

Intertidal Marine Invertebrates Guild (Intertidal Foraging Habitat Guild for Shorebirds)

Amphipod Crustaceans

Acanthohaustorius millsii
Lepidactylus dytiscus
Neohaustorius schmitzi
Parahaustorius longimerus
Protohaustorius wigleyi

Bivalve Mollusks

Coquina clam (*Donax variabilis*)
 Dwarf Surf Clam (*Mulinia lateralis*)
 Tellin Clam species (*Tellina* sp.)

Polychaete Worms

Arabella mutans
Drilonereis longa
Capitella capitata
Glycera americana
Glycera dibranchiata
Laeonereis culveri
Mediomastus sp.
 Common Southern Clamworm (*Nereis succinea*)
Paraonis fulgens
Scolecopsis sp.
Streblospio benedicti
Tharyx acutus

Chelicerate Arthropods

Atlantic Horseshoe Crab (*Limulus polyphemus*)



Haustoriid amphipod. Photo courtesy of Southeastern Regional Taxonomic Center (SERTC)



Polychaete worm, *Nereis succinea*.
 Photo courtesy of SERTC.

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DESCRIPTION

Species in the shorebird foraging habitat guild are critical food resources for many shorebirds including species of national concern: the Piping Plover (*Charadrius melodus*) and Red Knot (*Calidris canutus*). Prey availability has been shown to be a critical factor affecting the distribution of shorebirds (Fraser et al. 2005; Lyons 2005; Spruzen et al. 2008a, b), and therefore represents an important measure of habitat quality. Recent studies of overwintering habitat quality in South Carolina have investigated potential prey items found in sediment cores taken from known foraging areas of Piping Plover and Red Knot (Bergquist et al. 2011; Thibault and Levisen 2013; Coastal Eco-Group, Inc. 2013). Fecal samples have also been collected from overwintering locations in South Carolina to identify invertebrate taxa consumed by Piping Plover and Red Knot (USFWS unpublished data; Thibault and Levisen 2013). The dominant taxa from cores and fecal samples included amphipod crustaceans, polychaete worms, bivalve

mollusks, and eggs of the chelicerate arthropod *Limulus polyphemus*, all of which comprise this guild.

Shoreline modification projects and other human disturbances of coastal habitats have been shown to reduce the foraging success and fitness of migratory shorebird populations (Verhulst et al. 2004; Peterson et al. 2006). Physical changes resulting from beach re-nourishment may be associated with changes in infaunal macroinvertebrate distributions and subsequent reductions in shorebird utilization of the affected habitat (Peterson et al. 2006). The invertebrates included in this guild become species of concern because disruption of the biological characteristics of overwintering areas, including reduced abundance of these available prey items, could have substantial and long-lasting impacts on migratory shorebird populations.



Red Knot (*Calidris canutus*) foraging on an intertidal flat at Kiawah Island, SC. Photo by Janet Thibault, SCDNR.

Taxonomy and Basic Description

Amphipods are in the taxonomic order Amphipoda of malacostracan crustaceans which have no carapace and generally have laterally compressed bodies. These inconspicuous crustaceans are prominent members of marine communities worldwide. The species that occur in South Carolina are usually small (<0.5 in., 1.3 cm). *Acanthohaustorius millsii*, *Lepidactylus dytiscus*, *Neohaustorius schmitzi*, *Parahaustorius longimerus* and *Protohaustorius wigleyi* are burrowing amphipods of the family Haustoriidae. Haustorids are characterized by their white barrel-shaped body and the lack of a true rostrum and dactyls on pereopods 3-7.

The coquina clam, *Donax variabilis*, is a member of the bivalve family Donacidae. Coquina clams possess wedge-shaped shells, generally less than 0.8 in. (2 cm) in length, and are characterized by pastel colored bands radiating from the umbo to the margins of the valve (Ruppert and Fox 1988). [A separate species account is afforded this species.]

The dwarf surf clam, *Mulinia lateralis*, in the family Mactridae is one of the smallest clams found on Southeastern beaches, with lengths of only 0.6 in. (1.5 cm). *Mulinia lateralis* is characterized by its moderately inflated shape, solid strong valves and triangular hinge. The shell is pale cream-white in color with a radial ridge on each side of the posterior slope.

Species of the genus *Tellina* are members of the bivalve family Tellinidae. Tellin clams are small (usually < 1 in.), laterally compressed, and usually have a slight twist at the posterior end (Abbot 1974). Color can vary from iridescent white to pale pastels.

Polychaete worms are in the taxonomic class Polychaeta which are segmented annelid worms. They are characterized by an elongated body bearing appendages called parapodia which bear many bristles, called chaetae. *Arabella mutans* and *Drilonereis longa* are both members of the

family Oeononidae. Oeononids are typically large (as long as 12-14 in. or 30-35 cm) earthworm-like worms which burrow in sand and mud on protected beaches. Species of Oeononidae can be distinguished using such characters as the shape of the head and the presence or absence of eyespots.

The bloodworms, *Glycera americana* and *Glycera dibranchiata*, are both members of the family Glyceridae. Glycerid worms are bright red, segmented worms that can reach up to 9 in. (23 cm) in length. Glycerids are ferocious epi- and infaunal polychaetes that prey upon small invertebrates. They are characterized by their pointy snout used for burrowing in sediment and their eversible pharynx containing 4 poisonous fangs used for capturing prey.

Laeonereis culveri and *Nereis succinea* are both members of the polychaete family, Nereididae. Adult Nereid worms can range from approximately 2.5-6" (6-16 cm) and are characterized by their conspicuous heads with 2 short antennae, 4 eyes, 2 bulbous palps, and 4 pairs of long tentacular cirri (Ruppert and Fox 1988).

Tharyx acutus is a segmented worm of the polychaete family Cirratulidae. Members of this family are cylindrical, elongate, and characterized by reduced heads that lack appendages.

Capitella capitata and *Mediomastus* sp. are members of the polychaete family Capitellidae. Capitellid worms are red or purple in color with thread-like, flexible bodies that grow up to 4 in. (10 cm) in length. They are characterized by their conical shaped head and reduced appendages.

Paraonis fulgens is a segmented worm of the family Paraonidae. Paraonids are slender-bodied worms with many segments than can grow up to 1.3 in. (3 cm) in length. *Paraonis fulgens* is characterized by its lack of a median antenna on the head and hooked neurosetae on the postbranchial region of the body.

Scolelepis sp. and *Streblospio benedicti* are members of the tube-dwelling polychaete family, Spionidae. Spionids, also called palp worms, are characterized by their small heads and two long grooved palps used for deposit or suspension feeding. Spionids are mostly small (~6 in., <15 cm), but large species do exist.

The Atlantic horseshoe crab, *Limulus polyphemus*, is the only member of the Arthropoda subclass Xiphosura found in the Atlantic. Horseshoe crabs are not true crabs as their name suggests, but members of the subphylum chelicerata, which are more closely related to spiders, scorpions, and ticks. *Limulus polyphemus* are characterized by their lack of antennae and jaws and have 7 pairs of legs, including a pair of chelicerae. [A separate species account is afforded this species.]

Status

None of the species in this guild are officially recognized as threatened or endangered, but all are part of the macroinvertebrate prey community in coastal habitats of the Southeastern US which serve as critical habitats within the overwintering/foraging range for threatened, endangered, and priority shorebirds. There have been some concerns regarding reduced numbers of adult *Limulus*

polyphemus at some locations due to loss of habitat and overharvesting, which would result in fewer eggs and larvae available as prey items.

POPULATION SIZE AND DISTRIBUTION

Haustorid amphipods are very abundant along the intertidal gradient of the US East Coast (Bliss et al. 1983). The haustorid amphipods in this guild range from Saco Bay, ME through Cape Canaveral, FL (Bousfield 1973; Grant and Lazo-Wasem 1982). Although the distribution of this group is well documented, population size could vary considerably by location and season and would be difficult to quantify.

Donax variabilis is a familiar species on sandy intertidal beaches in the Southeastern US, where its shells are found in abundance. In the US, *D. variabilis* ranges from New Jersey to Florida and the Gulf of Mexico (DeVictor et al. 2010). Surveys in the Southeastern US have found that it is among the most abundant macroinvertebrates present in the intertidal area during spring, where numbers have been recorded in excess of 1,000 per m² (93 per ft.²) (Pearse et al. 1942; Shealy et al. 1975; Knott et al. 1983).

The dwarf surf clam, *Mulinia lateralis*, can be an abundant species in shallow water sandy areas on the Atlantic Coast of the US. This species ranges from Maine to North Florida and has been found in abundances as high as 21,000 individuals per m² (Santos and Simon 1980).

Tellinid clams are mud or sand dwellers found worldwide. Members of the Tellinidae family, especially the genus *Tellina*, are very common on the South Carolina coast (Ruppert and Fox 1988). Because there are many species in this genus, population size is difficult to estimate. Most of the species commonly found in the Southeast range from the Mid-Atlantic (Virginia/North Carolina) to Florida (Abbott 1974).

The Glycerid worms, *Glycera americana* and *Glycera dibranchiata*, are very common in shallow water areas of South Carolina (Ruppert and Fox 1988). In the Eastern US, *G. americana* ranges from Massachusetts to Florida, while *G. dibranchiata* ranges from Maine to Florida (Day 1973). Since these species can be epifaunal as well as infaunal, population size is difficult to estimate.

Polychaetes of the family Oeononidae (*A. mutans*, *D. longa*) are commonly found burrowed in sand and mud on protected intertidal beaches. In the Eastern US, *A. mutans* ranges from South Carolina to Florida and *D. longa* ranges from Massachusetts to Georgia (Day 1973). Although members of this family are more conspicuous than other polychaetes, population size is unknown.

Nereis succinea enjoys the widest distribution of any invertebrate species in the Southeast, occurring in all benthic habitats except outer beaches (Ruppert and Fox, 1988). In the North Atlantic, *N. succinea* ranges from the Gulf of St. Lawrence to Florida, while *Laeonereis culveri* ranges from Connecticut to Florida (Gardiner 1975). Studies in the Chesapeake Bay indicated that *N. succinea* may occur in considerable abundance, with densities of 400 individuals per m² in disturbed, partially anaerobic sediments (Hamilton, Jr. 1972).

Tharyx acutus ranges from the Gulf of Maine through North Florida on the East Coast of the US. Little has been reported on population estimates of *T. acutus*; however, a benthic invertebrate survey in New York reported abundances of 80 individuals per m² (USACE 2004).

Capitella capitata and *Mediomastus* sp. are both very abundant on the East Coast of the US. *Capitella capitata* is a cosmopolitan species (occurring worldwide) that is often found in very high densities up to several thousand per m² in sediments that have been enriched with organic pollutants (Ruppert and Fox 1988). Identifications to species level in the genus *Mediomastus* are often difficult due to the collection of incomplete worms, but there are several species that occur in high abundances on the US Atlantic Coast.

Paraonis fulgens ranges from Maine to Florida in the Atlantic coastal waters of North America. Little is known regarding the population size of this species.

The spionid polychaete, *Streblospio benedicti*, occurs along the US Atlantic coast from Maine south to Florida. Studies on *S. benedicti* abundance on the East Coast have reported the species to be among the most abundant and characteristic taxa occurring in Gulf of Maine mud flats (Larsen and Dogget 1991) and among 4 taxa dominating North Carolina saltmarsh macrofauna (Cammen 1979). The other spionid in this guild, *Scolecopsis* sp., ranges from New England to Florida in the North Atlantic and has been found in abundances higher than 100 individuals per m² on the studied beach (Degraer et al 2003).

Horseshoe crabs range from northern Maine to the Yucatan Peninsula. Adult horseshoe crabs migrate from deep bay waters and the Atlantic continental shelf to spawn on intertidal sandy beaches, especially the low-energy beaches within estuaries such as the Delaware and Chesapeake Bays. Although there is concern about the stability of the population, little is known about horseshoe crab abundance along the Atlantic Coast.

HABITAT AND NATURAL COMMUNITY REQUIREMENTS

Marine invertebrate members of the shorebird foraging habitat guild live in the intertidal zone on sandy ocean beaches. The intertidal zone lies between the high tide line and the low tide line and is alternately submerged and exposed depending on the stage of the tide. As the tide moves up and down the beach, sand formations such as bars and runnels can form which border elongated tidal pools that run parallel to the waterline. These tidal pools are also excellent habitat for the invertebrates in this guild.

Haustorid amphipods are free-swimming amphipods which are adapted for burrowing in sandy or silty substrates. They prefer a variety of intertidal areas including exposed and protected beaches, inlet entrances, and estuaries with fine sand or mud. They can be found from mean low water to 50 m in depth and in salinities from 6 ppt to fully marine, depending on the species (Bousfield 1973).

Donax variabilis are well-adapted to live and feed in the wave-washed swash zone of sandy, intertidal beaches. The coquina clams are shallow burrowers that have the ability to alternately

emerge and burrow in the sand to move up and down the beach with the tide in order to filter feed on the phytoplankton and other small suspended particles.

Mulinia lateralis live shallowly buried in sand or mud on the lower ocean beach where, like other bivalves, they filter feed on suspended materials. They are tolerant of low salinities and are also found in estuaries and lagoons.

Capitellid worms, such as *Capitella capitata* and *Mediomastus* sp., are sedentary deposit feeders that often occur in mud or muddy sand on the lower shore to sub-littoral zone. They may be found under pebbles or small stones, with the burrows at or near the surface of the sediment where they feed on deposited organic material (Ruppert and Fox 1988).

Polychaete worms of the family Nereidiidae are commonly found in all water depths, hiding under rocks or burrowing in sand or mud. *Laeonereis culveri* constructs tubes in shoals of sand mixed with mud and shell fragments (Gardiner 1975); *Nereis succinea* is often found on pilings, oyster clumps, under rocks, and in shoals of sand mixed with some mud or shell fragments. They prefer estuarine and intertidal habitats to 40 m in depth (Day 1973).

Tharyx acutus, of the polychaete family Cirratulidae, is a sluggish-type worm that inhabits medium to fine sand or muddy sediments. This species is usually found buried just below the surface of the sediment with only its feeding appendages visible.

Paraonis fulgens, like other members of the Paraonidae, are burrowers and deposit feeders that occur in the intertidal zone to 10 m in depth (Day 1973). They prefer fine sands as the deeper portion of their burrows are spiraled to provide better anchorage in the sediment (Ruppert and Fox 1988). *Paraonis fulgens* is often found in association with the spionid worms *Scolelepis* sp. and *Streblospio benedicti*. *Streblospio benedicti* prefer suitable soft sediments where they can form mucoid tubes just below the sediment-water interface that allow them to deposit feed. *Streblospio benedicti* is relatively tolerant to elevated levels of sediment organics (Reish 1979), a trait that contributes to its success as an opportunistic species. *Scolelepis* sp., unlike other spionids, are not deposit feeders. They construct inconspicuous sandy tubes at the surface of the beach where they can catch suspended particles in the sticky mucus of their palps (Ruppert and Fox 1988). *Scolelepis* sp. prefer a physically stressed habitat where there is rapid water movement.

Adult horseshoe crabs (*L. polyphemus*) mate in the spring and deposit up to 88,000 eggs in large bowl-like depressions in the intertidal region of quiet, sandy beaches. Planktonic larvae hatch from the eggs within 2-4 weeks, although some larvae may overwinter within nests and hatch out the following spring (Botton et al. 1992). Juvenile *L. polyphemus* remain in the intertidal flats, usually near breeding beaches.

CHALLENGES

Habitat loss and degradation from coastal development and rising sea levels are the main challenges to the beach invertebrate/shorebird feeding guild. Intertidal macroinvertebrate fauna play a key role in the sandy beach food chain, where filter feeders and deposit feeders turn over

high amounts of particulate organic matter and meiofauna (McLachlan and Brown 2006). In turn, they are an important food source for different kinds of predators such as shorebirds (Speybroeck et al 2008a).

Although beach re-nourishment projects restore sand to eroded beaches, these activities can significantly negatively affect populations of sand-dwelling invertebrates as they are buried under a thick layer of sand. Re-nourishment may alter the physical environment of a beach by adding non-native sand, potentially resulting in a changed sediment composition and beach morphology. If these environmental changes are permanent, long-term changes in the macroinvertebrate community may occur.

CONSERVATION ACCOMPLISHMENTS

In South Carolina, critical habitats for the Piping Plover overwintering population have been designated by the US Fish and Wildlife Service to help protect the species during their migratory period. Because of the official designation, standardized monitoring protocols which include assessing overwintering habitat quality (i.e. identity and quantity of prey organisms included in this guild) are required in conjunction with shoreline modification projects.

CONSERVATION RECOMMENDATIONS

Effective habitat management requires a better understanding of the factors that determine habitat use and value to shorebirds. Piping Plover conservation efforts continue to concentrate on increasing the population and on ensuring protection and maintenance of overwintering habitat for distinct populations (USFWS 2009). The Red Knot is currently a candidate species for federal listing under the Endangered Species Act due to the rapid decline of this species in the last 15 years. It is theorized that their population decline may be influenced by a lack of food availability, most notably *L. polyphemus* eggs, during migration. A fishery management plan is in place for horseshoe crabs on the East Coast through the Atlantic States Marine Fishery Commission (ASMFC) which implements regulations to limit the harvest of this species. Monitoring efforts to investigate potential impacts to the quality of overwintering Piping Plover and Red Knot habitat associated with shoreline construction projects is ongoing in South Carolina and will continue to provide estimates of the abundances of available prey items described in this guild.

MEASURES OF SUCCESS

Measures of success for this guild will directly correlate with conservation efforts to increase the populations of shorebirds such as the Piping Plover and Red Knot, as well as maintaining the quality of overwintering foraging habitats utilized for these distinct populations.

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