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Sea Life of The Wilderness Coast

The Big Picture

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SEA LIFE OF THE WILDERNESS COAST: THE BIG PICTURE

Overview

Florida's Panhandle and Big Bend Gulf waters – extending from Cape San Blas to Clearwater and termed the Wilderness Coast by local naturalists -- host some of the most diverse and abundant sea life on the continent, by virtue of highly productive unspoiled habitats. Primary habitats include extensive salt marshes and estuaries that grade near shore into seagrass meadows and oyster reefs, providing nursery and feeding grounds that are contiguous along the entire coast. Among the region's most highly valued life forms are grouper, blue crabs, stone crabs, shrimp, scallops, oysters, sea trout, red drum, flounder, clams, and more. But myriad other life forms comprise the foundation that allows the species of direct interest to us to prosper. Economically important species are integral to a complex interdependent web of relationships among many lesser-known species, including microorganisms, within a dynamic physical realm. Described here are key features of this biologically rich region and the physical, chemical, and ecological processes that support the area's intense productivity.

The Waters and Physical Factors

The eastern Gulf of Mexico comprises mainly tropical oceanic waters that flow westward from the Atlantic through the Caribbean Sea then shunt abruptly northward along the Central American coast, accelerating through the narrow channel between Yucatan and Cuba. As depicted in Figure 1, most of this water mass bends sharply clockwise then southward in a tight bend – named the Gulf Loop Current – well offshore south of Pensacola. The southward moving Loop Current funnels between northern Cuba and the Bahamas and Florida, giving rise to the Gulf Stream. The northern Loop Current, prevailing winds, and Florida continental shelf contour create a counter-clockwise rotating gyre, just offshore of the Florida Big Bend[1]. The gyre's currents act as a conveyor belt, delivering to the coastal habitats tropical marine species, as well as larvae of northern Gulf fishes and invertebrates that spawn offshore.

Although a fraction of our local inshore coastal species has tropical origins (e.g., wrasses, cowfish, tarpon), they are typically seasonal, dying or migrating offshore or southward during the colder months. Tropical forms do well at salinities of 37 parts per thousand (ppt) and temperatures ranging from 24 to 28°C (75-82°F) in the open Gulf. However, our shallow inshore water conditions are greatly regulated by the temperate seasonal climate and the freshwater inflow from rivers such as the Apalachicola (providing by far the largest volume of fresh water regionally), the Ochlockonee, and the St Marks, as well as many springs, creeks and a subsurface cascade of fresh water draining through porous sand into the shallows (Figure 2). The effect of the freshwater input is two-fold: salinities in the estuaries and near shore are lower than the open Gulf and highly variable, depending on rainfall over land. During tropical storm deluges, the salinity of St George Sound, in front of the Florida State University Coastal and Marine Laboratory (FSUCML), may be near 20 ppt. But during long drought periods, it rises to at least 33-34 ppt. Because the region is so shallow,

[1] Florida's Big Bend is the drowned karst region of the coast that lacks barrier islands and extends from Ochlockonee Bay near Alligator Point to North Anclote Key (or the Anclote River), covering a coastal distance of 200 miles.

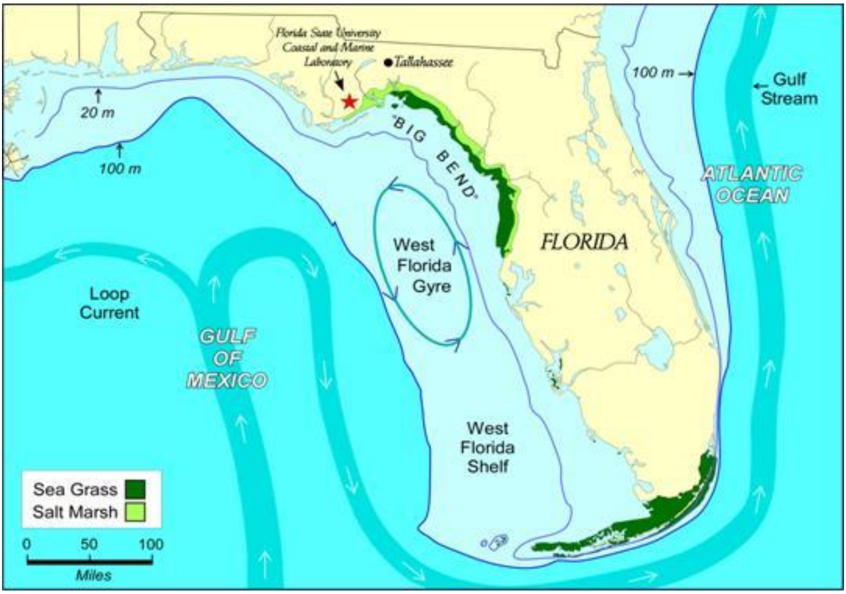

Figure 1. Tropical oceanic water delivered by the Loop Current brings stable offshore conditions to the northeastern Gulf of Mexico throughout the year. The West Florida gyre is an eddy that transports larvae and other life stages of both Gulf and Caribbean species along the Big Bend. The relatively shallow Florida shelf is flooded by a mixture of Gulf waters and brackish river and runoff waters from the land. Hence, coastal water conditions change seasonally. The extensive sea grass meadows and salt marsh creeks serve as the early nursery and feeding grounds for diverse fishes and invertebrates.

creating rapid thermal transfer, the temperature also varies greatly with season, ranging from 15 – 32°C (59 – 90°F) in the shallows.

In estuaries and salt marshes, conditions can be far more extreme, placing physiological stress on estuarine inhabitants. At high tide in the back marshes during dry periods in summer, salinities and temperatures can exceed 40 ppt and 35°C (95°F), respectively, conditions lethal to bay and offshore fish and invertebrates. Yet many near-shore Gulf species can cope with these stressful conditions by physiological mechanisms or behavioral changes, including migration. Most marsh species found locally fit this profile, including fiddler crabs, marsh periwinkles, and killifishes. Killifishes actually require high water temperatures for spawning and rapid embryonic development. Moreover, the hardy constitution of species of the sea's edge allows them to feast at the marine buffet of plant and animal plankton, whose growth is stimulated by the constant supply of nutrients delivered by freshwater rivers, runoff, and the incoming tide. Hence, some of our most prized commercial and recreational species – blue crabs, shrimp, red drum, clams, and oysters –have evolved to withstand the coastal rigors and so prosper to their -- and our – benefit.

Box 1. Declining freshwater flow in the northeastern Gulf of Mexico

The Apalachicola-Chattahoochee-Flint River Basin is a major watershed flowing through the states of Georgia, Alabama, and Florida. Water is withdrawn along its length for agricultural and municipal needs, especially from Lake Lanier, a retention lake created by the Army Corps of Engineers (USACE) outside of Atlanta. Water stores in the lake have declined significantly in recent years, reaching record lows due to severe drought conditions coupled with withdrawals that subsidize freshwater demands of Atlanta's growing population. As a result, the USACE has decreased freshwater releases downstream causing dramatic increases in the salinity of Apalachicola Bay.

Scientists at the FSUCML investigated the effects of this change in salinity on the oyster population of the Bay. They found that increased salinity caused increased oyster mortality by two routes: (1) by increasing the incidence of the parasite *Dermo,* which thrives at high salinities and has already infected a large portion of Apalachicola's oyster population; and (2) by increasing migrations of marine predators such as the rock snail into the bay, an extremely effective predator on oysters. The Apalachicola Bay is the source of 90% of Florida's oyster harvest as well as 10% of that of the entire United States, so losses from disease and predation can have significant economic impacts on the region (Petes et al. 2012)

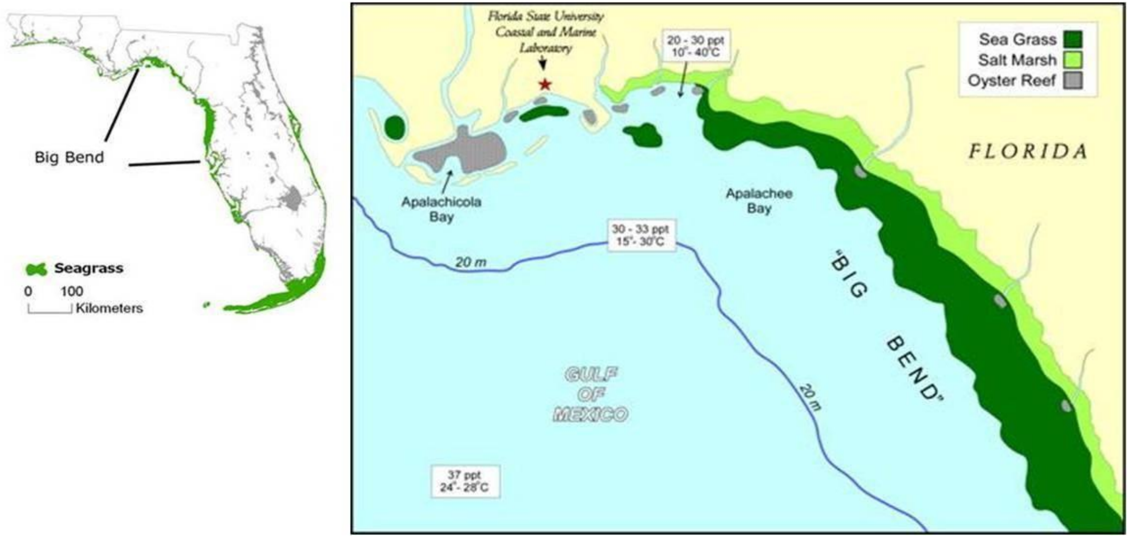

Figure 2. Florida's relatively undeveloped Big Bend Region contains bays and estuaries enriched by river-borne nutrients and extensive shallow, seagrass meadows – among the largest in North America. In the fringing salt marshes and near shore, species either adapt to the highly variable temperatures and salinities or migrate in and out as necessary to take advantage of the food and shelter derived from the primary coastal habitats (e.g., oyster reefs, marshes, seagrasses) and the intermittent rocky outcrops offshore.

Primary Habitats and Inhabitants

Sea grass and Salt Marsh as “Super Habitat” –

The Big Bend sea grass meadows and salt marshes, among the largest and most pristine in the US, lie on a shallow coastal shelf of low energy waves and current flow. The great coverage area reflects the shallow seaward slope of the low-lying coast and adjacent submerged lands. That is, pine flatwoods and wetlands slope gradually seaward grading into salt marshes up to ~6 miles (10 km) wide. The low-lying marshes are influenced by the reach of even the modest northeast Gulf tides of ~3 ft (1 m) height. At the shore, marsh vegetation stops abruptly and sea grasses begin and extend offshore as much as 9 miles (15 km). The coastal waters link the two great habitats. The creeks, river mouths, and adjoining bays constitute the estuarine waters that provide watery transit of nutrients and larval and swimming stages of crustaceans, mollusks and fishes. The estuarine margins also provide ideal conditions for oysters, plankton filterers that grow in large aggregations. Oysters provide the only regional large-scale solid substrate habitat, with its own distinct assemblage of inhabitants. In perspective, the marine habitats of the Wilderness Coast are interconnected physically, chemically, and biologically, creating one regionally continuous “super-habitat”. Collectively, these habitats provide many ecosystem services that range from regulating climate, water quality, circulation, waste absorption, and carbon fixation, to supporting nutrient cycling, primary production, and protection from wave surge while providing habitat that supports immense biological diversity.

Sea grass meadows in the Big Bend region consist primarily of three species: shoal grass, turtle grass, and manatee grass. Of these, turtle grass is the most extensive while manatee grass grows both in large stands and interspersed among turtle grass blades. Shoal grass, though less abundant, plays an important role colonizing the shallowest sandy bottom, stabilizing the substrate, and providing cover for many species. All of these species grow by underground runners that send up numerous leaf shoots into the water column, with patches composed of clones of one or a few individuals. The combined effects of the underground runners and vertical grass blades lock the substrate in place and slow water flow. Thus, sediment particles otherwise suspended in the water column by waves and currents, tend to settle to the bottom, reducing turbidity and allowing deeper light penetration to support more luxuriant grass growth. The typically murky estuarine waters near FSUCML limit sea grass distribution to a depth of ~6 ft (2 m). However, east of St Marks and along the Big Bend, meadows are found at depths of 16 ft (5 m) some 6-9 miles (10-15 km) offshore. In late fall and during severe storms, the grass blades slough off and are eventually decayed by microorganisms, thereby recycling the bound nutrients to reconstitute the base of the marine food chain.

Figure 3. Stone crab, sea cucumber, and bay scallop (Florida Fish and Wildlife Conservation Commission).

Sea grass habitat hosts tremendous biological diversity in Florida waters, topped only by that of coral reefs. Here are found many invertebrates, including hermit crabs, stone crabs, numerous shrimp species, amphipods and isopods; brittle stars, asteroid starfishes, and sea cucumbers; pen shells, clams, scallops, and herbivorous and predaceous snails (Figure 3). The diversity of fishes is remarkable, including residents (sea trout, sea horses, pinfish), those staying only during their juvenile stage, including some reef fishes (black sea bass, gag, gray snapper), and transients that use the seagrass as forage areas (Spanish mackerel, blue fish, jack crevalle). Despite the seemingly delicate nature of the sea grass blades, they are so durable that various filter-feeding animals attach to them as larvae and remain long enough to complete their life cycles.

Box 2. What Makes Up Our Sea Grass Meadows?

The most common type of sea grass, **Turtle Grass** has flat, ribbon-like blades that can grow to be up to 2 feet (0.61 m) long. It gets its name from the green sea turtles that graze upon it.

A favorite food of manatees, **Manatee Grass** can be found in patches in estuarine waters, often within fields of Turtle Grass throughout the Gulf of Mexico, Caribbean Sea, Bermuda, and the Bahamas. The cylindrical blades can be as long as 40 cm.

Shoal Grass grows in disturbed areas of estuarine waters, where other grasses have died or are unable to grow. It has flat, narrow blades that are only 4 to 6 inches long, much shorter than other sea grasses.

Attached organisms include red algae, colonies of sea squirts, sponges, hydroids, pygmy sea cucumbers, and juvenile stages of scallops. Except sea urchins and pinfish, few inhabitants feed directly on grass blades (and those often feed on attached algae –epiphytes – more than the grass itself); rather, the lush vegetation serves structurally as refuge from predation by many of the aforementioned fishes. Sea grass dwellers often exhibit special shapes, coloration patterns, and behaviors that camouflage them. The abundant arrow shrimps, *Tozeuma carolinense,* which grow to ~3 cm long, are quickly consumed by all kinds of predators in open water (Figure 4). However, in seagrass beds, they are

Figure 4. The arrow shrimp, *Tozeuma carolinense*

relatively well hidden. Individuals usually stay on and aligned with grass blades so that the matching color, elongated shape and low profile make it more difficult for visual predators (e.g., pinfish, pigfish, spot, sea trout) to detect them, although they are a primary source of food for certain juvenile fishes, including gag (*Mycteroperca microlepis*).

Sea trout, with their striking silver sides, spotted flanks, dark back, and brilliant white underside, become apparitions while swimming through the complex waving shapes and shadows of dense grass blades. This allows them to evade their predators while small and vulnerable and, in turn, makes them effective ambush predators throughout their lifetime in this habitat.

The large geographic extent and stability of food-rich seagrass meadows makes them critically important nursery habitats in the Gulf of Mexico. One particular resident has special relevance to this region – gag, a grouper in the family Serranidae (Figure 5). Adult gag are highly sought by both recreational and commercial fishermen in offshore waters. Millions of pounds are landed yearly and management of the fishery is always embroiled in one controversy or another as managers attempt to balance catch with sustaining the population.   Research conducted by FSUCML scientists showed that the gag life cycle is inextricably linked to the seagrass meadows. While adults spawn offshore on the West Florida shelf edge (80 m depth), the larvae are transported in spring by the Big Bend gyre to the seagrass meadows all along the coast, where young fish find both refuge and prey (shrimp, small fish) and individuals grow to nearly 30 cm length and gain sufficient strength to migrate to offshore low-relief reefs in the fall. However else the fishery is managed, these seagrass nursery meadows must be protected.

The gag is a protogynous hermaphrodite, meaning that it matures first as a female, with males produced by the female changing sex. In gag, this generally takes place when females reach ten or eleven years of age. The female that is changing sex first takes on male coloration, which occurs quite rapidly. She then starts to exhibit male behaviors, including increased aggression. In the final stages, the ovary turns into a testis and the fish becomes male, producing sperm rather than eggs.

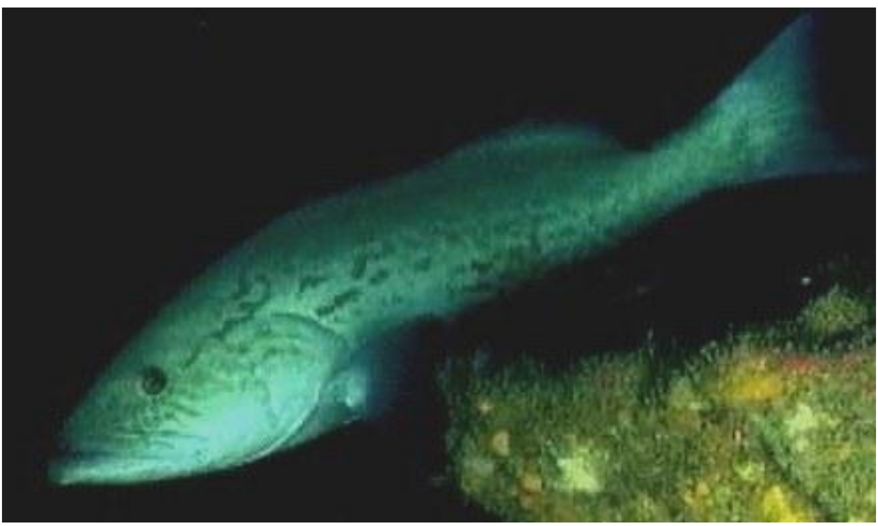

Figure 5. Gag (*Mycteroperca microlepis*) on a low-relief rocky reef in the Steamboat Lumps Marine Reserve of the northeastern Gulf of Mexico. *Courtesy of National Geographic.*

FSUCML scientists also demonstrated that intensive fishing led to a dramatic decline in the percentage of male gag (from 17% in the 1970s to 3% in the 1990s on the Gulf Coast). They found that fishing practices that targeted spawning sites year round removed so many males that sex change could not keep pace. This discovery led to the creation of two marine reserves in the Gulf of Mexico at known gag spawning locations with the intent of protecting males.

The lush vegetation of salt marshes provides exceedingly high in primary production, perhaps the most productive in the world. The main plants comprising salt marshes are cord grass (*Spartina alterniflora*) and needle rush (*Juncus roemerianus*). Cord grass grows at the margins of the bay and creeks while needle rush occupies the back marsh and slightly higher elevations. As with the sea grasses, marsh grasses are seldom eaten directly by the marine fauna but epiphytic algae attached to grass stalks typically are consumed, and a multitude of species benefit indirectly up the food chain as microorganisms break down the sloughed vegetation.

While the species richness of salt marshes is lower than that of sea grass meadows, the abundance of individual species can be enormous. Among the most abundant and productive species are mussels, oysters, fiddler crabs (*Uca sp.*), marsh periwinkles (*Littoraria irrorata*), crown conchs (*Melogena corona)*, mullet (*Mugil cephalus*), and blue crabs (*Callinectes sapidus*). One cannot help but be impressed by herds of tens of thousands of sand fiddler crabs, blanketing low tide beaches where they feed, creating a loud background noise as they rush up the shore as you approach. At high tide, the stands of salt marsh cord grass are festooned with an abundance of 2 cm long white shells of marsh periwinkle snails, sometimes as many as 500 per square meter.

Marsh periwinkles (Figure 6) occupy exposed mud/sand substrate during low tides, grazing on diatoms and organic particles amidst the grass stems. Before the flooding tide reaches them, they stop eating, triggered by an internal biological clock, visually locate the nearest grass stalk, crawl to it, and ascend before they are submerged. The highest snails rest above the water surface, thus evading predatory blue crabs and crown conchs that come with the rising tide. Even so, low snails or those caught on the substrate suffer high mortality, either crushed by crabs or their soft body devoured by crown conchs. In the latter case, small long-wrist hermit crabs in old and small shells swarm to conch/periwinkle predation sites, drawn by the distinct odors of partly digested snail flesh, where they aggressively negotiate among themselves for access to the brand new periwinkle shell being prepared

Figure 6. The marsh periwinkle snail (*Littoraria irrorata*).

for them by the conch. As one hermit moves into the new shell, the others switch shells and leave behind the smallest, most damaged or weakest shell – a veritable housing vacancy chain. Thus, this remarkable web of behavioral and ecological interactions is based on both food (conch v. periwinkle) and portable refuge (periwinkle shell to hermit crab).

Overgrazing of saltmarsh cordgrass by the marsh periwinkle snail appears to be compromising the integrity of salt marsh ecosystems throughout the southeastern United States, leading to expansive salt marsh die-offs. A key factor in this problem, at least on the Atlantic coast, may be the overharvesting of blue crabs, the primary predator of marsh snails, which leads to increased abundance of the snails. Periwinkles are normally detritivores, feeding upon decomposing matter on the mud and sand rather than on living organisms. However, when threatened by predators during certain parts of the tide cycles, periwinkles will seek refuge by climbing high up the shoots of cordgrass, where detritus is not accessible. In this habitat, periwinkles become "fungal farmers," using their tongue-like radula to create slits in the cordgrass shoots in which fungus grows and can be harvested by the periwinkles. The fungal growth is detrimental to the health of the cordgrass and, with expanded populations of the fungal-farming periwinkle snail, leads to the degradation of the salt marsh ecosystem in which cordgrass is a vital species.

Scientists at the FSUCML are also examining the extent of salt marsh loss in the Big Bend and Panhandle, where the tidal regime is irregular and weaker in magnitude than elsewhere in the southeastern U. S. This may alter the relationship between periwinkles and their predators, and alter periwinkle behavior and grazing habits as a result.

Additionally, a predatory gastropod, the crown conch (*Melogena corona*), also preys upon periwinkles in this region, which may complicate the predatory relationship between blue crabs and periwinkles. By specifically analyzing the causes of cordgrass and salt marsh degradation in this region of Florida, this research will contribute not only to knowledge of the complexities of Florida's salt marsh ecosystems, but also toward salt marsh restoration efforts by Florida organizations which may use the results of this study to develop strategies for preserving salt marsh ecosystems.

The marsh creeks, connecting freshwater land runoff to inflowing bay waters, host large numbers of shrimp, crabs and fishes. These include species that spend most of their lives there as well as juveniles of bay species. Small transparent glass shrimp bury and feed in the soft mud, safe from large open water predators throughout their bottom-dwelling life, while pink shrimp grow there during their early months of life then emigrate. Killifishes reside in the creeks lifelong while swarms of early juvenile mullet make only temporary residence before moving out to bayside shallows. The marsh creeks and adjacent estuaries serve as the primary nursery to red drum, blue crabs, stone crabs and flounders.

Sand and mud Substrates. At first view, sandy shores seem inhospitable to life. The substrate shifts with storm waves; the shallows are exposed to air, UV rays, and desiccation at low tides. Coastal predators such as blue crabs, red drum, and stingrays invade on the flood tide while ghost crabs and sea birds attack on the ebb. Yet life is surprisingly abundant and diverse there. Most striking is subsurface life – several annelid worm species pack themselves in at densities as high as hundreds per square meter, along with mussels, and razor, surf and quahog clams plus predaceous moon snails and lightning whelks (Figure 7).

Especially numerous are fiddler crabs and beach hopper amphipods. On submerged bottom, there are copious sand dollars, starfish, box crabs, brachiopods, sun ray venus clams, mantis shrimp, toothed flounders, and soft-mouthed soles. All of these take refuge within the ever-wet substrate where the temperatures are livable, tidal waters and runoff deliver abundant nutrients, and the buried individuals are hard for predators to find or to capture.

The iconic horseshoe crab uses the extreme spring high tides to reach well up the sandy shores to mate and spawn, the larvae developing deep in the wet sand until uncovered by waves during the subsequent spring high tide two weeks hence, a scenario that has played out for millions of years.

Figure 7. Lightning whelk (*Busycon contrarium*). *Photo by Kurt Spaugh*

Oyster Reefs. Hard rock substrate, scattered limestone outcrops, is rare along the Wilderness Coast. Oysters create the most prevalent, crevice-rich natural solid structure (Figure 8). Settling oyster larvae (spat) require a hard attachment point and preferentially settle on shells of adult oysters.

Figure 8. Oysters (*Crassostrea virginica*) form reefs that serve as foundations for complex communities, providing many essential ecosystem services in coastal communities within which they occur.

That is, if a single oyster successfully grows, it will potentially become the site of further oyster settlement and growth, leading in a few years to a growing reef.

Oyster shell also attracts settlement of numerous other animals (e.g., mussels, slipper shells, barnacles). The irregularity of oyster shell shape provides abundant holes and spaces to house small vulnerable individuals, especially juveniles, of estuarine species. Common oyster reef dwelling species include porcelain crabs, annelid worms, peppermint shrimp, several small mud crab species, snapping shrimp, gobies, and toadfish. Small juvenile stone crabs, which dwell in the reef and feed on oysters, are particularly abundant but they migrate away at adulthood. Oysters are eaten also by large blue crabs, rock snails (oyster drills), and crown conchs. At high tide, the reef is swarmed by red drum, black drum, sheepshead, and flounder. Species diversity on oyster reefs is limited by the variable estuarine salinity conditions and low tide aerial exposure. These conditions constrain colonization by sponges, sea whips, corals, and sea squirts. Nevertheless, oyster reefs are an important component of the Big Bend ecosystem.

Biogeography

Those familiar with the US Atlantic shores may discern that many common Wilderness Coast species have similar looking counterparts in the Carolinas but relatively few in the Florida Keys. This is largely explained by the thermal conditions and habitat differences of the southeast US over the past ice age cycles (Figure 9). During the peak of glaciations (more than 10,000 years ago), sea level was much lower – parts of the now submerged west Florida shelf were dry land (once occupied by native Americans[2]) -- while the coastal waters were cooler than now (an interglacial period). The coastal marine fauna was continuous along the eastern Gulf and south Atlantic coast. When the glaciers receded, sea level rose, the common species like oysters, lightning whelks, sand fiddler crabs, blue crabs, toothed flounders, quahog clams, etc. followed the shoreline north as water levels rose. Meanwhile, as the waters warmed and tropical conditions returned to the Keys, a different habitat emerged there with typically tropical species (mangroves, corals, spiny lobsters, snook). The Keys have become a barrier to continuous reproductive mixing for species that were once unified from the upper Gulf to the Carolinas. Enough time has passed that many have undergone speciation and are now genetically distinct despite close appearance and biological characteristics.

Understand, Sustain, Conserve

If we are to be successful stewards of the Wilderness Coast, it is essential that we adopt policies that protect and sustain its productivity and dynamics. This applies to managing our fishing, boating, construction, waste disposal, agriculture, and freshwater use. To do so, we must understand how each species functions within the ecological system at play. The Apalachicola estuary serves as a case in point. The distribution, health, and productivity of the greatly valued oysters in the

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[2] The Apalachee Native Americans, considered the most advanced indigenous nation in Florida, lived in the Florida panhandle between the Aucilla River and the Ochlokonee River at the head of Apalachee Bay until the late 1700s. The remaining tribe members now live in Louisiana.

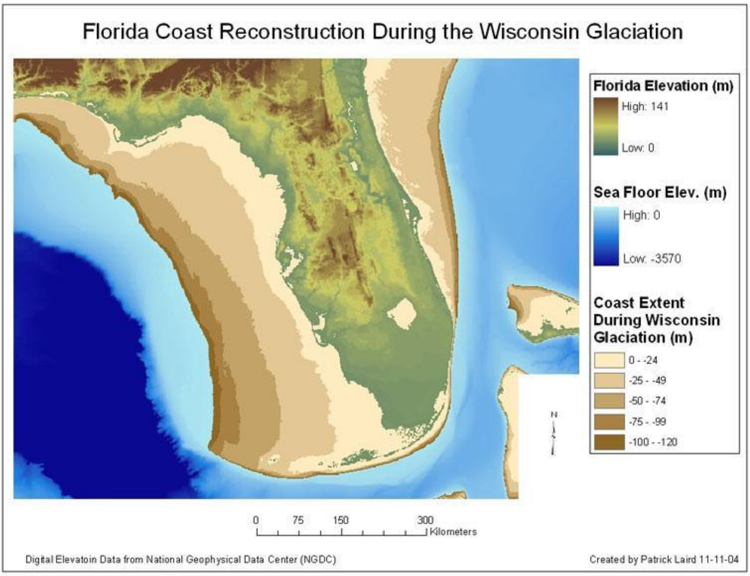

Figure 9. Model of the Florida coast showing sea level change of -120 meters may be the most realistic based on the accepted values for sea floor change. *Constructed by Patrick Laird, Emporia State University, Kansas.*

Bay are measurably declining. Scientists posit that drought and ever-increasing human water use upstream, river dredging, damming and coastal growth, have disturbed the supporting ecological conditions. However, restoring the oyster population requires specific knowledge of the actual rate and timing of flow and bay salinities. Furthermore, we need to know how such levels are likely to affect the linkages of microorganisms, predators and redistribution of the panoply of interactive species that includes oysters. Good research knowledge of the ecosystem underpins effective management planning and facilitates politically appropriate actions. This principle applies to the entire region's habitats and species, including those that have no direct human use, and linchpin habitat patches that may simply have to be defended from disturbance by us.

Endnote

The edge of the sea is a remarkable zone of life in many unique forms and styles along the Wilderness Coast. It is the objective and privilege of marine scientists to reveal the amazing processes at play and to raise awareness about them.

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