Grass Shrimps Guild

Daggerblade Grass Shrimp (*Palaemonetes pugio*)
Marsh Grass Shrimp (*P. vulgaris*)
Brackish Grass Shrimp (*P. intermedius*)

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DESCRIPTION

Taxonomy and Basic Description

These small decapod shrimp are collectively known as 'carideans.' Common names include grass shrimp, jumpers, glass shrimp, popcorn shrimp, glass prawns, and hardbacks.

Grass shrimp have a well-developed 'horn' or 'rostrum' (hence the name of one of the species, daggerblade) with teeth along the dorsal and or ventral surfaces. The presence and position of these and other nearby teeth are used to separate out the species in the genus. Important distinguishing characteristics are a lack of claws on the third pair of walking legs and their diminutive size. They are rarely larger than 5 cm (2 in.); this differentiates them from commercial shrimp. Because of their morphological similarities and the need of a dissecting scope to view key characteristics, the species are often misidentified. Grass shrimp are nearly transparent. Males can be separated from females by the presence of the 'appendix masculina' attached to the 'appendix interna' of the endopod of the second pair of pleopods. Also, the endopod of the first pleopod is larger in males versus females. A significant positive correlation between female length and egg number has been also observed as it has in many decapod crustaceans (Hines 1982; Anger et al. 2002).

Spawning occurs from February through October, although this may vary with location. More than one brood may be produced during the spawning season. During mating, which occurs within 7 hours of molting, the male transfers a spermatophore to the female. The eggs are fertilized externally as they are extruded. The female attaches the eggs to her pleopods, where they remain until hatching 12 to 60 days after they are fertilized. Ovigerous females—those carrying eggs—are easy to recognize because the eggs are visible through the carapace. Egg incubation varies among species and is shorter in the Southeastern United States. Females molt again after spawning, thereby producing a second brood. Grass shrimp larvae undergo a series of developmental stages: 10 zoeae and a postlarva. Juvenile grass shrimp mature when they are perhaps 1.5 to 2 months old or about 15 to 18 mm (0.6 to 0.7 in.) long; they live from 6 to 13 months. Older, overwintering individuals usually spawn early in the year and die by the following winter. Most young-of-the-year spawn late in the fall as adults. Post-larvae that survive fall and winter spawn the following spring. Since some grass shrimp populations reproduce two broods each year, length-frequency distributions may be polymodal (two or more peaks), with growth rates difficult to characterize. Growth rates vary somewhat between species, sexes, habitats, and times of the year. In colder coastal waters, growth patterns are different with salinity also affecting growth (Anderson 1985).

Grass shrimp eat a wide variety of foods, but are considered by many to be primarily detritivores. Nevertheless, they can be quite carnivorous in captivity, where they are often also cannibalistic (E. Wenner, pers. obs.). Grass shrimp are also predators of meiofauna and small infaunal polychaetes, oligochaetes, and nematodes (Bell and Coull 1978; Smith and Coull 1987; Gregg and Fleeger 1998).

Status

Grass shrimp are not state or federally listed; however, they are an important species from an ecological perspective because they serve as a link for energy transfer between trophic levels in the coastal food web. Their feeding on the epiphytic algae that occur on marsh grass assists with the mechanical breakdown of organic material (Orth et al. 1984). The fecal pellets from the unused part of their diet are rich in nutrients and, therefore, an important component of energy cycling in estuarine ecosystems. Marsh grass shrimp are hosts to several ectocommensals, including the bopyrid isopod *Probopyrus pandalicola*, as well as microsporidians, trematodes, coccidian, and leeches (Anderson 1985). Marsh grass shrimp have been extensively documented as the prey of fishes and other carnivores. They are instrumental in transporting energy and nutrients between various estuarine trophic levels: primary producers, decomposers, carnivores, and detritivores (Haertel-Borera et al. 2004). Grass shrimp are consumed in large quantities by commercially important fishes and forage species, including Spotted Seatrout (*Cynoscion nebulosus*), Red Drum (*Sciaenops ocellatus*), and Mummichogs (*Fundulus heteroclitus*) (Heck and Thoman 1981; Anderson 1985; Wenner 1990; Posey and Hines 1991; Wenner and Archambault 1996; C. Wenner pers. comm.).

POPULATION SIZE AND DISTRIBUTION

Grass shrimp are found in large numbers in estuarine waters along the Atlantic and Gulf Coasts, where they occur from Massachusetts to Texas. Although there are many freshwater members of the genus, the 3 species considered here are common in estuaries and tidal creeks in South Carolina waters.

Although there are no estimates of population size of grass shrimp in South Carolina, they are amongst the most widely distributed, abundant, and conspicuous of the shallow water benthic macroinvertebrates in our estuaries, often reaching hundreds to thousands per meter (Coen and Luckenbach 2000; Leight et al. 2005; L. Coen unpublished data).

HABITAT AND NATURAL COMMUNITY REQUIREMENTS

Grass shrimp are very common estuarine species in Southeastern marshes and tidal creeks where they are usually associated with beds of submerged or emergent vegetation, oyster reef habitats or structures such as oyster shell, fouling communities, woody debris (Ruiz et al. 1993), docks, or pilings (Coen et al. 1981). The marsh grass shrimp (*P. vulgaris*) tolerates somewhat higher salinities than its congener, the daggerblade grass shrimp (*P. pugio*). This has led some to suggest a separation of the 2 species based on preferred habitat, although biotic interactions such as competition for food and space may be more important (Thorp 1976; Coen et al. 1981). Grass shrimp are eurythermal. In estuarine waters, daggerblade grass shrimp can survive at temperatures from 5 to 38^{o}C (41 to 101°F); however, optimal temperatures range from 18 to 25^{o}C (65 to 77°F). Marsh grass shrimp are more tolerant of high salinity water and less tolerant of low salinity water than daggerblade grass shrimp. Although salinities as low as 3 parts per thousand (ppt) have been lethal to adult marsh grass shrimp, they have been collected in freshwater (Anderson 1985).

Although brackish grass shrimp are also considered euryhaline, they have typically been collected from waters with salinities of 5 to 39 ppt. The 2 freshwater species, *P. paludosus* and *P. kadiakensis*, often live in brackish waters. *P. paludosus* was reported in salinities of 0 to 10 ppt (Anderson 1985).

Grass shrimp can inhabit very shallow areas near their margins, but have been reported at depths as great as 15.2 m (50 ft.). In winter during temperature lows, and in summer when water temperatures approach seasonal highs, daggerblade grass shrimp may move from shallow to relatively deeper water. The extent of the movement of grass shrimp among various depths often coincides with the distribution of oyster shell substrates, which, in some waters, are preferred by both daggerblade grass shrimp and marsh grass shrimp. They are abundant in these structured estuarine and marine habitats as they provide abundant food and protection from predators such as various fish species (Thorp 1976; Coen et al. 1981; Heck and Thoman 1981; Heck and Crowder 1991).

CHALLENGES

The main challenge to conserving grass shrimp is the degradation of habitat associated with extensive anthropogenic development along the South Carolina coast. Estuaries and tidal creeks are increasingly being affected directly and indirectly through runoff and spraying, to name just a few impacts. As epibenthic predators and sediment disturbers, grass shrimp can significantly alter infaunal community structure. For example, in North Carolina, a sharp decline in the abundance of marsh grass shrimp due to predation by Mummichogs *(Fundulus heteroclitus)* may have changed marsh infaunal composition (Anderson 1985).

Since grass shrimp often rely on aquatic vegetation or other structured habitats (Boesch and Turner 1984), activities that reduce structural complexity can negatively affect grass shrimp populations (Thorp 1976; Coen et al. 1981; Heck and Thoman 1981; Heck and Crowder 1991; Weaver and Holloway 1974). In West Bay, Texas, dredging, bulkheading, and filling of coastal marshes caused a permanent loss of intertidal vegetation (Trent et al. 1976). The reduction of detrital input into the adjoining aquatic systems caused a noticeable decrease in the abundance of grass shrimp. Coen et al. (1999 a,b) found that juvenile grass shrimp were collected in much higher numbers (20 to 60 times greater) over marsh than other adjacent estuarine habitats (mud or oyster reefs).

Changes to water regimes that alter salinity or dissolved oxygen through diversion or rediversion may also alter grass shrimp abundance patterns.

Grass shrimp have been used extensively by researchers in South Carolina and across the US as a bioassay organism for contaminant and toxicological research (Mayer 1987; American Public Health Association (APHA) 1975); a great deal of information is available regarding mortality and sublethal effects. Researchers conducting toxicological work with the genus *Palaemonetes* have noted that grass shrimp adults are generally more sensitive than fish (Scott et al. 1994; Strozier 1996; Van Dolah et al. 1997); however, this may vary greatly upon the toxicant (Scott et al. 1987). Grass shrimp larvae are also generally more sensitive to many organophosphates (Lund 1997; Lund et al. 2000; Key and Fulton 1993; Key et al. 1998b). Overall, grass shrimp appear to be more sensitive to organophosphate and pyrethroid insecticides and less sensitive to several organochlorine insecticides at high versus low salinities (Scott et al. 1989; Fulton and Scott 1991; Key and Scott 1993). Concentrations of heavy metals (mercury, cadmium, and chromium) are acutely toxic to adult grass shrimp, usually in the order of 100 to 1,000 parts per billion. Work in Charleston by NOAA and other scientists at Fort Johnson have focused on grass shrimp as an invaluable model organism (Scott et al. 1992, 1994; Key and Fulton 1993; Fulton 1993, 1997; Cochran and Burnett 1996; Lund 1997; Finley et al. 1999; Wirth et al. 2001; Bolton-Warberg 2005; Leight et al. 2005).

CONSERVATION ACCOMPLISHMENTS

Extensive research on grass shrimp population dynamics has been conducted around sites with known pollution sources in South Carolina, including suburbanized Murrells Inlet, Charleston Harbor, North Inlet, the Broad and Okatee Rivers (Van Dolah et al. 1999), and the ACE Basin. Thus, an extensive historical database (1985 to present) exists for grass shrimp population dynamics within South Carolina. Egg number per female has also been compared among tidal creeks, rivers, and intertidal habitats to evaluate impacts.

CONSERVATION RECOMMENDATIONS

- Determine species' associations, critical habitats, and population abundance patterns for grass shrimp.
- Determine grass shrimp predator-prey relationships.
- Determine the effects of contaminants on the reproduction, growth, and longevity of grass shrimp.
- Protect important habitats, such as fringing marsh and oyster habitats, from the direct and indirect impacts of development, and increase our directed restoration efforts. Oyster habitats have only recently begun to be appreciated for their unique ecosystem services (see Oyster Habitat document and references therein).
- In order to conserve grass shrimp habitat, protect aquatic vegetation by directing dredge and fill operations away from intertidal marshes.
- Partner with NOAA-NOS to develop and implement ways to use grass shrimp as an indicator of ecosystem health.
- Work with municipalities to encourage the use of BMPs that reduce non-point source runoff and reduce acute and chronic effects on grass shrimp.

- Encourage the use of conservation buffers that intercept pollutants to mitigate the movement of sediment, nutrients, and pesticides within non-point source pollution.
- Developing and implementing a nutrient management plan (NMP) by farmers would be helpful in minimizing nutrient loss while maintaining yield, decreasing the flow of nutrients into waterways, and reducing eutrophic effects.
- Work with communities and municipalities to reduce runoff by improving and implementing Best Management Practices (BMPs).
- Develop and implement a management plan for grass shrimp.

MEASURES OF SUCCESS

By implementing the above recommendations, SCDNR will be able to protect important marsh habitat and monitor water quality. The measurement of success will be to observe stable populations of grass shrimp (during annual surveys) that should result from this proactive management approach.

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