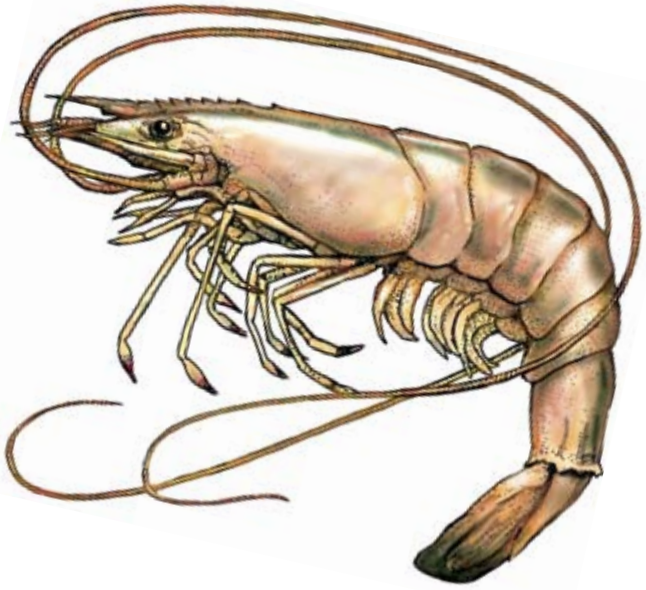
# Deep Sea Trawl Fisheries of the Southeast US and Gulf of Mexico:

## Rock shrimp, Royal red shrimp, Calico scallops



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COVER DRAWINGS | Royal red shrimp (*Hymenopeneaus robustus*), Rock shrimp (*Sicyonia brevirostris*), Calico scallop (*Argopecten gibbus*)

# Deep Sea Trawl Fisheries of the Southeast US and Gulf of Mexico: Rock shrimp, Royal red shrimp, Calico scallops


Sorting the royal red shrimp catch in Fernandina Beach, Florida.

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# INTRODUCTION

Although most bottom trawl and dredge fisheries in the Southeast US and Gulf of Mexico stay close to shore, three trawl fisheries have developed in the deep sea in search of rock shrimp, royal red shrimp, and calico scallops. This report provides a snapshot of each fishery for consideration in their future management, based on information from the South Atlantic and Gulf of Mexico Fishery Management Council documents, scientific literature, and interviews with fishermen, seafood dealers, restaurants, council staff, and staff of NOAA Fisheries. It also includes maps of potential habitat and core fishing grounds based on this information.

Deep sea trawl vessels transit regularly between waters of the Gulf of Mexico and Southeast United States and operate in fairly discrete depth ranges in pursuit of calico scallops, royal red shrimp, and rock shrimp. Although each of the fisheries takes place primarily in soft bottom areas of the seafloor, juveniles of each species may occasionally be found in other habitats that are sensitive to fishing gear such as deep sea corals or shell mounds.

Information needed for management and assessment of royal red shrimp, rock shrimp, and calico scallop is patchy and sometimes nonexistent. A complete stock assessment has not been conducted for rock shrimp or royal red shrimp. Even the most basic management plan is absent for royal red shrimp in the South Atlantic and for calico scallops in either region.

Interviews suggest that these three fisheries are carried out by the same fleet of boats and shrimp permit holders, with the exception of royal red shrimp traps that were formerly utilized in the Gulf of Mexico. Overlap in the location of key ports such as Cape Canaveral further illustrates this connection. All three fisheries show rapid, wide-ranging changes in fishing pressure in response to externally driven prices, costs, and the health of other fisheries. While environmentally-driven population changes contribute to variability in landings, the abrupt changes in shrimp and scallop landings also reflect shifts in trawl effort to different locations and between species. This is emblematic of the calico scallop fishery but also explains the cyclic landings of royal red shrimp and rock shrimp. Management of these deep sea species will require an overarching approach and consideration of the potential for rapid changes in effort and in the resource.

These fisheries have remained at the periphery of scientific research and management due to their small number of participants, exclusive market niche, episodic or seasonal nature, and remote location of operations. However, they cover a large geographic area, occur in poorly understood deep sea habitats, and play a significant role in the overall ecosystem. This highlights the need for ecosystem-based management that incorporates the full scope of habitats, fish, and fisheries of the deep sea in the South Atlantic and Gulf of Mexico regions.

# ROCK SHRIMP

The brown rock shrimp (*Sicyonia brevirostris*) is the largest of six rock shrimp species found in U.S. waters of the South Atlantic and Gulf of Mexico, growing to more than 4 inches (10cm) in shell length (Sea Grant Louisiana 2006, Hill 2005b). Rock shrimp are named for their characteristically tough, rock-like exoskeleton that sets them apart from the more well-known shallow water shrimp (Hill 2005b). Both rock shrimp and royal reds represent a very small catch compared to other sectors of the overall shrimp fishery, as illustrated in the figure 1.1. Independent estimates of the rock shrimp population are not available though the fishery is thought to be near the maximum possible fishing level (SAFMC, 1999).

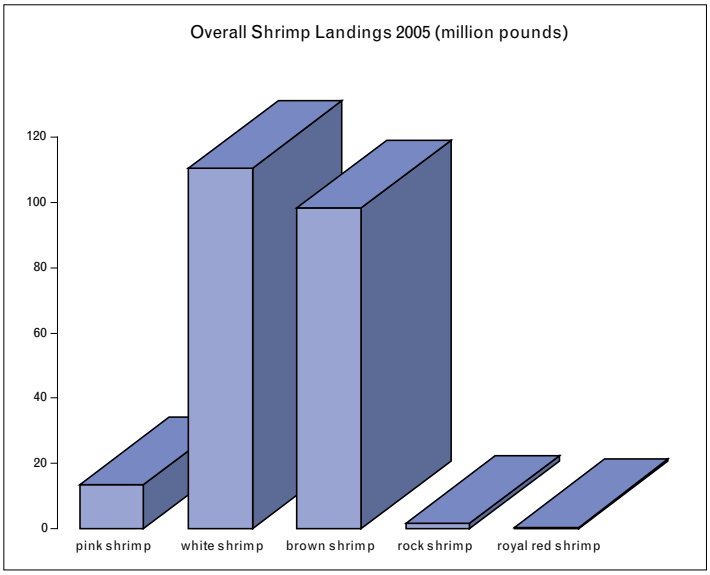



Figure 1.1

## Habitat

Prime habitat for rock shrimp is thought to be fine to medium grain sand made of shell. Rock shrimp are rarely found on mud (Cobb 1973 in SAFMC 2004). Juvenile rock shrimp may be found in hard bottom habitat areas such as Oculina coral (SAFMC 1998a, Geiger pers.comm.).

The estimated biological range for rock shrimp extends along the continental shelf in depths of 82 to 213 feet (25-65m). They are found at their greatest density between 110 and 180 feet (34-55m) (Kennedy 1977 in SAFMC 1996) and sporadically in shallower and deeper waters (SAFMC 1996). Their deep water range is thought to be limited by habitat availability, while the shallow water limit of their range is unexplained (Kennedy 1977 in Hill 2005b). Along the Atlantic coast, the potential range for rock shrimp reaches from Virginia to Florida, into the Gulf of Mexico, around Cuba, and out to the Bahamas. Potential rock shrimp habitat is illustrated in the map on pages 16-17 based on published depth ranges.

Core habitat areas are located off North Carolina near Cape Lookout (Hill 2005b), from Northeast Florida south to Cape Canaveral and Jupiter Inlet, and in Mexican waters along the Yucatan Peninsula (Hill 2005b). Additional species of rock shrimp are distributed worldwide in tropical and temperate waters (SAFMC 2004). Core rock shrimp habitat is also illustrated in the map on page 14 based on published descriptions and informal interviews.

## Fishery Description

Rock shrimp are active at night and are caught in deeper water than penaeid shrimp* as they burrow into the seafloor during the day (Hill 2005b). The months of greatest availability are July through November, with September being the most prolific, though rock shrimp are fished year round (OceanGarden Inc. 2006, King 1999b). Gulf coast landings have varied over time, averaging around 1.1 million pounds from 2001 to 2003 (Muller 2005). Atlantic coast landings are generally more consistent, averaging around 5.9 million pounds from 1993 to 1995 (Muller 2005).

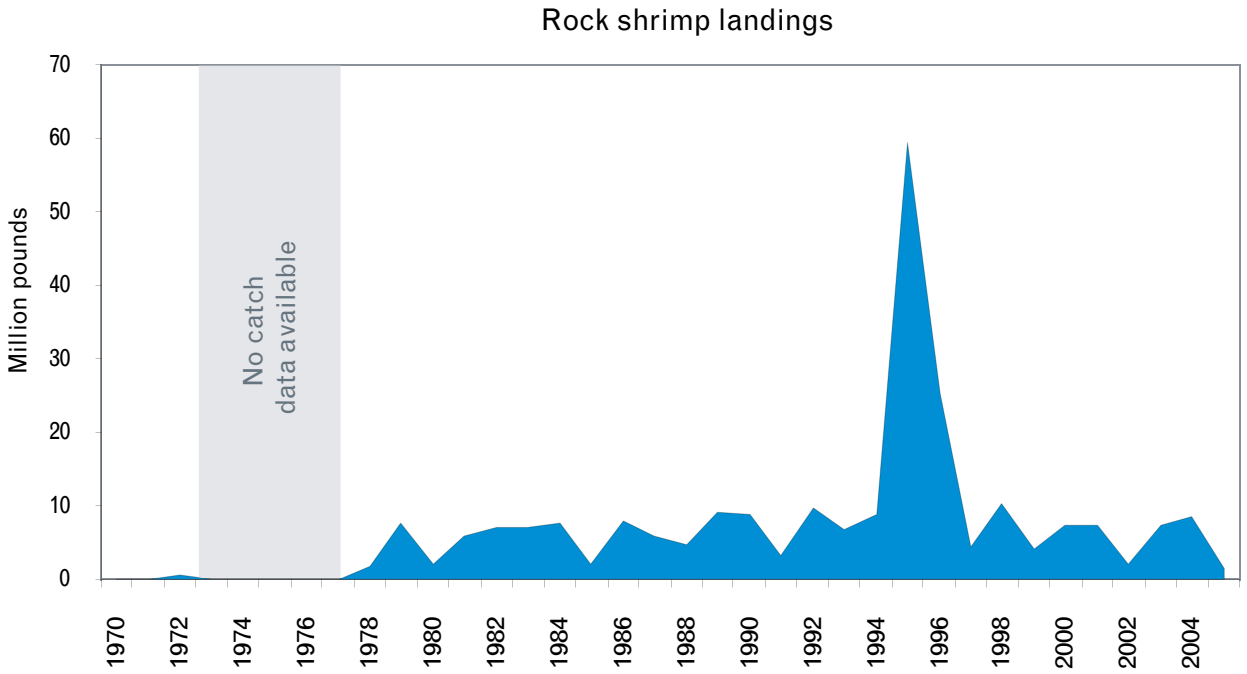
Rock shrimp usually settle on the bottom and are therefore not usually caught in the first pass with a dredge. As the bottom is disturbed they are caught on the second or third pass (Geiger pers.comm.). Even a single pass of a bottom trawl can cause significantly affect the underlying seafloor habitat (NRC 2002), and this repeated dredging can cause severe disruption (Geiger pers.comm.).

As reported to the SAFMC Shrimp Committee (2007), participants in the fishery included up to 134 active vessels, of which approximately 61 had qualifying landings within the last four years. Large freezer boats (greater than 70 feet ) tend to dominate the fishery with some participation from smaller boats that use ice to store the shrimp (SAFMC 1996, SAFMC 1999). Reinforced trawl nets are used on vessels similar to other shrimp boats in the Gulf of Mexico (King 1999b, Geiger pers.comm.).

## Fishing History

Rock shrimp were first caught incidentally by trawlers fishing for penaeid shrimp, or on dedicated trips at the beginning or end of the season for other species (SAFMC 1995, Hill 2005b). The hard shell made rock shrimp difficult to process on a large scale until 1969, when a Florida fisherman devised a machine to split and de-vein the shrimp (Anonymous seafood restaurant, 2006).


Rock shrimp have been called mini lobsters because of their hard shell. Credit: South Carolina Department of Natural Resourses.




**Industry**

1969 — Technology to split and devein rock shrimp developed in Florida

1984 — Technology to peel rock shrimp with Lathram machine developed in Alabama

1992 — Industry concern at public meetings over juvenile shrimp and declining landings

1994 — Rock shrimp effort increases with a longer season and high prices

**Management**

Pre-1970 — Rock shrimp classified as bycatch

1970 — First official commercial landing of rock shrimp

1981 — Gulf of Mexico shrimp fishery management plan includes rock shrimp

1991 — South Atlantic shrimp fishery management plan excludes rock shrimp

1995 — Rock shrimp included, Oculina coral protected (South Atlantic Amendment 1)

2002 — Number of permits limited, Vessel Monitorting System required (South Atlantic Amendment 5)

Figure 1.2

The first commercial catch was landed in 1970 weighing in at 1200 pounds and valued at $642 (Hill 2005b). The fishery grew rapidly and only two years later commercial landings reached 443,035 pounds and a value of $258,528 (Hill 2005b). Despite strong interest in the fishery, processing still limited the ability to bring the shrimp to market. In 1984 in Alabama, a second technology was developed to peel rock shrimp using a modified version of the sandpaper-covered rollers and Lathram machines used for other shrimp (King 1999b, SAFMC 2006).

This new technology fueled additional growth, as illustrated in the landings chart and industry timeline in figure 1.2. Both participation and landings increased to a peak in 1996, followed by a steep drop in rock shrimp catches (Muller 2005, SAFMC 1996). By 1992, the industry expressed concern over declining catches and increased marketing of juvenile shrimp due to automated peeling technology (SAFMC 1996). Participation declined from 2000 until limited access was introduced in 2002. By 2003, statewide rock shrimp landings had declined to levels 21 percent lower than the historical average (Muller 2005).

## Fishery Location

Core fishing areas are illustrated on the map on page 14 based on interviews, fishery management council documents, and scientific literature where available. Rock shrimp have historically been fished throughout the Gulf of Mexico and along the South Atlantic coast, though the current fishery operates in a much smaller area. Landings have been recorded in Virginia, the Carolinas, Georgia, and Florida (OceanGarden Inc. 2006, Anonymous seafood restaurant 2006). Within the Gulf, rock shrimp grounds have also been described closer to shore between Destin, Florida and Apalachee Bay (Rezak et al. 1985). Most rock shrimp are landed in Florida, as illustrated by figure 1.3 on page 4 comparing landings by state with data from NOAA Fisheries Statistics.

The predominant fishing activity is concentrated off the Atlantic coast of Florida and particularly near Cape Canaveral (Sea Grant Louisiana 2006, SAFMC 1999). Some sources describe the coast between Jacksonville and St. Lucie Inlet as being of particular importance (Hill 2005b).

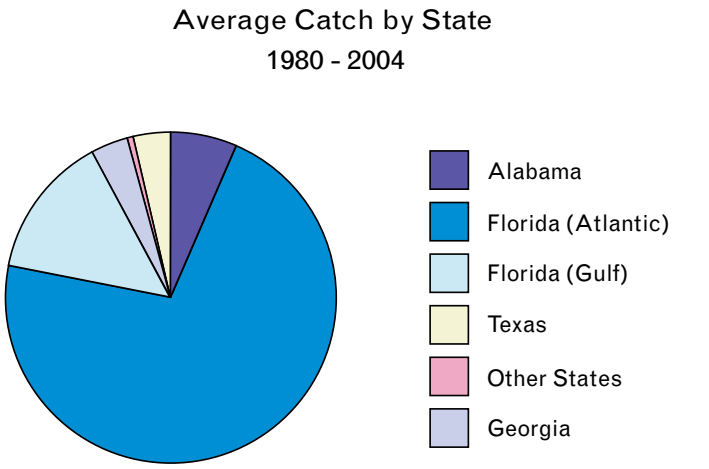



Figure 1.3

After years of heavy fishing and a massive catch in 1996, where nearly 23 million pounds were landed in Florida alone (NMFS 2006), catches declined and boats ranged farther and increased effort to compensate (Geiger pers.comm.). In attempting to maintain former catch levels, fishing vessels entered juvenile shrimp grounds, some of which were within the Oculina reefs, a deep-sea coral habitat found only off the coast of Florida that has since been designated as a Habitat of Particular Concern (Geiger pers.comm.).

Trawling in these areas resulted in much of the juvenile population being caught and caused significant damage to the deep sea coral reefs (SAFMC 1996, Anonymous seafood restaurant 2006). Additionally, many of the undersized shrimp did not survive capture and were dumped back in the sea, resulting in fewer mature shrimp in following years (Anonymous seafood restaurant 2006).

## Management

Prior to 1970, rock shrimp landings were classified as bycatch in the penaeid shrimp fishery, as described in the management timeline in figure 1.2. Management of other species of shrimp began when the Shrimp Fishery Management Plan was established in 1991, though rock shrimp were not included until 1995.

While some data was collected on landings of rock shrimp, the fishery essentially operated off the radar until protection for Oculina coral was proposed (Council staff pers. comm.). Submarine research in the deep reefs of Oculina coral documented wide swaths of broken coral attributed to rock shrimp trawls fishing outside of their usual sand areas. The South Atlantic Fisheries Management Council took action to protect these corals in 1995 and added rock shrimp to their Shrimp Fishery Management Plan by approving Amendment 1 (SAFMC 1996).

This amendment prohibited trawling for rock shrimp within the "Oculina Habitat Area of Particular Concern," east of 80° W longitude between 27° 30' N and 28° 30' N latitude in depths less than 100 fathoms to protect Oculina coral reefs and additional living hard bottom habitat (SAFMC, 1996). Fishermen and vessels catching rock shrimp were required to obtain permits and dealers receiving rock shrimp were required to report any landings they received to NOAA Fisheries (SAFMC, 1996).

In 2002 the Council also established a limited access program for the rock shrimp fishery through Amendment 5 and required all vessels fishing with a limited access permit to use a vessel monitoring system (VMS) (SAFMC, 2002). Permits were issued to vessels qualified by recent landings of rock shrimp and a fixed number of permits was set. To limit effort while still allowing new participants to join the fishery, permits are releasted to the public after not being used for four years in a "use it or lose it" provision. This amendment also set up a minimum mesh size for rock shrimp nets to allow juvenile shrimp to escape.

## Potential for Growth

Trawl boats fishing for rock shrimp can switch to fishing for brown, white and pink shrimp (the penaeid shrimp) without changing gears.* This means that effort can shift rapidly from one fishery to another depending on changes in price and other incentives, with implications for management of the fishery.

For example, the amount of time and effort directed to the rock shrimp fishery often depends on the success of the other shrimp fisheries in the area (SAFMC 1999).* Fishing for rock shrimp provides supplementary income for participants in other shrimp fisheries or is treated as a fallback option when other shrimp are not available (SAFMC 1999).*

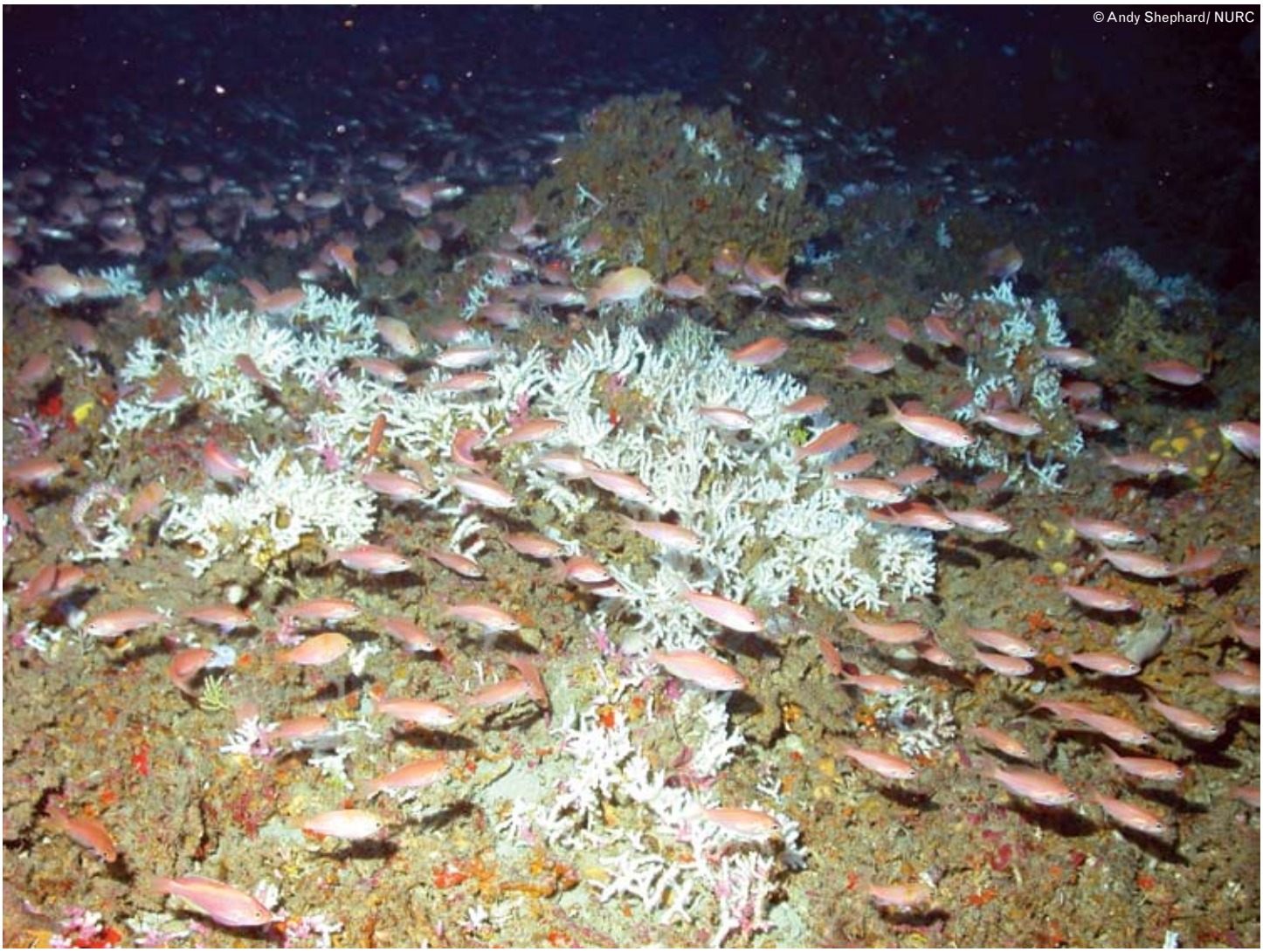
A subset of the large freezer trawlers focus solely on the rock shrimp fishery (SAFMC 1999).* This specialization is likely due to their success with rock shrimp and the recent limits on entry into the fishery.*

## Fleet Movement

In addition to participating in other fisheries, many of the larger rock shrimp vessels in the region are very mobile and range widely throughout the south Atlantic and the Gulf of Mexico region (SAMFC, 1999).

Vessels will not necessarily land their catches in the states from which they are based. For example, in 1994 vessels from North and South Carolina, Georgia, Florida, Texas and Alabama all landed rock shrimp in Florida (SAFMC, 1999). Even with more recent rising fuel costs, some


Rock shrimp are a popular item at restaurants and in this case are served with their hard shells still attached.




Schools of fish on the Oculina deep sea coral reef.

fishermen report regularly traveling from the Gulf to fish the Atlantic Coast of Florida.*

Movement of rock shrimp effort between jurisdictions and landings recorded in other states delayed development of a management framework for this fishery and underlines the importance of information exchange between regional fishery management councils.

# ROYAL RED SHRIMP

Royal red shrimp (*Hymenopeneaus robustus* or *Pleoticus robustus*) is a deep sea shrimp known for its sweet, juicy flesh and striking red color. The fishery for royal red shrimp serves a niche market, representing a very small proportion of the overall shrimp industry in the Southeast U.S. and Gulf of Mexico as illustrated in figure 1.1 on page 2. Unlike the shallow-water shrimp species that complete their life cycle within a year, royal red shrimp live for several years and a range of ages are caught by the fishery (Cascorbi 2004).

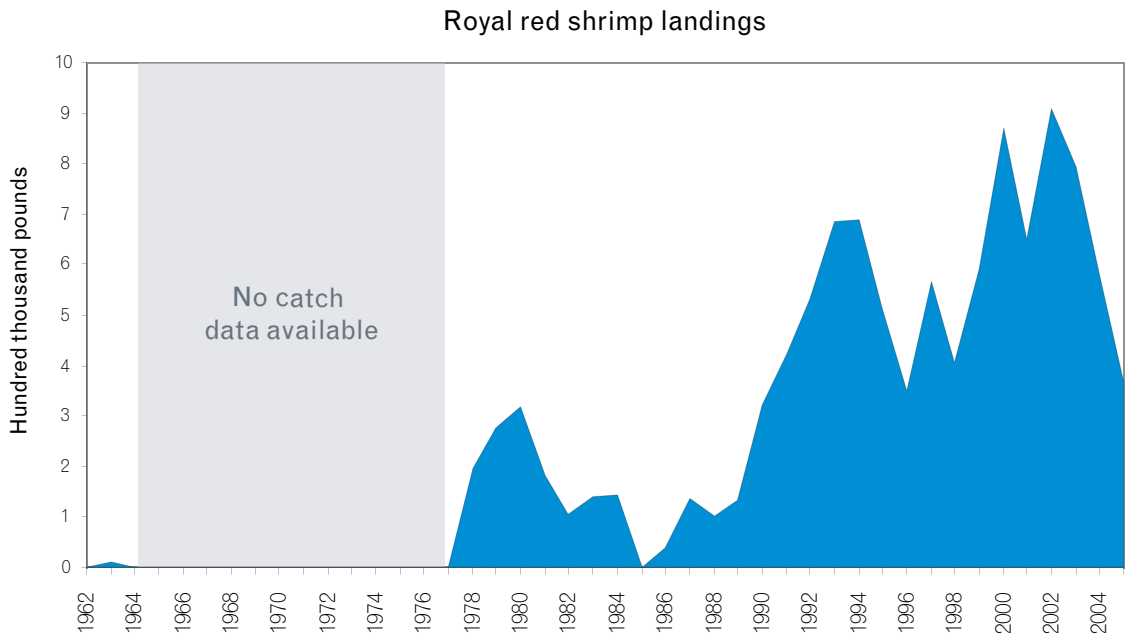
## Habitat

Typical habitat for royal red shrimp includes sediment carried offshore by the Mississippi and other rivers emptying into the sea. This includes blue/black mixtures of sand, silt, mud, and a more gritty white calcareous mud (SAFMC 1998a, GMFMC 2004). Specific examples of these characteristic habitats include white calcareous mud off the Dry Tortugas and blue/black silt of the Mississippi River Delta (GMFMC 2004).

Royal red shrimp larvae are carried north by the Gulf Stream to settle into adulthood along the Atlantic Coast (SAFMC 1998a). Observations by submarine suggest that royal red shrimp are also sometimes found among deep sea corals in association with these complex reef habitats (Ross 2005).

The estimated biological range for royal red shrimp extends along the continental shelf from 590 to 2,395 feet (180-730m) (Perry and Larson 2004). Peak concentrations are usually found at depths of between 820 and 1,558 feet (250-475m) (GMFMC, 2004). Potential royal red shrimp habitat is illustrated in the map on page 14 based on published depth ranges. This shrimp species appears consistently in the same locations over time (Sherman pers.comm.).

Royal reds are found throughout the Gulf of Mexico and along the Atlantic coast from Cape Cod, Massachusetts, to French Guiana in South America (SAFMC, 1998a). In the Southeastern United States the core habitat areas are located off Florida and the northeastern Gulf of Mexico (GMFMC, 2004). Core royal red habitat areas are illustrated on the map on page 14 based on published descriptions and informal interviews, including specific depths between Louisiana and Tampa, Florida, and an area off the Dry Tortugas in the Florida Keys (Rezak et al. 1985).




**Industry**

1950 — Federal agency sponsors experimental fishery

1962 — First commercial landings

1995 — New England experimental fishery

**Management**

1981 — Gulf of Mexico shrimp fishery management plan includes royal red shrimp

1991, 1994, 1996 — Overfishing and total allowable catch defined (Gulf Amendments 5, 7, 8)

1996 — Sustainable Fisheries Act negates earlier total allowable catch

2002 — Traps prohibited (Gulf Amendment 11)

Figure 2.1


Deep sea shrimp such as this one may be found in *Lophelia* coral reefs at 1700 feet deep off Florida.

## Fishery Description

Royal red shrimp occupy a niche market due to their small size, sweet taste, and bright red color. They are sometimes popular because they look good on a plate (Nicholson pers.comm.) or are used as "sweet shrimp" in sushi and in Asian restaurants (Jamir pers.comm., The Shrimp Lady 2007). The market for this species is relatively small because they do not freeze as well as the more well-known shallow water shrimp (National Shrimp Festival 2004). These shrimp require specialized equipment on board so that they can be individually quick frozen and stored in brine (Alabama Sea Grant 1987, The Shrimp Lady 2007).

The royal red fishery off St. Augustine, Florida, operates at peak levels in late summer and fall (Florida Dept. of Agriculture 2006). Royal red shrimp are harvested with trawl boats that fish in waters more than 120 feet (37m) deep, dragging four nets at a time that are each 55 feet (17m) long (Cajun Steamer 2005, Florida Dept. of Agriculture 2006). Vessels typically leave port for three weeks at a time, though shorter trips closer to port may be made to provide a consistent supply of fresh royal reds (Sherman pers.comm.).

The extreme ocean depths require additional cable, strong winches, and a solidly seaworthy boat due to the risk of capsizing in poor weather conditions (Nicholson pers.comm., Sherman pers.comm,). Standard shrimp boats regularly focused on shallow-water penaeid species are not always large enough to fish for royal reds (Nicholson pers.comm.).

In 2005 an estimated fleet of 14 vessels participated in the royal red shrimp fishery, fluctuating between four and 15 vessels since the year 2000 (GMFMC 2005). In the Gulf of Mexico, less than one percent of the estimated 2,600 shrimp vessels land royal red shrimp in any given year (GMFMC 2005). Along the east coast of Florida, between two and ten vessels are estimated to participate in the royal red shrimp fishery, as reported to the Shrimp Committee of the South Atlantic Council (2007).

## Fishery History

Royal red shrimp were developed as an experimental fishery in 1950 with support from the Bureau of Fisheries, the federal agency that later became NOAA Fisheries (NOAA 2004a, NOAA 2004c, Sherman pers.comm.). The commercial fishery began officially in 1962 in the Gulf of Mexico and off Florida's east coast (NOAA 2004b). Trawl boats were converted from other shrimp fisheries and the fleet grew to 19 boats by the end of the first year (NOAA 2004b). The New England fishery did not develop until 1995, when an experimental fishery was initiated (Balcom et. al 1996).

The Gulf of Mexico fishery has been the most active with landings averaging about 272,000 pounds per year since 1998, and has not yet reached the limit of 392,000 pounds set by NOAA fisheries as an estimated total allowable catch (Cascorbi 2004, GMFMC 2003). Seafood dealers in Alabama report that they tend to receive landings of 80,000 to 90,000 pounds at a time of royal red shrimp (Graham and Loney pers.comm.) Overall patterns in historic landings of royal red shrimp are described in figure 2.1 based on NOAA Fisheries Statistics.

Hurricanes Katrina and Rita interrupted operations and damaged equipment at coastal shrimp processing plants in the Gulf of Mexico, but as of 2006 business was underway for at least some processors (Graham and Loney pers.comm., Bon Secour Fisheries, Sea Pearl Seafood). Despite reduced effort, landings of royal red shrimp have not declined following the hurricanes (GMFMC 2005b).

## Fishery Location

Core royal red fishing areas are illustrated on the map on page 14 based on interviews, fishery management council documents, and very limited scientific literature. Royal red shrimp are not fished in their entire range because not all areas have a high enough density of shrimp to be commercially viable (GMFMC 2005, Sherman pers.comm.).

Royal red shrimp has been caught off Texas, Louisiana, Mississippi, Florida, Georgia, and the Carolinas (GMFMC 2005, Moon pers.comm., Graham and Loney pers.comm., Sherman pers.comm.). Core areas are located off Florida and the northeastern Gulf, including specific sites off of Mississippi, Tampa and Pensacola on the Gulf coast of Florida, the east coast of Florida, and Georgia. Catches from the Gulf of Mexico and South Atlantic council regions are illustrated in the figure 2.2 with data from NOAA Fisheries Statistics.


Fishing for royal red shrimp with a deep sea trawl.

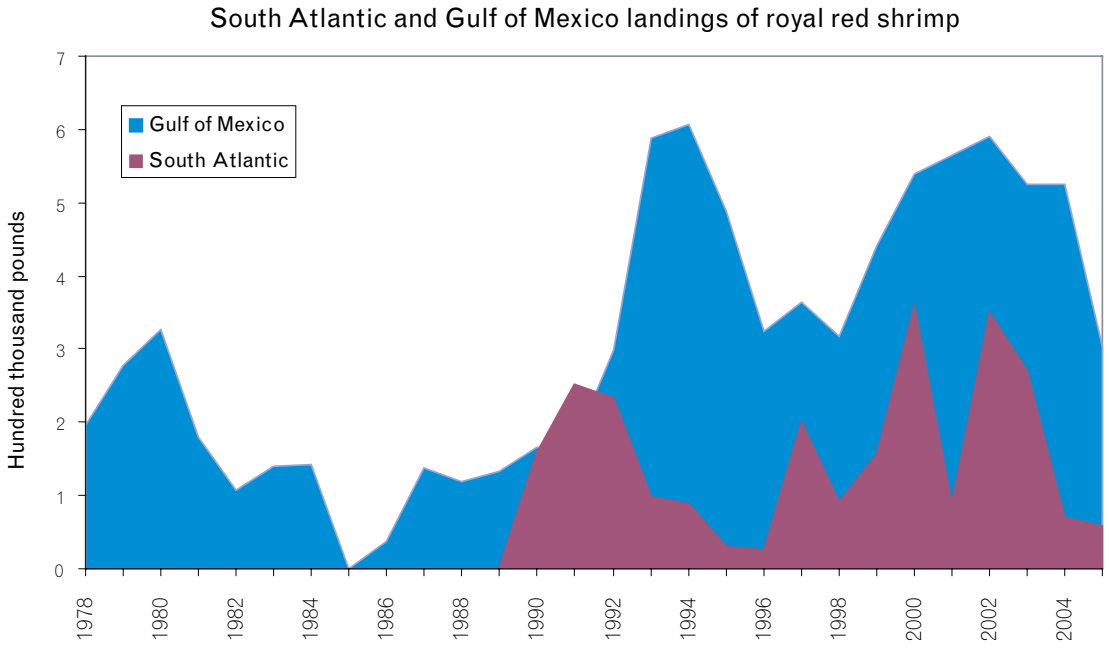



Figure 2.2

Reported depth ranges for the royal red shrimp fishery include depths from 800 feet to more than 1800 feet (250-550m) (Perry and Larson 2004, Rezak et al. 1985, Alabama Sea Grant, 1987). For example, trawl boats may drag as deep as 1800 feet, starting at one depth and continuing deeper at intervals of 150 feet (Nicholson pers.comm., Sherman pers.comm.).

## Management

As described in the management timeline, figure 2.1 on page 6 , royal red shrimp were included in the first Shrimp Fishery Management Plan in 1981 by the Gulf of Mexico Fishery Management Council, nearly twenty years after the first commercial landing of the species (GMFMC 2007).

Additional discussions led to the approval of three subsequent amendments to define overfishing and total allowable catch levels in 1991, 1994, and 1996. These criteria for management were later negated by new national requirements for the prevention of overfishing in the 1996 Sustainable Fisheries Act (GMFMC 2007).

In 2002, the Gulf of Mexico Fishery Management Council passed Amendment 11 to the Shrimp Fishery Management Plan of 1981 to require commercial vessel permits for royal red shrimp boats. This action made it possible to estimate fishing effort (GMFMC 2002). Amendment 11 also prohibited the use of traps to harvest royal red shrimp (GMFMC 2002). Traps were banned to end gear conflict between sectors of the industry in favor of the trawl boats and against participants using traps.

Starting in 2006, the Gulf Fishery Management Council began requiring a specific permit to catch royal red shrimp rather than the generic fishing permit that was previously used. This amendment also established overfishing criteria and total allowable catch levels to replace those invalidated in 1996 (GMFMC 2007).

Specific areas of royal red shrimp become depleted if they are fished too often, and some fishing operations will direct effort toward another location for a while to allow the shrimp to return (Sherman pers.comm.). Despite these localized examples and the naming of an official threshold for overfishing in Amendment 13, it is completely unknown whether the fishery is approaching or has reached the level of being overfished, because NOAA Fisheries has not described the specific biology and needs of this species (Cascorbi 2004).

The National Marine Fisheries Service has not conducted a full stock assessment on royal red shrimp and the South Atlantic Fishery Management Council does not have a management plan for the royal red shrimp fishery.

## Potential for Growth

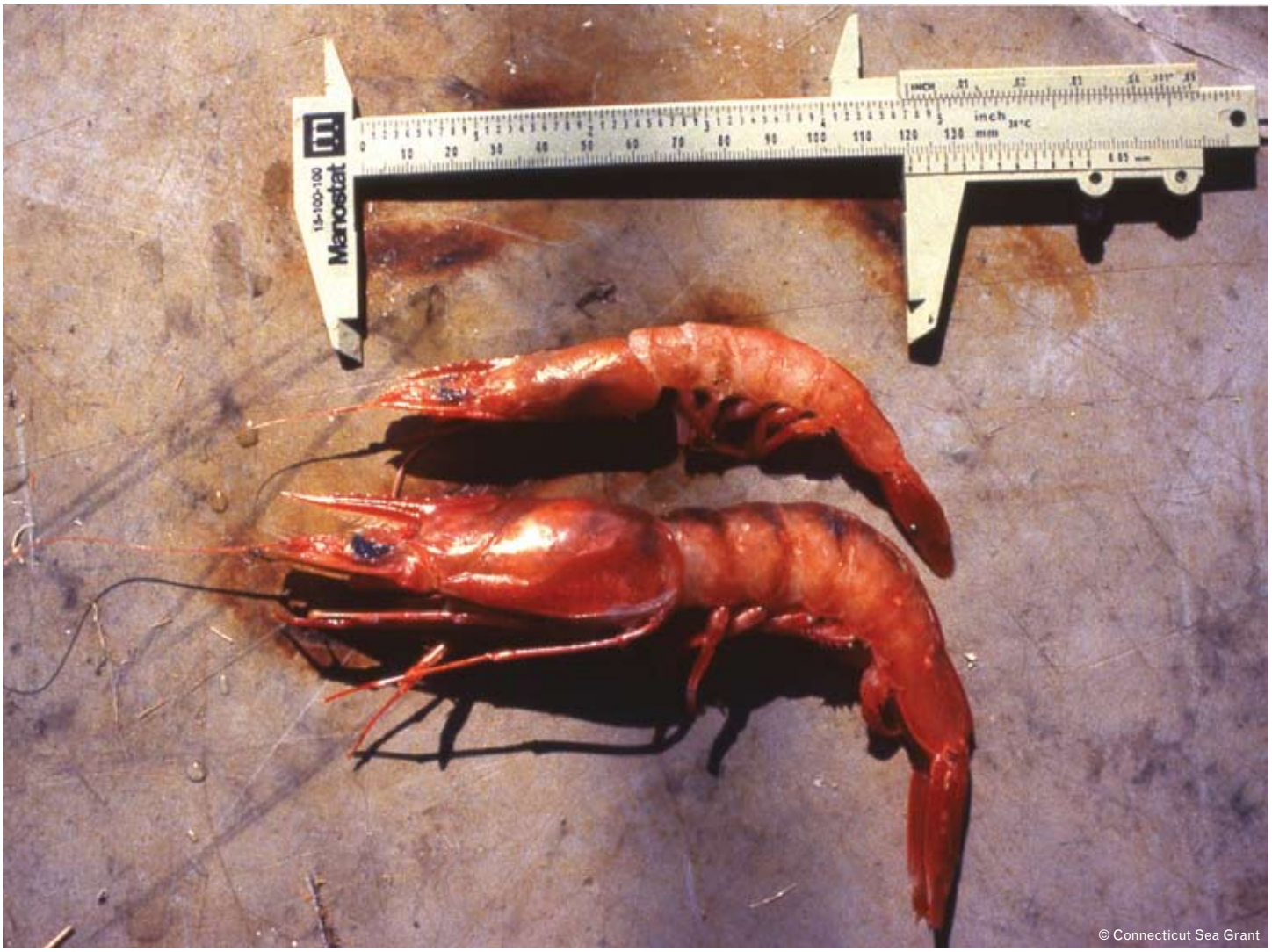
Though targeting royal red requires additional gear, there is some flux between the shallow-water peneaid shrimp fleet and the royal red fleet (GMFMC 2005). Royal red shrimp receive more fishing pressure as their price rises (Cascorbi 2004) or when prices for other shrimp are down (Moon pers.comm.). This suggests that latent effort in the fishery may be larger than is initially apparent.

While fishing for royal red shrimp requires specialized equipment, the larger, heavier gear used for this fishery is then used to trawl for other species. The estimated cost to retrofit an average shrimp boat to harvest royal reds ranges from about $50,000 to $70,000 (GMFMC 2005). Royal red shrimp sell at a premium price, though per-pound prices for royal reds may appear lower at a glance if sold with the heads on.

Of the 14 active vessels identified in 2005, a third relied on royal reds as their primary revenue source, with more than 40 percent of revenue derived from royal red shrimp (GMFMC 2005). Another third relied on royal reds as one of several income sources. The remaining third relied on royal red shrimp as a minor component of their business, landing royal red shrimp for 20 percent or less of their revenue (GMFMC 2005).

Several businesses in the royal red fishery combine boat ownership and operation with onshore processing facilities. Each business owns a small group of four to six boats in addition to processing or selling wholesale and retail from one facility near the dock. If needed, they may supplement their own catch with purchases from other boats (Anonymous seafood dealers).

Fishermen perceive the royal red shrimp fishery as a more difficult fishery, requiring greater investment and specialization and presenting higher risks. This may explain why past participation has been relatively low. Costs are higher due to the longer distance traveled to reach offshore areas and higher fuel consumption to trawl deep water shrimp (GMFMC 2005). In the strong currents and deep water of the Gulf Stream, sea conditions increase both safety concerns and fuel costs (National Shrimp Festival 2004).





Royal red shrimp are a deep sea species known for their brilliant color.

# CALICO SCALLOPS

Calico scallops (*Argopecten gibbus*) are more closely related to bay scallops than to sea scallops (Allen and Costello 1972, Powers pers.comm.). Sea turtles, rays, skates, crabs, pufferfish, batfish, sea stars, and twenty-four species of fish feed on calico scallops (Arnold 1995). Calico scallops are excellent swimmers and improve the water quality in their surroundings as they continually remove particles for food (Murphy 2004, Allen and Costello 1972, Powers pers.comm).

Calico scallops are relatively small with a maximum size under 4 inches, and some say their meat is sweeter and more succulent than other species (MacKenzie et al. 1997, King 1999a). Atlantic calico scallops sold in the United States traditionally come from within U.S. waters (Environmental Defense 2005).

Calico scallops filter the surrounding water in search of food.

## Habitat

Scallop beds tend to parallel the coast, with scallops concentrated around coastal high points (Hill 2005a, SAFMC 1999). Prime habitat for calico scallops includes low-relief rock habitat in marine and estuarine waters from subtidal depths out to the continental shelf (Hill 2005a, Powers pers. comm.). Calicos have a low tolerance for fresh water and are a more strictly marine species than other scallops.

Observations by submarine in 1967 and in the 1970s identified "deep mounds of living scallops" in sand-shell bottom west of the Oculina coral reefs (Cummins 1971, Reed pers.comm.). Typical seafloor habitats where these scallops are found include unconsolidated quartz sand, other hard sand, sand-shell, sand-gravel, or gravel (Allen and Costello, 1972). In Bermuda, calico scallops may also associate with turtle grass beds (Allen and Costello, 1972).

Delivery of scallop larvae by ocean currents may help define the locations of productive scallop beds (Allen and Costello 1972). For example, similar genetics and physical characteristics suggest that North Carolina populations are supported by scallop larvae carried by the Gulf Stream from Florida (Murphy, 2004). The importance of ocean currents would also explain why beds are near coastal high points and aligned parallel to the coast (Allen and Costello, 1972).

Juveniles land on adult scallops, empty shells or other hard substrate after drifting through the first phase of their life. Young scallops require these hard surfaces to survive, where they then become attached to the seafloor with special fibers like those of a mussel (Allen and Costello 1972, Powers pers.comm.).

The estimated range for calico scallops includes depths between 30 to 1,300 feet (10-400m) along the continental shelf (Murphy 2004, Arnold 1995). Scallop beds have a patchy distribution along the Atlantic from Delaware Bay, through Florida and the Gulf of Mexico, Bermuda, the Caribbean Sea, southward to Brazil (Murphy 2004, Arnold 1995). Potential calico scallop habitat is illustrated in the map on page 14 based on published depth ranges and fishery management council reports.

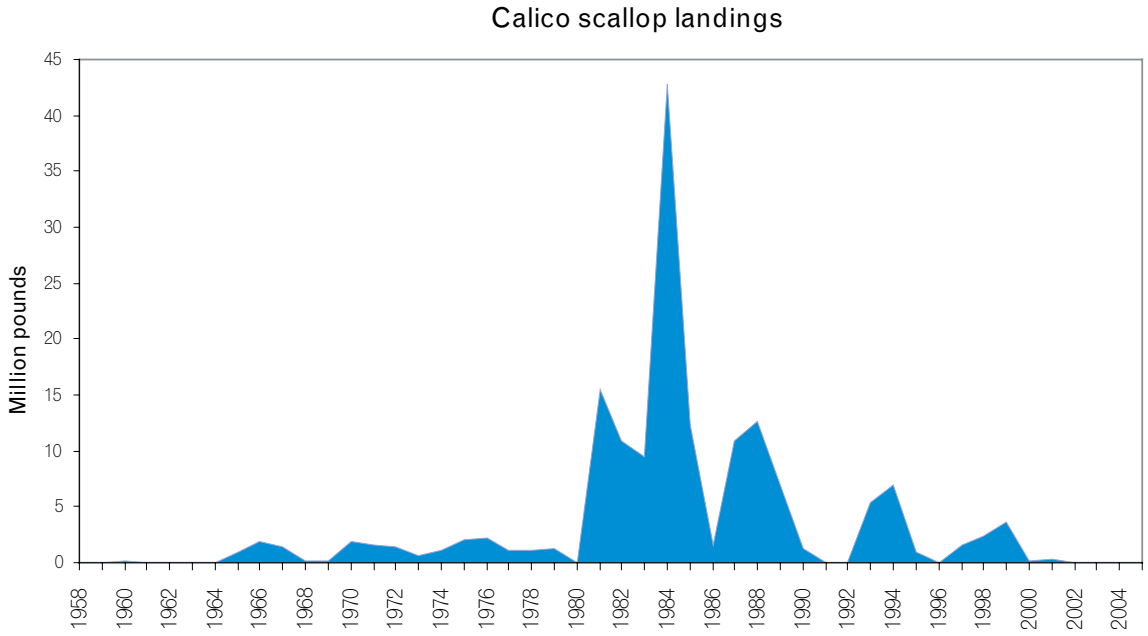
Core habitat areas include beds off Cape Lookout, North Carolina; Cape Canaveral on Florida's Atlantic Coast; and Cape San Blas on Florida's Gulf Coast (Cummins 1971, Hill 2005a). Calico scallop beds cover broad expanses of seafloor off Cape Canaveral, including areas more than 2600 x 8600 feet (730 x 2600 m) continuing along the Florida coast for more than 200 miles (320km) between St. Augustine and Stuart (Hill 2005a, SAFMC 1999).

Calico scallop beds are highly consolidated and become depleted by trawling, requiring a number of years to recover before they reach commercially viable densities, if they recover at all (Flanigan pers.comm.). Trawling has homogenized the seafloor in some of the prime habitat areas and may have reduced the ability of scallop populations to recover, since young scallops often attach to old shells and adults in well-developed scallop beds (SAFMC 1999, Geiger pers.comm., Murphy 2004). Off Florida, dense calico scallop beds observed by submarine in the 1970s had been depleted and were no longer seen in the same locations by the 1980s (Reed pers.comm.).

## Fishery Description

Scallop dredges were the primary gear used during the early years of the fishery, but calico scallops are now most commonly caught with shrimp trawls (MacKenzie et al. 1997, Murphy 2004, Cummins 1971, Powers pers. comm.). The shrimp boats drag two 40-foot trawl nets at the same time for half an hour at a time, covering large areas (Murphy 2004, Powers pers.comm.).

Calico scallops provide food for sea turtles and play an important role in the ecosystem.




**Industry**

| 1949 | 1954 | 1958 | 1959 | Mid-1960s | 1978 | 1984 | 1993 | 1996 |
|---|---|---|---|---|---|---|---|---|
| Research vessel discovers calico scallops off North Carolina | Experimental fishery begins in northeast Gulf of Mexico | Florida Gulf coast fishery begins and declines within a year | North Carolina fishery begins | Technology developed to remove scallops from their shells | South Carolina-Georgia fishery begins | Florida Atlantic coast yields peak landings | Florida Gulf coast fishery declines | No landings as calico scallop boats target rock shrimp |

**Management**

| 1981 | 1986 | 1995 | 1998 | 1999 |
|---|---|---|---|---|
| Council discusses calico scallop, decides not to manage the fishery (South Atlantic) | Council reconsiders, again decides not to manage the fishery (South Atlantic) | Public meetings on calico scallop (South Atlantic) | Oculina protected, VMS required, management drafted (South Atlantic) | Management plan rejected by federal agency |

Figure 3.1

Some vessels shuck scallops on board and return the shells to the sea where they can provide substrate for juvenile scallops. However, many more vessels process their catch onshore (Murphy 2004, MacKenzie et al. 1997,*). The dominance of shore-based processing means that the fishery relies on deepwater ports with suitable facilities. Calico scallop ports in the South Atlantic region are described in the map, figure 3.2 on page 12. Additional criteria for calico scallop ports include docks that accommodate tractor trailers, fuel and processing plants (SAFMC 1998b).

In addition to the primary market for calico scallop meat, historically the roe, guts, and shells have been used for specialty foods, animal feed, industrial applications such as concrete, and substrates for oyster culture (Allen and Costello, 1972).

## Fishery History

A research vessel first identified populations of calico scallop off North Carolina in 1949, followed by federal agency explorations in the 1950s, and development of a small-scale commercial fishery by 1959 (MacKenzie et al. 1997, Arnold 1999, Arnold 1995). During early years of the fishery the federal Bureau of Fisheries explored the range of calico scallops and gave dredging demonstrations at sea to fishermen (Cummins 1971).

The invention of technology to shuck and remove scallops from their shells in the mid-1960s facilitated growth of the industry with peak landings of around two million pounds in the 1960s (MacKenzie et al. 1997, Geiger pers. comm.). South Carolina and Georgia first supported a fishery in 1978 after calico beds were identified in 1977 (Anderson and Lacey 1979).

As illustrated in the graph of calico scallop landings in figure 3.1, catches have fluctuated wildly and declined overall after passing their peak. Landings in North Carolina have never rebounded to the peak fishing levels of 1965-1972 (Arnold 1995). North Carolina landings continued intermittently after this time and as the beds became depleted the fishery shifted southward to Cape Canaveral, Florida in the 1970s (Murphy 2004).

Calico scallop populations have been depleted in recent years and are believed to be at a low point (Environmental Defense 2005, *). Landings

in the Florida beds peaked in 1984 after several years of record landings, dropping dramatically to current levels which remain less than 50 percent of peak landings of over 40 million pounds (Murphy 2004). More recent Florida landings (2003) are only 1 percent of the historical average. The geographic range of the fishery has also contracted and is now focused exclusively in waters off Brevard County, Florida (Murphy 2004).

Several sources report that the fishery is not active and not currently profitable due to high fuel costs and participation in other fisheries, despite expectations that there may be calicos available (Shumway pers.comm., Geiger pers.comm.,*).

## Fishery Location

Calico scallops are caught primarily in three areas: off the coast of North Carolina, off the east coast of Florida, and in northeastern Gulf of Mexico. Core fishing areas are illustrated in the map on page 14 based on fishery management council documents, interviews, and scientific literature.

The North Carolina fishery previously operated northeast and southwest of Cape Lookout. The Florida fishery extracts scallops from beds off the Atlantic coast from St. John's River to Fort Pierce. The Gulf of Mexico fishery rarely seeks calico scallops, operating in beds off Apalachicola Bay from Carrabelle, Florida, to Mobile, Alabama. (SAFMC 1999, Schwartz and Porter 1977, Murphy 2004). Additional landings have been recorded off Tampa and Key West, Florida; South Carolina; and Georgia (SAFMC 1999).

## Potential for Growth

The calico scallop and shallow water shrimp fisheries are fluid, and the same boats can be used in both fisheries relatively easily.* For example in 1985, 250 of the 1000-2000 shrimp boats participated in the calico scallop fishery.* In the reverse example from 1996, no landings were reported in Florida due to an apparent switch by the entire fleet to the rock shrimp fishery (Murphy, 2004). Some of these separate fisheries could be more accurately characterized as one fleet with varying targets and a multispecies catch, similar to groundfish trawls in other regions.


Calico scallops get their name from the mottled or calico markings on the shells.

Calico Scallop Ports, 1980 - 2003

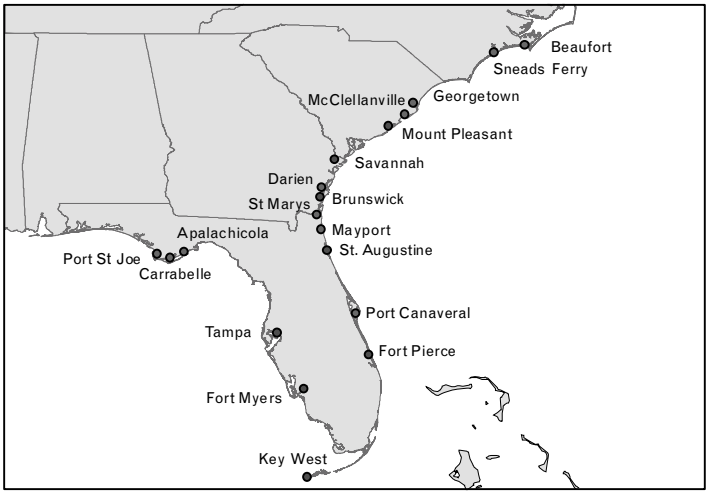



Figure 3.2

Many fishermen participate in scalloping as a part-time or seasonal activity to supplement their primary income from catching other species (SAFMC 1999). In addition to this highly variable fleet size and effort, local populations of calico scallops appear to experience dramatic natural fluctuations in their abundance. Commercial landings of calico scallops are typically "boom and bust" with large catches in one year followed by years of little or no catches (Arnold 1999).

This rollercoaster appears to be driven by a combination of uneven fishing pressure and uneven recruitment of young scallops. Contributing factors include fluctuations in ocean currents, the supply of young scallops, the removal of shell habitat by trawls and dredges, and excess removal of adult scallops (FMRI 2003, SAFMC 1999, Powers pers.comm.).

## Fleet Movement

Vessels from the Atlantic and Gulf will travel to where the fishing is most profitable, and all but the smallest shrimp boats are capable of traveling around the Florida Keys to cross between council jurisdictions.*

New England scallop landings and prices have spiked in recent years, attracting a large number of boats, people, and fishing effort from other areas along the Atlantic coast (Flanigan pers.comm.). For example, shrimp boats that might otherwise target calico scallops have been traveling up to New England participate in the now-lucrative sea scallop fishery. New England fishermen have also been buying up boats in the Gulf following hurricanes Katrina and Rita for use in the Mid-Atlantic and New England sea scallop fleets. However, regulations currently being discussed would limit access by long-distance boats (Flanigan pers.comm.).

# APPENDIX 1. INTERVIEW QUESTIONS

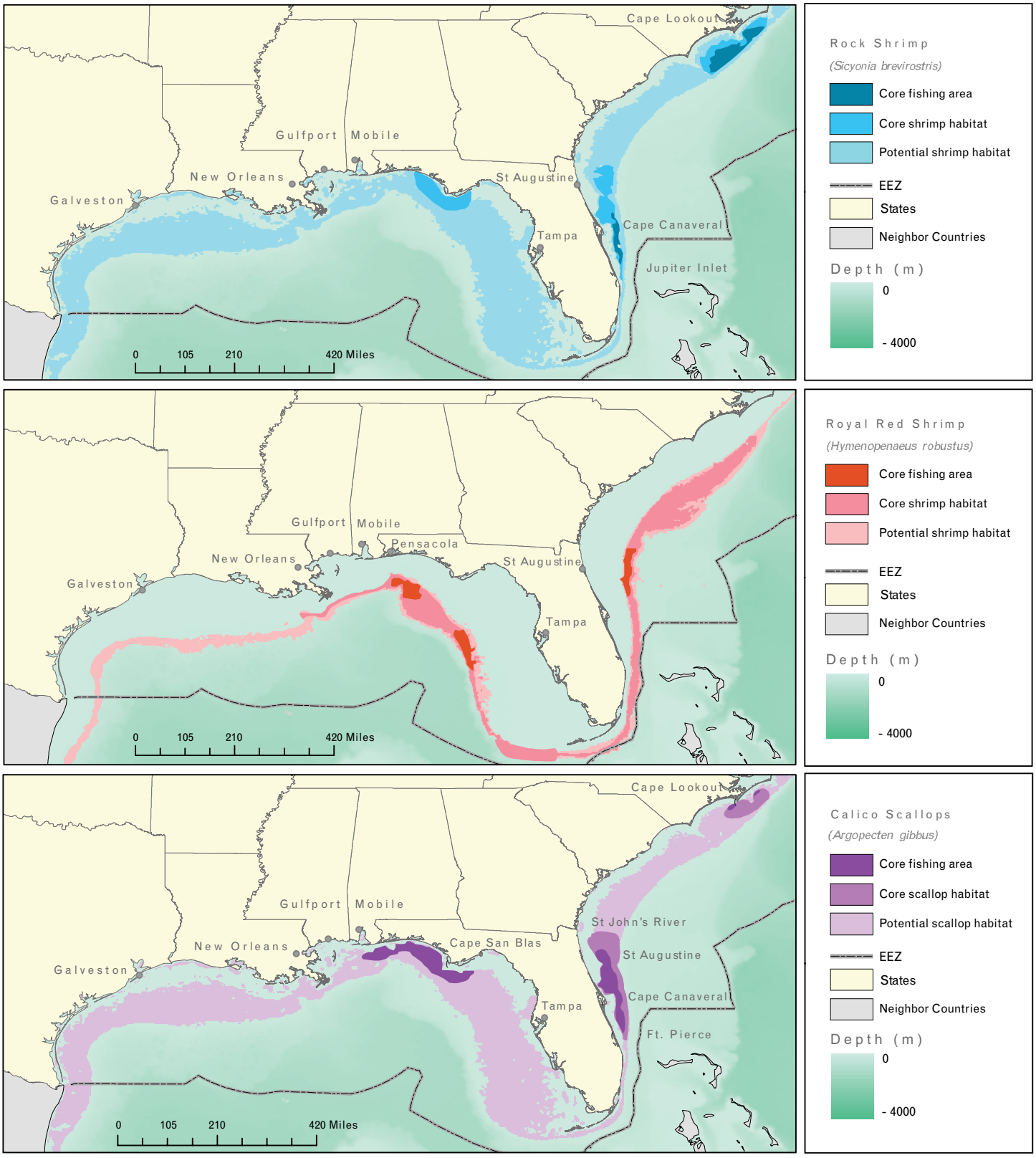
Interviews were conducted with fishermen, seafood dealers, restaurant owners, university researchers, Sea Grant representatives, and South Atlantic Fishery Management Council Advisory Panel members. Respondents were contacted by phone, email, and in-person interviews were conducted in Cape Canaveral, FL; Bayou Le Batre, AL; and Bon Secour, AL. The response rate for the survey was between 37 and 46 percent, with fourteen respondents providing detailed information and many more answering more briefly.

1. Which times of year are rock shrimp/royal red shrimp/calico scallops available?
2. Which ports are they landed in? (especially royal red shrimp)
3. Are they caught as a side business?
4. Is there are crossover between the royal red shrimp, rock shrimp and calico scallop fisheries?
5. Do boats travel around Florida to fish?
6. How does the market for them compare to other fisheries?
7. What is the status of the Gulf fishery in recovery after Katrina?
8. Can you suggest further contacts? Or send any literature or photographs?
9. Where would the best place to conduct in-person interviews be?

# APPENDIX 2. MAP OF FISHERIES

## Deep Trawl Fishing in the Gulf of Mexico and Southeast

Approximate depths reported by fishermen and dealers



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* In the text above, sentences marked with an asterisk represent information from interviewees who prefer not to be named.

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