in these studies regarding the “nursery role” of seagrasses in providing both abundant food and protection from predators. We rely heavily on our own work (both published and as yet unpublished) and studies by other U.S. scientists. Consequently, our conclusions should be strictly applicable only to eastern North America, although we believe that they may have broader relevance.

## GROWTH RATES

*Invertebrates.*—In the past 2 decades, the growth rates of suspension-feeding northern quahogs (*Mercenaria mercenaria*) in seagrass and in nearby unvegetated substrates have been compared many times. Much work has been done on this commercially important species in North Carolina by Peterson and colleagues (Peterson et al., 1984; Peterson and Beal, 1989; Irlandi and Peterson, 1991; Irlandi and Mehlich, 1996). Conclusions have varied, with different studies finding enhanced, equal, or reduced growth in seagrass compared to that on unvegetated substrate (e.g., Peterson and Beal, 1989). Similarly, in the northern Gulf of Mexico, variable responses of hard clam growth to the presence of seagrasses have been found, with positive, negative, and nonmeasurable effects on quahog growth (Coen and Heck, 1991; Wilson, 1991; Coen et al., unpubl. data).

Studies of another commercially important suspension feeder, the bay scallop (*Aequipecten*

*irroratus*), have also produced mixed results regarding the effects of SAV on growth rates. In the northern Gulf of Mexico, growth rates of tethered scallops were greater at the edges of seagrass beds than in their interiors or on unvegetated sand (Bologna and Heck, unpubl. data).

The commercially important herbivorous gastropod *Strombus gigas* (the queen conch) grows at faster rates in seagrass than on sand at medium and larger sizes (11 and 22 mm shell length, respectively) tested, but smaller conchs (5 mm shell length) grow more rapidly on unvegetated sand (Ray and Stoner, 1995).

Juvenile [50–70 mm total length (TL)] brown shrimp (*Penaeus aztecus*), a commercially important penaeid shrimp often closely associated with seagrass meadows (Zimmerman and Minello, 1984a, 1984b; Zimmerman et al., 1990), usually showed no significant difference in growth rate among living or artificial seagrass or unvegetated substrates (Academy of Natural Sciences of Philadelphia, 1992, 1993, 1995a, 1995b; Heck et al., unpubl. data). These unpublished studies differ from previous studies that found growth of shrimp (up to 59 mm TL) to be greater in marsh vegetation (*Spartina alterniflora*) than on nearby unvegetated substrate (Zimmerman and Minello, 1984b).

Growth rates of juvenile blue crabs (*Callinectes sapidus*), which are closely associated with seagrasses in their early juvenile stages (cf. Orth and Von Montfrans, 1987; Thomas et al., 1990), have been shown to be significantly greater in seagrass than on unvegetated substrates in both field and laboratory experiments (Perkins-Visser et al., 1996).

*Fishes*.—Sogard (1992) used field enclosures to compare the growth rates of three species of fishes on eelgrass and on nearby unvegetated substrates. These species were eelgrass specialists to varying degrees: winter flounder occurs on all types of substrates but is most frequently found on sand; tautog (*Tautoga onitis*) is primarily found in vegetated habitats, including both eelgrass and macroalgal-dominated substrates; and naked goby (*Gobiosoma bosc*) is found in structured habitats such as seagrass beds and oyster reefs and is much more common in seagrass than on unvegetated substrate (Sogard, 1992). Sogard's (1992) results showed that only the tautog grew at significantly greater rates in seagrass than on unvegetated sand.

In similar types of experiments with juvenile red drum (*Sciaenops ocellatus*), Nadeau (1991) found no significant difference in growth rates

between vegetated and unvegetated substrates, despite the fact that early juvenile red drum are closely associated with seagrass beds (Holt et al., 1983). Furthermore, enclosure experiments with spotted sea trout, a species also closely associated with seagrass habitats, showed significantly greater growth in seagrass on one occasion (Heck and Nadeau, unpubl. data) in Alabama waters, but not when the same experiments were done in Texas with living and artificial seagrass and unvegetated substrate (Academy of Natural Sciences of Philadelphia, 1992, 1993, 1995a, 1995b; Heck et al., unpubl. data).

#### PROTECTION FROM PREDATORS

Although there are differences in the details of predation studies, virtually all attempts to investigate the effect of seagrass biomass on predator success rates have found that seagrass does significantly reduce predation risk (cf. review of Heck and Crowder, 1991). This is true of laboratory studies using both living and artificial seagrasses (e.g., Nelson, 1979a; Heck and Thoman, 1981; Coen et al., 1981; Main, 1987; Ryer, 1988), as well as field studies using caging (Leber, 1985) and tethering techniques (Heck and Thoman, 1981; Heck and Wilson, 1987; Wilson et al., 1987, 1990; Heck and Valentine, 1995). These studies have used primarily crustacean prey (amphipods, shrimp, anomuran and brachyuran crabs) and fish predators, although other prey taxa have been used (sea urchins; Heck and Valentine, 1995), and crustacean and fish predators are also presumed to be involved in some field studies (Heck and Wilson, 1987; Wilson et al., 1990). We are aware of only a few studies that have used fish as prey (Lascara, 1981; Rozas and Odum, 1988), but the results of these studies appear to be consistent with those of studies using invertebrate prey in finding that vegetation reduced predator effectiveness.

There is uncertainty about the amount of vegetation required to produce a significant decline in predator effectiveness and about the shape of the relationship between vegetation biomass and predation rate (cf. Nelson and Bonsdorff, 1990; Heck and Crowder, 1991). However, we are aware of one study (James and Heck, 1994) that showed no significant reduction in predation success rates as vegetation abundance was increased. This study used a predator with an "ambush" foraging mode, and this "exception to the rule" had previously been predicted (Heck and Orth, 1980a).

## SYNTHESIS

We conclude that the evidence for the role of food in the seagrass "nursery paradigm" is less compelling than the role of seagrass as shelter from predation. There are no obvious differences in seagrass "nursery function" between invertebrates and vertebrates. To date, only those taxa very closely associated with seagrass appear to show elevated growth rates in the presence of vegetation, and this is not without exception. However, relatively few species have been tested, and relationships between growth rates and the identity and abundance of seagrass species present have not yet been fully explored. In fact, much of our own work, as cited here, is still unpublished. We think it likely that a more complex set of relationships will be identified when additional studies are completed.

In contrast, studies of a wide variety of invertebrate prey taxa have shown the beneficial effects of seagrass presence on avoidance of potential fish predators. There is much less evidence for the effects of seagrass as protection for small fishes from their predators, but existing results are in accord with studies on invertebrates. At present, it appears that the provision of shelter is by far the best documented and most important "nursery function" of seagrass meadows.

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