Table 30. Common algal species in the Panhandle (Menzel 1971, Earle 1972, Humm 1973, Dawes 1974).

Class	Species
Cyanophyta	*Calothrix crustacea*
	Dichothrix penicillata
	Entophysalis conferata
	Entophysalis deusta
	Lyngbya confervoides
	Lyngbya majuscula
	Lyngbya semiplena
	Microcoleus tenerrimus
	Plectonema calothrichoides
Rhodophyta	*Bostrychia radicans*
	Botryocladia uvaria
	Ceramium fastigiatum
	Chondria cnicophylla
	Chondria littoralis
	Chondria sedifolia
	Eucheuma acanthocladium
	Fosliella farinosa
	Gelidium corneum
	Gelidium crinale
	Halymenia pseudofloresia
	Jania rubens
	Laurencia intricata
	Laurencia obtusa
	Laurencia poitei
	Lithothamnium occidentale
	Polysiphonia echinata
	Polysiphonia howei
	Polysiphonia subtilissima
Phaeophyta	*Dictyota dichotoma*
	Ectocarpus coinfervoides
	Ectocarpus mitchellae
	Padina vickersiae
	Sargassum filipendula
	Sargassum linifolium
	Sporochnus pendunculatus
Chlorophyta	*Acetabularia crenulata*
	Acetabularia farlowii
	Caulerpa prolifera
	Chaetomorpha linum
	Cladophora gracilis
	Cladophora fulginosa
	Cladophoropsis membranacea
	Codium decoratum
	Enteromorpha clathrata
	Enteromorpha flexuosa
	Enteromorpha lingulata
	Enteromorpha plumosa
	Entocladia viridis
	Halimeda tridens
	Monostroma latissimum
	Penicillus lamourouxii
	Protoderma marinum
	Udotea conglutinata
	Ulva lactuca

Much of the patchiness is due to a myriad of physical factors such as local salinity and temperatures fluctuations and wind and tidal mixing (on daily and seasonal scales). In addition, many organisms, especially fish, are migratory and spend only a portion of their lives in the estuary.

This habitat contains a "permanent" fauna (holoplankton) that live in the water column for an entire life cycle and also a "temporary" fauna (meroplankton) that include the larval forms of many nonplanktonic organisms (e.g., polychaetes, fish, bivalves, and crabs) that use the currents to disperse to different habitats. Some organisms traditionally classified as benthic (e.g., the polychaetes, *Polydora ligni* and *Scolelepsis squamata*) are present in the water column at night. They may use the water column to feed, to disperse to a new habitat area, or to reproduce.

Phytoplankton and zooplankton abundances usually demonstrate strong seasonal peaks that track nutrient inputs (primarily nitrogen and phosphorus from land runoff), temperature, and light levels. The phytoplankton standing crop is usually low at any particular time, but overall productivity is high because of a rapid turnover rate.

The nekton (e.g., fishes and sharks) are extremely patchy and generally unpredictable in their spatial distribution. This group, however, constitutes the primary commercial catch from the coastal environment.

This habitat proves one of the most difficult to characterize. The large diversity of organisms, wide range of physical conditions, and extreme spatial and temporal patchiness of the flora and fauna are the primary causes of the problem. An attempt was made to report the major groups and species present, concentrating on commercially and ecologically important species.

b. Species present. Estuarine water column organisms in the Panhandle have been described in a number of investigations (phytoplankton—Curl 1956, Estabrook 1973, Myers 1977; zooplankton—Grice 1960, Hopkins 1966, Cosper 1969, Edmiston 1979; squid—Laughlin and Livingston 1982; fish—Parrish 1966, Hansen 1969, Irby 1974, Nakamura 1976, Naughton and Saloman 1978, Pristas and Trent 1978, Nall 1979, and many others). Because of the tremendous diversity of the habitat, only dominant species are discussed; over 180 fish species are reported from the Pensacola estuary alone (Cooley 1978).

Diatoms tend to dominate the phytoplankton, while copepods are the dominant zooplankton form. Phytoplankton abundances demonstrate distinct seasonal peaks, but there are resident assemblages that characterize Panhandle estuaries (Steidinger 1973). Many of the estuarine phytoplankton—for example *Skeletonema costatum*, *Chaetoceros* spp., *Gonyaulax* spp., and others—form resting spores or cysts and are considered meroplanktonic because a portion of their life is spent on the estuarine floor.

Tables 31 and 32 list the common planktonic and nektonic species in the Panhandle.

c. Recreationally and commercially important species. The Panhandle estuarine open water habitat contains numerous species of commercial and recreational importance. Additionally, juvenile and larval forms of marine organisms use the estuarine areas as "nursery grounds." These include three shrimp species (brown—*Penaeus aztecus*, white—*P. setiferus*, and pink—*P. duorarum*) (Brusher and Ogren 1976), ladyfish (*Elops saurus*), spotted seatrout (*Cynoscion nebulosus*), red drum (*Sciaenops ocellatus*), silver perch (*Bairdella chrysoura*), Atlantic croaker (*Micropogonias undulatus*), spot (*Leiostomus xanthurus*), southern kingfish (*Menticirrhus americanus*), gulf menhaden (*Brevoortia patronus*), striped mullet (*Mugil cephalus*), and sheepshead (*Archosargus probatocephalus*). In addition, several anadromous species, e.g., Alabama shad (*Alosa alabamae*) and Atlantic sturgeon (*Acipenser oxyrhynchus*), pass through the Apalachicola Bay system on their way to spawning grounds in the Apalachicola River (Wooley and Crateau 1982). The Atlantic sturgeon also migrates into the Pensacola Bay system. Descriptions of the most important species follow.

(1) Striped mullet. The striped mullet is one of the most important commercial fish species along the Panhandle coast. It spawns from October through February, with peak activity from November through January. Mullet form large schools before spawning and migrate from their normal estuarine habitat into offshore water. Growth rate and age to maturity are highly correlated with water temperature (Cato and McCullough 1976).

(2) Red drum. Within Panhandle estuaries young red drum are generally found in quiet shallow waters with grassy or slightly muddy bottoms that are not greatly affected by tides. Most juvenile or immature red drum (<720 mm total length (TL)) remain in the estuaries throughout the year but move into deeper bay waters in winter. They move from the estuaries into the gulf at maturity (>700 mm TL). After spawning, some adults may move back into bays for a short time but, on the whole, less time is spent in the estuaries after maturity. Their longevity is probably more than 12 years.

Crustaceans, especially crabs and shrimp, and fish are the most important items in the red drum diet. Food habits change with age. Gut contents indicate that red drum feed over sandy to muddy bottoms in both shallow and moderately deep water. Most

Table 31. Common planktonic organisms found in Panhandle estuarine open waters (Estabrook 1973, Edmiston 1979).

Group	Species	Group	Species
Phytoplankton		(Cyclopoids)	*Corycaeus americanus*
Diatoms	*Bacteriastrum delicatulum*		*Oithona brevicornis*
	Bacteriastrum varians		*Oithona nana*
	Cerataulina pelagica		*Oithona simplex*
	Chaetocerus deciphens	Crab zoeae	
	Chaetocerus lorengianum		
	Coscinodiscus radiatus	Larvacean	*Oikopleura dioica*
	Hemiaulus hauckii		
	Hemiaulus sinensis	Polychaeta larvae	Spionidae
	Melosira sulcata		Phyllodocidae
	Nitzschia closterium		
	Rhizosolenia alata	Rotifer	*Synchaeta* sp.
	Rhizosolenia stolterfothii	Cladocerans	
	Skeletonema costatum		
	Thalassionema nitzschioides	Chaetognaths	*Sagitta helenae*
	Thalassiothrix frauenfeldii		*Sagitta hispida*
			Sagitta tenuis
Dinoflagellates	*Ceratium tripos*		
	Gonyaulax balechii	Echinoderm larvae	*Mellita quinquiesperforata*
	Peridinium depressum		
Coccolithophores	*Pontosphera* spp.	Ctenophores	*Beroe ovata*
			Mnemiopsis mccradyi
Zooplankton			
Copepods		Coelenterates	*Aurelia* spp.
(Calanoids)	*Acartia tonsa*		*Chrysaora* spp.
	Anomalocera ornata		*Stomolophus* spp.
	Labidocera aestiva	Mysids	
	Paracalanus crassirostris		
	Paracalanus parva	Various fish eggs and larvae	

feeding takes place in the early morning or evening. Red drum have been observed "tailing" in shallow areas, rooting about with heads lowered and tails occasionally out of the water.

Red drum are harvested in a mixed-species fishery, using a variety of gear including haul seines (common and long), fish trawls, pound nets, gill nets, hand lines, trammel nets, and shrimp trawls. Runaround gill nets are the predominant gear used in the Panhandle. Highest landings are generally recorded in the fall and early winter. Recreational fishermen generally find shrimp, squid (*Loliguncula* spp.), cut mullet (*Mugil* spp.), spot, herring (Clupeidae), or menhaden good bait for red drum. An 18-inch limit is set by the State of Florida for red drum. Currently the commercial take of red drum in Florida is banned and the recreational take restricted by the State and regulations regarding take should be checked.

(3) Spotted seatrout. The spotted seatrout is a nonmigratory euryhaline estuarine species that is most abundant in the confines of semilocked lagoons and quiet estuaries. It has a protracted spring and summer spawning season that peaks in late

Table 32. Common nektonic forms found in Panhandle estuarine open waters.

Group	Species	Common name
Squid	*Lolliguncula brevis*	Brief squid
Fish	*Anchoa hepsetus*	Striped anchovy
	Anchoa mitchilli	Bay anchovy
	Archosargus probatocephalus	Sheepshead
	Arius felis	Sea catfish
	Bagre marinus	Gafftopsail catfish
	Bairdiella chrysoura	Silver perch
	Brevoortia patronus	Gulf menhaden
	Cynoscion arenarius	Sand seatrout
	Cynoscion nebulosus	Spotted seatrout
	Echeneis naucrates	Remora
	Elops saurus	Ladyfish
	Leiostomus xanthurus	Spot
	Menidia beryllina	Silverside
	Menticirrhus americanus	Southern kingfish
	Menticirrhus littoralis	Gulf kingfish
	Micropogonias undulatus	Atlantic croaker
	Monocanthus hispidus	Planehead filefish
	Mugil cephalus	Striped mullet
	Pogonias cromis	Black drum
	Sciaenops ocellatus	Red drum
	Urophycis floridana	Southern hake
Sharks	*Carcharhinus acronotus*	Blacknose shark
	Carcharhinus isodon	Finetooth shark
	Carcharhinus leucas	Bull shark
	Carcharhinus limbatus	Blacktip shark
	Rhizoprionodon terraenovae	Atlantic sharpnose shark
	Sphyrna lewini	Scalloped hammerhead
	Sphyrna tiburo	Bonnethead
Turtles	*Caretta caretta*	Loggerhead
	Dermochelys coriacea	Leatherback
Porpoise	*Tursiops truncatus*	Bottlenose dolphin

April to July. Young-of-the-year spotted seatrout are generally associated with seagrass beds in estuaries.

Spotted seatrout are carnivorous, feeding primarily on crustaceans (penaeid shrimp and crabs) and fish (anchovies (*Anchoa* spp.), menhaden, mullet, pinfish (*Lagodon rhomboides*), and silversides (*Menidia beryllina*)). Food habits change with age. Copepods are important prey for fish less than 30 mm TL. Larger crustaceans are important prey for fish less than approximately 275 mm SL (standard length). Larger specimens predominately eat fish.

There are seasonal changes in the types of commercial gear used in the Panhandle. Trammel nets and haul seines are primarily used near river mouths during the winter months. Hook and line fishing is productive throughout most of the year, whereas trolling is usually best in the fall. The best gill- and trammel-net fishing is from mid-November to mid-February when the fish congregate in deep holes.

Recreational spotted seatrout fishing includes bridge, skiff, and shoreline fishing. Live bait, including shrimp, sailors choice, pinfish, mullet, and needlefish (*Strongylura marina*), is generally used with greater success than are lures. Fishing usually takes place year round in the Panhandle. It is one of the most sought after and most frequently caught species of sportfish. A 12-inch minimum size limit is set by the State of Florida for spotted seatrout.

(4) Gulf menhaden. The gulf menhaden supports a large fishery in the gulf and its young are prey for many other species of sport or commercial importance (Tagatz and Wilkens 1973). Spawning occurs in the open gulf. Larvae spend 3–5 weeks offshore before moving into estuaries at 9–25 mm SL. After transformation, juveniles remain in low-salinity nearshore areas where they travel in dense schools near the surface. The schooling behavior is retained throughout life. Feeding behavior changes from selective, particulate-feeding carnivory to filter-feeding with age. Adult and mature juveniles emigrate from estuaries to gulf waters primarily from October to January.

Gulf menhaden is a short-lived species. Individuals rarely exceed 2 years of age. The fishery season runs from mid-April to October when the fish are inshore and sexually inactive.

(5) Atlantic croaker. The Atlantic croaker is a target species of the industrial groundfish fishery and is often dominant in inshore and offshore sport catches. The species is considered estuarine dependent because all stages from larvae to adults are known to occur in abundance in estuarine waters. Postlarvae and juveniles grow rapidly in estuarine nursery grounds and are subject to predation by several other species (Kobylinski and Sheridan 1979).

The species has a protracted spawning season from October to March with a peak in November. After hatching, larvae and postlarvae may spend some time as plankton, but eventually become demersal. The schooling behavior is maintained throughout life. The heaviest concentrations of adult Atlantic croaker are found at river mouths. Marshes are very important to juvenile development.

(6) Sea catfish and gafftopsail catfish (*Arius felis* and *Bagre marinus*). The sea catfish and gafftopsail catfish are not favored sport or food fishes, but their widespread abundance and distribution cause them to rank high in trawl and angler catches in the Panhandle. Commercial and sport fishermen consider both species to be nuisances and dangerous. Toxic substances from sea catfish spines are quite virulent. Copious slimy mucus secreted by the gafftopsail catfish is a problem in nets and to humans handling the fish. The oral gestation behavior of the two species is of scientific interest. The male carries the fertilized eggs, larvae, and small juveniles in its mouth.

The distribution and abundance of the two species in gulf coastal and estuarine waters is related to spawning activities, as well as water temperatures and salinities. Adults avoid lower temperatures by migrating offshore in winter and returning inshore in spring.

Both species are opportunistic feeders over submerged mud and sand flats. Stomach contents generally include algae, seagrasses, coelenterates, holothurians, gastropods, polychaetes, crustaceans, and fish. Scavenging may also be indicated, since large fish scales and human garbage have been reported from some individuals.

(7) Bay anchovy and striped anchovy (*Anchoa mitchilli* and *Anchoa hepsetus*). Both species are important prey species that spawn in the estuaries. They are not of direct commercial importance (as human food). The months of peak abundance vary, but anchovies are generally common from spring through early winter in Panhandle waters. Both species primarily feed on zooplankton such as calanoid copepods, mysids, and cladocerans (Sheridan 1978).

d. Species of special concern. The saltmarsh topminnow *Fundulus jenkinsi* (Everman) is found in Escambia, East, and Blackwater Bays of the Pensacola estuarine system (Gilbert 1978). It is known to live in salt, fresh, and brackish water (salinity range 3.4–24 ppt). It prefers protected tidal ponds, creeks, and marsh areas near river mouths and possibly soft mud substrates. It has been recorded only a few times in Florida waters, and the aforementioned bays may represent the species' easternmost occurrence.

Two species of turtle are occasionally present in the Panhandle estuaries: the Atlantic loggerhead *Caretta caretta* and Atlantic leatherback *Dermochelys coriacea*. Loggerhead turtles nest yearly during summer months on many Panhandle beaches (Harris et al. 1984).

e. Natural Impacts. Red tide outbreaks occasionally occur within estuarine waters in the Panhandle. The primary components are dinoflagellates, primarily *Ptychodiscus brevis* (formerly *Gymnodinium breve*) and *Gonyaulax monilata*. In addition, storms and localized temperature and salinity fluctuations affect the water column organisms (Bortone 1976).

f. Human Impacts. Petroleum pollution is a primary artificial impact. The input of an oil spill is usually considered less severe on open water organisms (at least adult forms) since many can avoid the spill itself (i.e., the nektonic forms can swim away). The effect on planktonic forms is not well established. Productivity is reported to decline immediately after a spill. A possible important indirect effect may be the incorporation of carcinogenic and potentially mutagenic or teratogenic chemicals into lower food chain organisms, such as the plankton, and subsequent ingestion by higher trophic forms.

Though adult fish are usually capable of avoiding spilled floating oil, other life stages such as eggs and larvae are more susceptible. Because the estuaries are spawning and nursery grounds for many species, an oil spill could cause serious damage to future commercial and noncommercial stocks.

Other impacts include sewage inputs, pesticides (Nimmo et al. 1971) and pulp mill effluent.

7.2.9 Subtidal Soft Bottoms

a. Introduction. Subtidal unconsolidated bottom environments (e.g., mud and sand) make up the most extensive habitat area in the Panhandle estuarine system, approximately 75% of the total submerged bottom area. In many ways, they are the least understood (e.g., in terms of governing processes) and most difficult to study of all the habitats. Problems arise from (1) limited access to the habitat for direct observation of and experimentation on processes important to the system and (2) the commonly bad visibility (high turbidity) often encountered. Except in the extremely shallow areas, field work often requires SCUBA gear.

A cursory inspection of the sediment surface gives an impression of a homogeneous, desert-like habitat without much physical structure (e.g., vegetation or rocks) and with few organisms. Upon closer investigation, however, a myriad of small burrow openings and projecting tubes can be observed. The overwhelming majority of organisms in this habitat live within the substrate (infauna), concealed from view. This habitat is three dimensional, and vertical (depth into the sediment) distances are important, as opposed to the two dimensionality of hard substrate environments. Microscopic inspection of a scoop of sand or mud reveals hundreds to thousands of organisms, most of which are important prey items in the ecosystem.

Abiotic factors play an important role in determining the distribution of the benthos, especially in the upper regions of the estuaries near the river mouths (Livingston et al. 1976). Sediment characteristics, such as grain size and organic content, and physical factors, such as salinity and temperature, are most important. Grain size appears to be the single most critical factor because many organisms have specific requirements for feeding and tube building (e.g., White 1971). Deposit feeders (i.e., animals that ingest sediment particles) usually dominate in fine-grained muddy sediments because of the increased availability of detrital material and microorganisms as food. Suspension feeders require contact with the sediment-water interface to feed and are usually present in more stable sedimentary environments where there is less sediment movement and suspended material to clog their feeding structures.

Of all the water bodies in the Panhandle, the eastern half of St. George Sound, Apalachicola Bay, and Alligator Harbor have been the most intensively studied, primarily because of the Florida State University Marine Laboratory facilities (e.g., SCUBA equipment, boats, and eager graduate students) at Turkey Point.

b. Physical description. Unvegetated soft-bottom environments in the Panhandle are generally made up of quartz sand and fine silt. Ray feeding-pits, crab pits, horseshoe crab trails, gastropod trails, and sand dollar trails, and enteropneust (i.e., acorn worm) fecal mounds and cones are prominent microtopographic features on the surface. After rough weather, wave-formed ripple marks up to 3 cm tall may be present for a few days.

c. Distribution. Because of the reduced light penetration and the siltation from the large amounts of sediments deposited by rivers, the majority of the bottom area of Panhandle bays and estuaries is unvegetated. Unvegetated soft bottoms cover more than 75% of the total bottom area in the Panhandle.

d. Faunal composition. The organisms in soft-bottom communities can be categorized into various functional groups based upon life positions (i.e., infaunal or epifaunal) and feeding (or trophic) group (i.e., deposit feeder, suspension feeder, carnivore, etc.). Infaunal organisms include most polychaete, bivalve, amphipod, and isopod species. Typical epifaunal organisms are asteroids (e.g., starfish—*Astropecten articulatus* and *Luidia clathrata*), echinoids (e.g., sand dollars—*Mellita quinquiesperforata* and *Encope mitchelli*), decapods (e.g., *Libinia* spp.), various gastropods, benthic fish, and skates and rays (Table 33). Trophic group classification is less taxon specific, but requires natural history information on the specific organism. Such information is too detailed for inclusion in this document. Ray (1986) has compiled heavily referenced life histories for most of the polychaete species in the Panhandle.

The most abundant metazoan constituents of soft-bottom habitats are the meiofaunal nematodes and harpacticoid copepods (Table 34). In terms of biomass, however, polychaetes, mollusks, and macrocrustaceans dominate (Table 35). These groups are especially abundant in higher salinity

Table 33. Demersal fish, skates, and rays commonly encountered in Panhandle soft-bottom habitats (Hoese and Moore 1977).

Group	Species	Common name
Fish	*Paralichthys albigutta*	Gulf flounder
	Paralichthys lethostigma	Southern flounder
	Prionotus scitulus	Leopard sea robin
	Synodus foetens	Lizardfish
Skates and Rays	*Aetobates narinari*	Spotted eagle ray
	Dasyatis americana	Southern stingray
	Dasyatis sabina	Atlantic stingray
	Dasyatis sayi	Bluntnose stingray
	Gymnura micrura	Smooth butterfly ray
	Narcine brasiliensis	Lesser electric ray
	Pristis pectinata	Smalltooth sawfish
	Raja eglanteria	Clearnose skate
	Raja texana	Roundel skate
	Rhinobatus lentiginosus	Atlantic guitarfish
	Rhinoptera bonasus	Cownose ray

Table 34. Abundant or common benthic meiofauna in Panhandle soft-bottom habitats (Reidenauer and Thistle 1981; Sherman et al. 1983; D. Thistle, Florida State University, Tallahassee, unpublished data; Carman 1984).

Group	Species	Group	Species
Nematoda	*Chromadorella* sp.	Copepoda	
	Chromaspirina sp.	Harpacticoida	*Amphiascus* spp.
	Desmodora sp.		*Ectinosoma* spp.
	Innocuonema spp.		*Enhydrosoma littorale*
	Metachromadora (*Metachromadoroides*) spp.		*Halectinosoma* spp.
	Microlaimus spp.		*Leptastacus* cf. *aberranus*
	Monoposthia sp.		*Mesochra* cf. *pygmaea*
	Sabatieria sp.		*Pseudobradya* cf. *exilis*
	Theristus spp.		*Robertgurneya rostrata*
	Viscosia brachylaimoides		*Zausodes arenicolus*

Table 35. Abundant or common benthic macroinvertebrates in Panhandle soft-bottom habitats (Hartman 1951, Carpenter 1956, Trott 1960, Griffin 1983, Reidenauer 1986).

Group	Species	Group	Species
Polychaetes	*Aricidea cerrutii*	Polychaetes (continued)	*Scololepsis squamata*
	Aricidea taylori		*Typosyllis* sp.
	Axiothella mucosa	Crustaceans	*Acanthohaustarius* spp. (amphipod)
	Capitella capitata		*Apanthura magnifica* (isopod)
	Eteone heteropoda		*Corophium louisiana* (amphipod)
	Haploscoloplos fragilis		*Kalliapseudes bahamensis* (tanaid)
	Haploscoloplos robustus	Mollusks	*Anodontia alba*
	Heteromastus filiformis		*Tellina* spp.
	Laeonereis culveri	Cephalochordata	*Branchiostoma floridae*
	Mediomastus californiensis	Echinodermata	*Astropecten articulatus*
	Paraonis fulgens		*Luidia clathrata*
	Paraprionospio pinnata		
	Prionospio heterobranchia		
	Prionospio pygmaea		
	Spio benedictii		

areas of the estuaries (Winternitz 1936, Yentsch 1953, Wass 1955, Trott 1960, Borror 1961, Griffin 1983). In the lower salinity regions near river mouths, insect larvae and oligochaete worms become more important. Soft-bottom benthic communities are characterized by a high degree of spatial variability at nearly all scales (centimeters, meters, and kilometers), yet individual populations are usually highly persistent and, in many instances, seasonal. Also included as part of this habitat are demersal fish (e.g., flounders), skates, and rays, that spend a majority of their life and feed on the bottom.

Most infaunal members of the soft-bottom community are concentrated within the upper few centimeters of the sediment surface. This is the depth of the aerobic zone. The aerobic zone can be extended deeper within the sediment by animal tubes and burrows, which bring oxygenated water to otherwise anoxic sediments. Meiofaunal organisms are concentrated along these structures and are therefore capable of existing deeper within the sediment.

The total number of species and individual organisms observed at any particular site is a function of many different factors. Among these are the time of year that samples are taken, the sampling gear used, and the physical conditions (e.g., tide stage, weather, and time of day) at the time of sampling.

Many organisms demonstrate not only seasonal differences in abundance, but year-to-year variations that are not, at present, readily predictable (Figure 75). For example, the five-slotted sand dollar is a common visible member of the subtidal soft-bottom habitats in the Panhandle, which can undergo periods of extremely high population densities, with 200–800 individuals/m² (Salsman and Tolbert 1965, Reidenauer, in prep. a) (Figure 76). These periods of high density are short-lived and most times densities are around 20/m². The high densities are apparently the result of appropriate conditions for the successful recruitment of juveniles. Many benthic species, such as *Mellita*, have planktonic larval forms that require specific physical conditions and low predator densities for successful recruitment.

e. Recreationally and commercially important species.

(1) Southern flounder (*Paralichthys lethostigma*). The southern flounder migrates and spawns offshore in the fall and winter (Nall 1979). Larvae eventually move inshore into the estuaries. Juveniles (10–15 cm) are abundant in shallow soft sediments during the late spring and early summer (Reidenauer, personal observation). Juveniles feed on a variety of polychaetes and crustaceans. Adults feed almost exclusively on fish and crustaceans. An 11-inch minimum size is placed by the State of Florida on landed flounders.

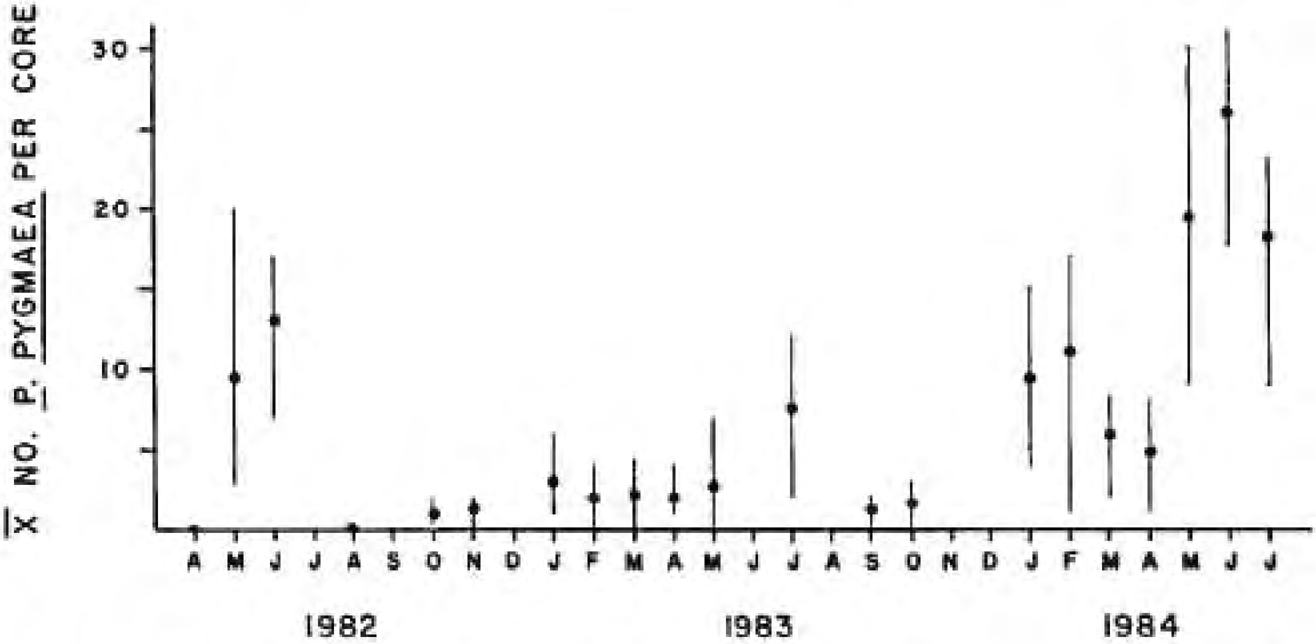

Figure 75. Seasonal variation of the spionid polychaete *Prionospio pygmaea* in a St. George Sound subtidal soft-bottom habitat (Reidenauer 1986).

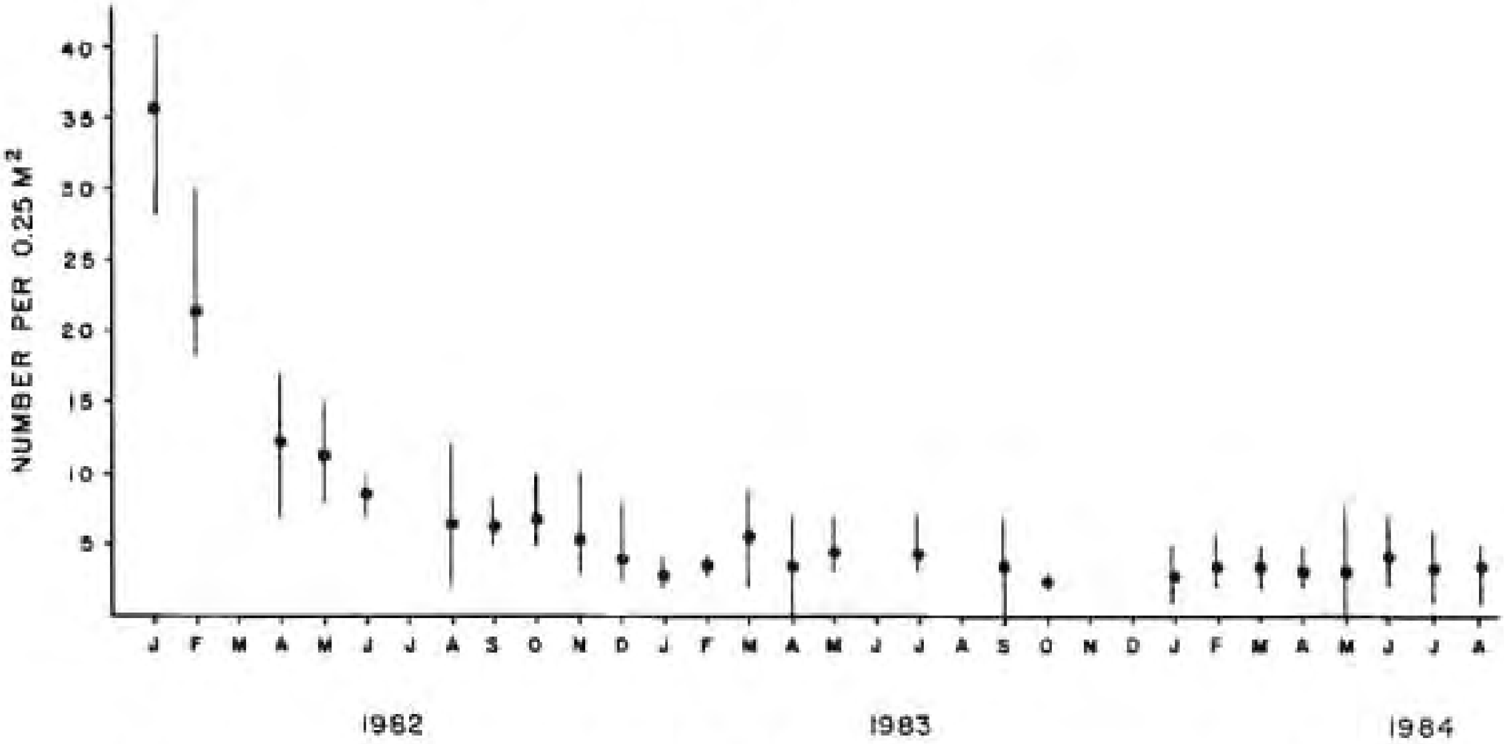

Figure 76. Variation in a five-slotted sand dollar *(Mellita quinquiesperforata)* population from St. George Sound (Reidenauer 1986).

(2) Northern quahog (*Mercenaria mercenaria*), and sunray venus clams (*Macrocallista nimbosa*). Both species are found in the estuaries and near-shore coastal waters of the Panhandle from the mean high tide level to 15 m depth with highest abundances on shallow flats (Akin and Humm 1959, Menzel 1961, Haines 1975). Harvesting is limited in the Panhandle although maricultural and commercial attempts have been made (Joyce 1970, Menzel et al. 1976).

f. Trophic dynamics and interactions. The majority of benthic species are prey for higher trophic organisms. The meiofauna, especially harpacticoid copepods, are important prey for juvenile fishes such as pinfish (*Lagodon rhomboides*) and southern flounder. Polychaetes and bivalves are important in the diet of many fish and crabs.

In general predation appears to be an important, if not the single most important, process governing soft-bottom benthic community dynamics (Mahoney and Livingston 1982). Historically, competitive interactions have been difficult to demonstrate in the soft-bottom environment given the hydrodynamic problems of predator exclusion pens (i.e., increased siltation due to current baffling) and the nearly invisible nature of the benthic inhabitants (i.e., hidden in the sediment or of a small size). In most regions, population densities are usually too low for competition to be an important process. Spatial competition (as in hard substrate communities) is rare in soft sediments, and competition for food is extremely difficult to demonstrate conclusively.

Mutualism is present in a variety of forms in the soft-bottom environment. The pea crab, *Dissodactylus* spp., (approximately 6 mm carapace width) lives among the spines of the five-slotted sand dollar and apparently selects food particles as the echinoid burrows through the sediment. In addition, other pea crabs (Family Pinnotheridae), use the burrows of various burrowing shrimp, such as *Callianassa* and *Upogebia*, as shelter.

g. Natural impacts. The soft-bottom subtidal environment appears more resilient to natural impacts than most marine habitats. A primary reason may be the planktonic larval dispersal characteristic of many of its residents. Furthermore, many benthic species traditionally categorized as sessile organisms are now known to disperse some distances as adults, especially at night, through the water column.

Natural disturbances such as ray feeding pits and enteropneust fecal mounds have been intensively examined in St. George Sound (Thistle 1980, Reidenauer and Thistle 1981, Griffin 1983, Sherman et al. 1983). Generally, the benthic communities, both meiofaunal and macrofaunal, initially decrease in abundance immediately after the disturbance but return to predisturbance levels within hours or a few days. Apparently these types of disturbances are either not on spatial scales large enough to produce long-lasting effects, or the community as a whole has adapted to them. Natural disturbances such as sand-dollar burrowing are apparently a source of mortality for newly settled polychaete, especially spionids (Reidenauer in prep. b). The most important effect of disturbance, therefore, may be on juvenile or larval members of the community and not on adult members that can more easily disperse.

Storm-induced waves often form ripple marks on the estuarine floor. In investigations performed outside the Panhandle, it was found that the troughs of the ripple field tend to collect fine particles and therefore food, which is attractive for a variety of organisms such as meiofaunal nematodes and harpacticoid copepods. Storms in general appear to disrupt the distribution of benthic organisms temporarily.

Duncan (1977) has reported on the effects of stormwater runoff on benthic communities in the Panhandle. An influx of silt or fine-grained sediment may decrease the number of sedentary or sessile members of a benthic community through suffocation. On the other hand, small burrowing deposit-feeding forms, such as capitellid and opheliid polychaetes, usually increase in abundance because of their planktonic larval stage.

h. Human Impacts. The effects of human activity on soft-bottom communities has not been extensively studied within the Panhandle. Some of the studies that have been done were not well designed or executed, so the results are not reliable. Problems have included samples taken without proper controls or without regard to season and use of improper sieve sizes to ensure that the majority of the community was sampled.

The most important human influences on the soft-bottom communities are dredging, boat traffic, petroleum pollution, and toxic substances such as pesticides. Dredging and the offshore collection of sediment for beach renourishment have been reported to have minimal but long-term effects on the benthic community (Water and Air Research, Inc. 1975, Saloman et al. 1982a). Apparently, natural seasonal variations are so great that short-term isolated perturbations are not permanently damaging. However, the evidence is limited and the problem is one that should be more thoroughly addressed in terms of implications for the higher trophic group organisms. Disturbances from boat traffic are not documented for the Panhandle and probably represent only localized impacts. Byrne (1976) has reported on the effects of petroleum pollution on larvae of the quahog clam (*Mercenaria* sp.) found in Alligator Harbor. The effects of various pesticides on the benthic community have been examined by Duke et al. (1970), Hansen and Wilson (1970), Livingston et al. (1978), Tagatz and Ivey (1981), and Winger et al. (1984).

7.2.10 Seagrass Beds

a. Introduction. Seagrasses represent one of the most important habitats in the nearshore coastal zones of Florida. Of the approximately 12,000 km² of seagrass present in the Gulf of Mexico over 9,100 km² lie in Florida gulf coast waters (Iverson and Bittaker 1986).

Seagrasses are marine angiosperms that possess all the structures of their terrestrial counterparts (i.e., a root system, a vascular system, and vegetative and sexual reproduction). Seagrasses are obligate halophytes, living fully submerged and carrying out their entire life cycle in seawater. Seagrass meadows are highly productive and rich in organisms. Total productivity of dense beds (which may consist of more than 4,000 individual plant shoots per square meter) including the plants themselves and the attached flora can reach 20 g C/m² per day, making them more productive on a per unit basis than either tropical coral reef systems (10 g C/m² per day) or the upwelling regions off Peru (11 g C/m² per day).

The physical structure provided by seagrass blades and rhizomes increases available habitat surface area for surrounding organisms as much as 15–20 times compared to unvegetated bottoms. In addition, it offers refuge from predators to many large juvenile populations of commercially important species of invertebrates and fish. For example, the commercial yield of shrimp in an estuary is directly related to the amount of seagrass habitat present (Figure 77). The combination of shelter and food makes seagrass meadows one of the richest and most critically important nursery grounds in Florida Panhandle coastal waters.

Two types of food webs are associated with seagrass communities: (1) a "grazing" food chain component comprised of herbivores that feed on living plants (both the seagrass blade itself and the associated algae) and their predators; and (2) a detrital food chain component comprised of herbivores that feed on dead material, together with their associated predators. Only a few species of animals in the Panhandle graze directly on living seagrasses (e.g., urchins, fishes, and some ducks and geese at low tide) and only a small fraction of the energy and nutrients in a seagrass bed is channeled through these herbivores (Thayer et al. 1984). For the vast majority of the herbivores (e.g., gastropods) in the seagrass ecosystem, the epiphytic algae constitute their primary food source (Kitting et al. 1984).

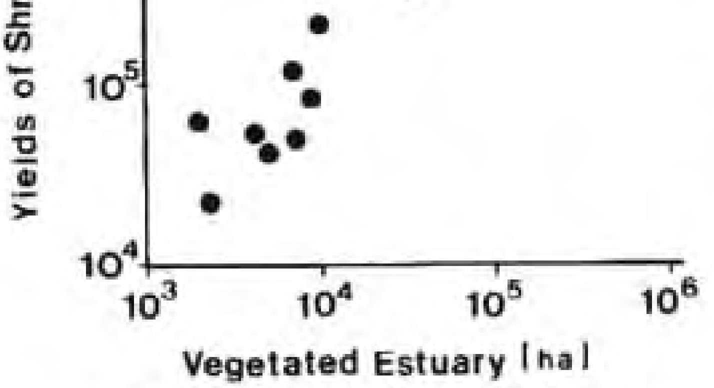

Figure 77. Yield of penaeid shrimp and vegetation coverage in an estuary (after Turner 1977).

Seagrasses have many critical functional roles in the coastal environment. Some of the most important include:

(1) serving as a sediment trap and stabilizer of bottom sediments;

(2) providing primary productivity to the sea;

(3) serving as a direct food source for herbivorous organisms;

(4) serving as a source of large quantities of detritus and dissolved organic matter;

(5) providing an attachment substrate for epiphytic algae that is a primary food source for many seagrass herbivores;

(6) providing a refuge from predators for many juvenile forms of fish and invertebrates, including economically important species;

(7) providing a habitat for a certain assemblage of invertebrate species that burrow or grow attached to leaves and that would otherwise be uncommon or absent, and;

(8) possibly serving as a major link in the main biochemical cycles of coastal areas.

Like terrestrial grasses, seagrasses form recognizable biological and physical entities that are often termed meadows. Like many terrestrial systems, the seagrass meadow is defined by a visible boundary grading from an unvegetated to vegetated substrate. In the Panhandle, meadows vary in size from small isolated patches of plants <1 m across, to continuous distributions of grass over many square kilometers. Meadows can be composed of a single species (usually turtle grass—*Thalassia testudinum*) or multiple species (*Thalassia*, shoal grass (*Halodule*), and manatee grass (*Syringodium*) are commonly found together).

Although still a conspicuous feature of the shallow-water coastal areas of the Panhandle, seagrass coverage appears to have suffered significant declines in many of the major bays over the last few decades. The primary reason appears to be the increased impacts (e.g., from dredging and pollution) of a growing coastal population.

b. Seagrass species present. For this report, *Ruppia martima* is not considered a true seagrass because it is not an obligate halophile and can grow in fresh water. It is found in the brackish vegetation habitat. Of the approximately 50 worldwide species of seagrass, 5 occur in the Panhandle region (Figure 78 shows the four most common):

Thalassia testudinum, turtle grass, is the largest, most robust of the seagrasses. Its ribbon-like leaves are 4 to 12 mm wide and 10 to 35 cm long with rounded tips (Figure 79). Two to five leaves are commonly present per shoot. Rhizomes, or roots, are found 2–5 cm deep in the sediment. Undisturbed, *Thalassia* is capable of forming extensive meadows. It grows at a minimum water depth of 0.5 m and rarely grows in water deeper than 11–12 m (Moore 1963). Bittaker and Iverson (1976) and Bell (1979) reported on the productivity of *Thalassia* in St. George Sound, which averaged 500 mg C/m^2 per day and was linearly proportional to the light energy.

Syringodium filiforme, manatee grass, has leaves that are circular in cross-section and typically has 2 to 4 leaves per shoot. Leaf diameters range from 1.0 to 1.5 mm. Blade length is highly variable but can exceed 50 cm. The rhizome system is less robust than that of *Thalassia* and not as deeply rooted. It is commonly found mixed with other seagrasses or in small, dense monospecific patches. It rarely forms extensive meadows like those of *Thalassia*.

Halodule wrightii (=*Diplanthera wrightii*), shoal grass, is extremely important as an early colonizer of disturbed areas where *Thalassia* and *Syringodium* are excluded. It commonly grows in water either too shallow or too deep for other species. The leaves are flat, typically 1 to 3 mm wide, 10 to 20 cm long, and arise from erect shoots. The tips of the leaves have two to three small points. It is the most tolerant of all seagrasses to variations in temperature and salinity.

Halophila engelmannii is a shade-loving species. It is an initial colonizer of newly available substrate and is extremely pollution tolerant. It is almost never present in monospecific beds, except in areas offshore. In the Gulf of Mexico it grows up to 30 m deep.

Halophila decipiens is known from isolated areas of the Panhandle region at least 6–7 m deep in the open gulf off Alligator Point and Pensacola (Humm 1956). It is a tropical species which may be limited to deeper water in the Panhandle where temperatures are not as extreme as those in the shallows.

Of the five species, the first three are the most commonly encountered in the Panhandle. A diagram of distributional ranges (i.e., salinity and depth) for 4 species is given in Figure 80.

c. Seasonality. Seagrasses in the Panhandle are perennial and reach a peak in biomass in the summer. New short-shoot production occurs only during the spring and summer. *Thalassia* leaf biomass in St. George Sound and St. Joseph Bay reaches a seasonal maximum during August (Iverson and Bittaker 1986). Seagrasses grow at a very reduced rate during the winter months. Each winter the seagrass blades of all species die back to within several centimeters of the sediment-water interface (Iverson and Bittaker 1986).

d. Species succession. Seagrass beds in the Panhandle go through an orderly process of succession, if left undisturbed. See Zieman (1982) for a discussion of the successional theory of seagrasses. Since there are only a few species present, the sequence is fairly simple (Figures 81 and 82). Algae are usually the first to colonize a disturbed area. Their primary contribution to the successional process is the accumulation and binding of sedimentary particles. The pioneer grass species is *Halodule*, which colonizes either by seed or rapid vegetative branching. It further stabilizes and protects the substrate surface. *Syringodium* appears next and as development continues, *Thalassia* becomes established. The time required for the recovery of a damaged bed depends upon the magnitude of the initial disturbance and on local wave and current intensity. However, even small patches take 2 to 5 years to recolonize (Zieman 1982). If the entire bed is removed, recovery may never occur since the source of potential colonizers is gone.

Seagrass bed morphology is believed to denote maturity and successional stages (Hartog 1970,

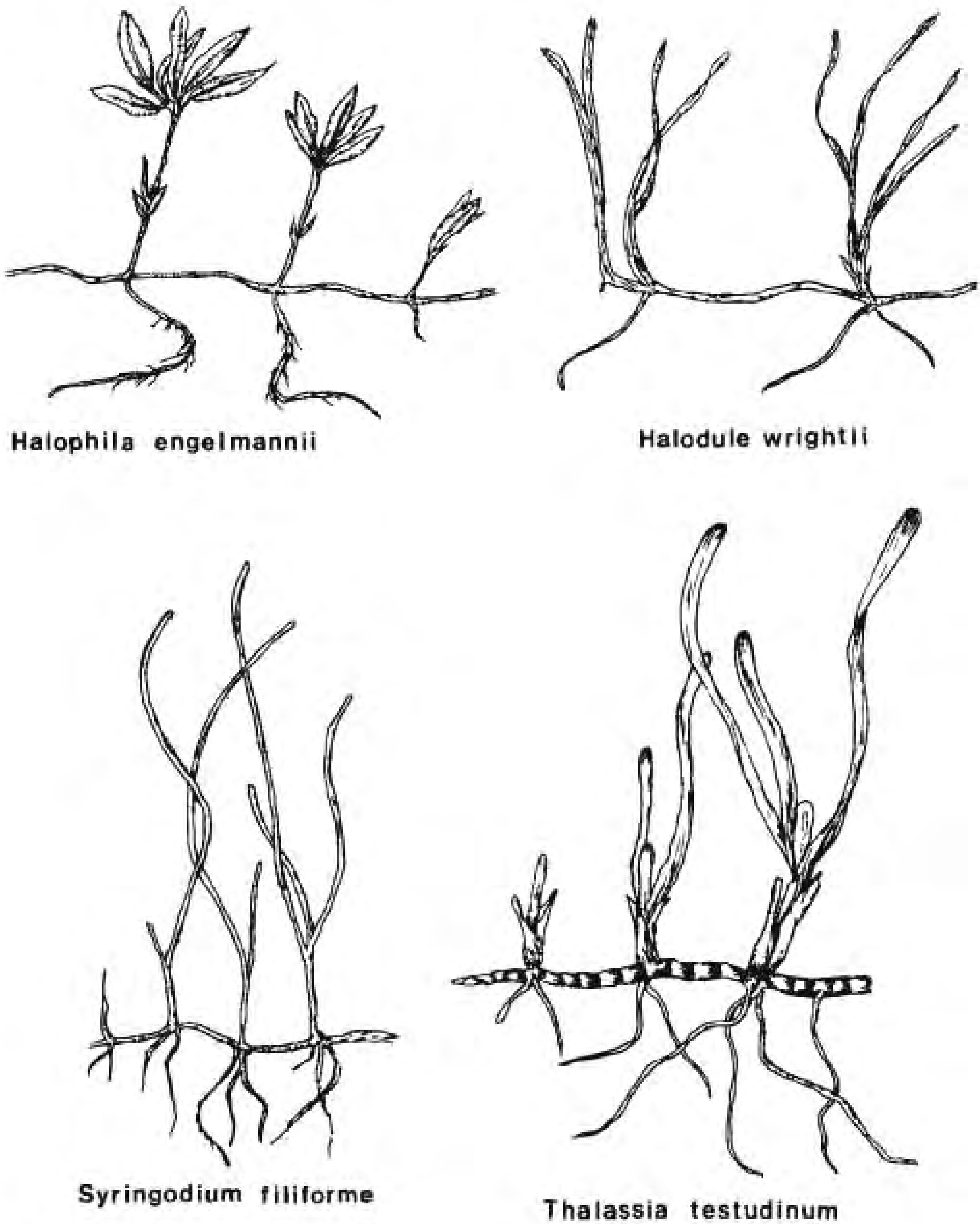

Figure 78. Four common seagrass species present in Panhandle waters (after Zieman 1982).

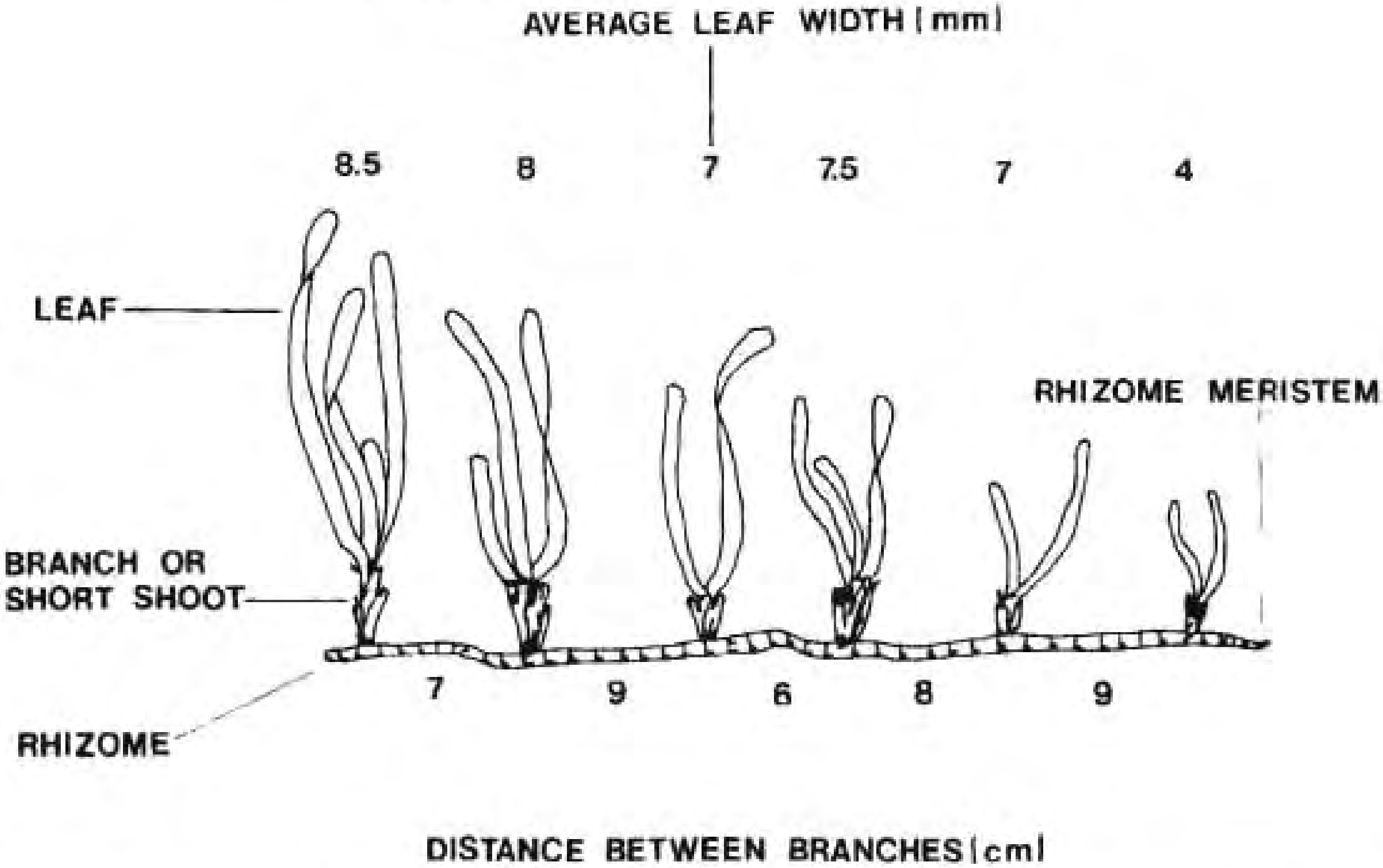

Figure 79. Diagram of a typical *Thalassia* shoot showing oldest leaves to left and new growth on right (after Zieman 1982).

Winter 1978). A pure *Halodule* bed is considered pioneer. A nearly equal mix of all three species is considered intermediate in development. Core-fringe morphology with a central core of intermixed *Thalassia* and *Syringodium* surrounded by a fringe of *Halodule* indicates mature beds.

e. Distribution. The most recent estimate of total coverage of seagrass beds in the Panhandle is approximately 637 km^2 (Table 36).

The data that exist for the 1970's and 1980's show an accelerated decline of grassbeds in many bays, especially in the Pensacola estuary system where Escambia Bay grassbeds are nearly entirely absent. Generally, there is no documentation of areal extent prior to the last few decades, so it is not known how much has been lost. The following discussion documents the most recent account of seagrass distribution in each major bay system in the Panhandle and discusses changes in the system if such information was available at the time of writing.

(1) Ochlockonee Bay. Only a few scattered patches containing some *Thalassia* have been reported near the opening of the bay into Apalachee Bay (Phillips 1960, McNulty et al. 1972).

(2) Alligator Harbor and St. George Sound. Alligator Harbor has large beds in its eastern one-third, along the northern shore, and on Bay Mouth Bar at the entrance of the harbor. There are extensive, continuous beds along the northern shores of St. George Sound. These beds are concentrated in the eastern one-half of the Sound.

(3) Apalachicola Bay System (i.e., East Bay, Apalachicola Bay, and St. Vincent Sound). The

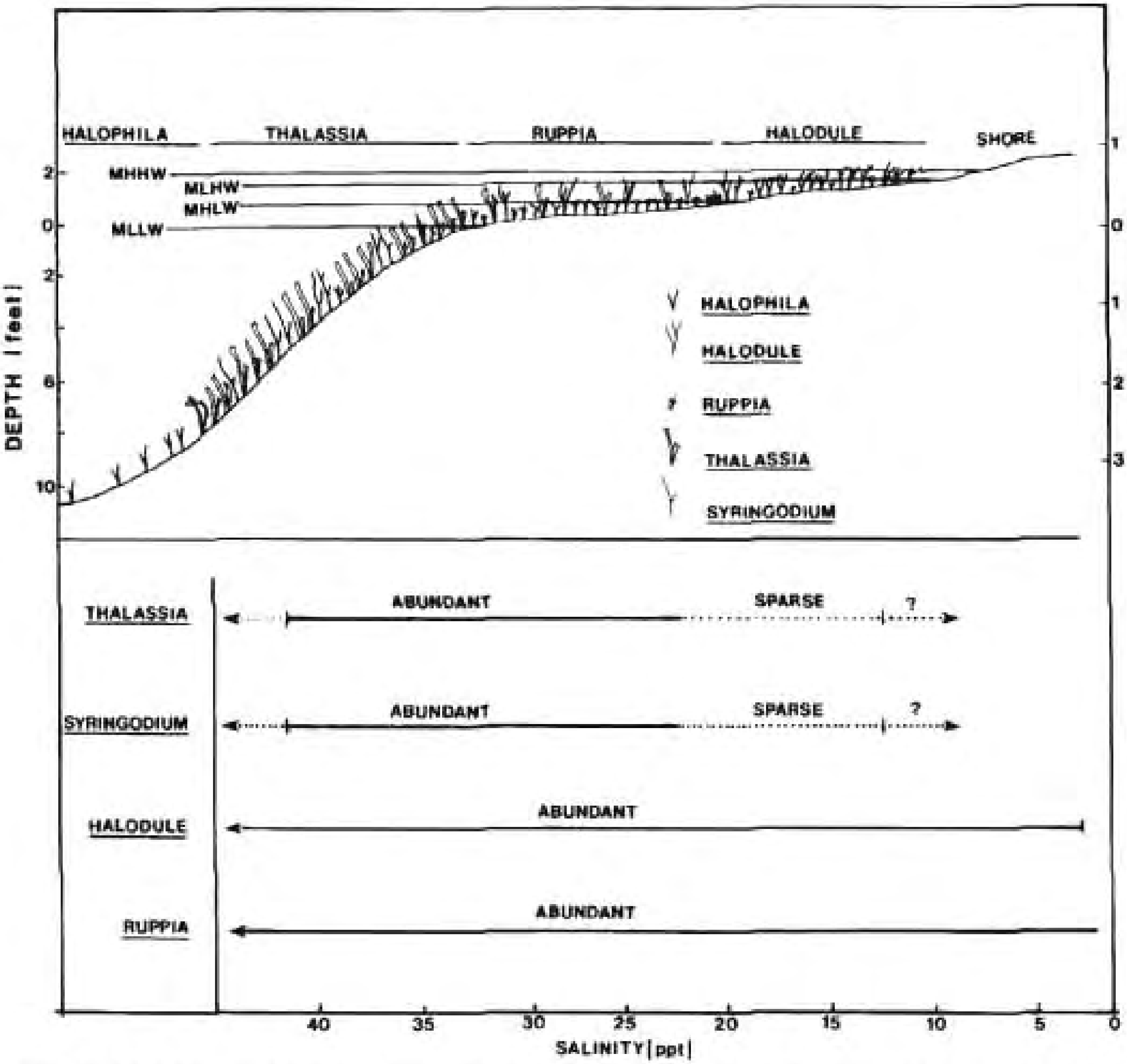

Figure 80. Diagram showing typical depth distributions of three seagrass species and a common brackish species *Ruppia maritima* (after McNulty et al. 1972). MHHW = mean higher high water; MLHW = mean lower high water; MHLW = mean higher low water; and MLLW = mean lower low water.

seagrass distribution in the Apalachicola Bay System is not very extensive given the large area of the estuary (30,480 ha). High turbidity and sedimentation from river input decrease light levels and produce an unsuitable substrate for seagrass growth in most areas. Seagrasses are primarily concentrated along the fringes of the estuary in less than 1 m of water in upper East Bay, inside St. George Island in Apalachicola Bay, and in western St. George Sound (Livingston 1984). *Halodule* and *Syringodium* dominate most areas. Grassbeds are nearly absent from St. Vincent Sound but some small isolated beds do exist (H. Bittaker, Florida Department of Community Affairs, Tallahassee; pers. comm.).

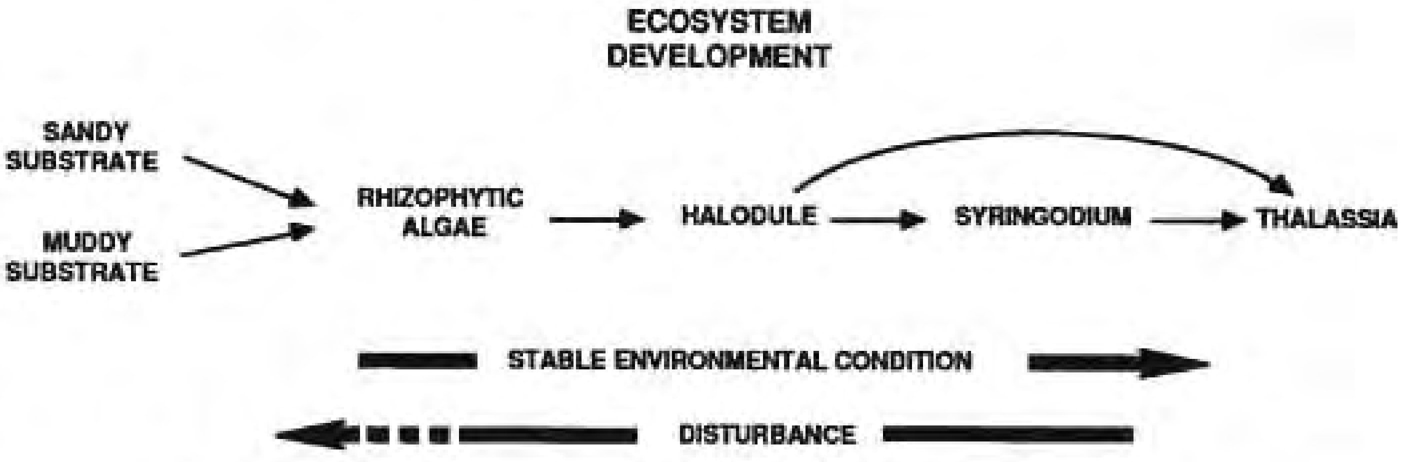

Figure 81. Ecosystem development in seagrasses. Without disturbance a Thalassia climax is reached (modified from Zieman 1982).

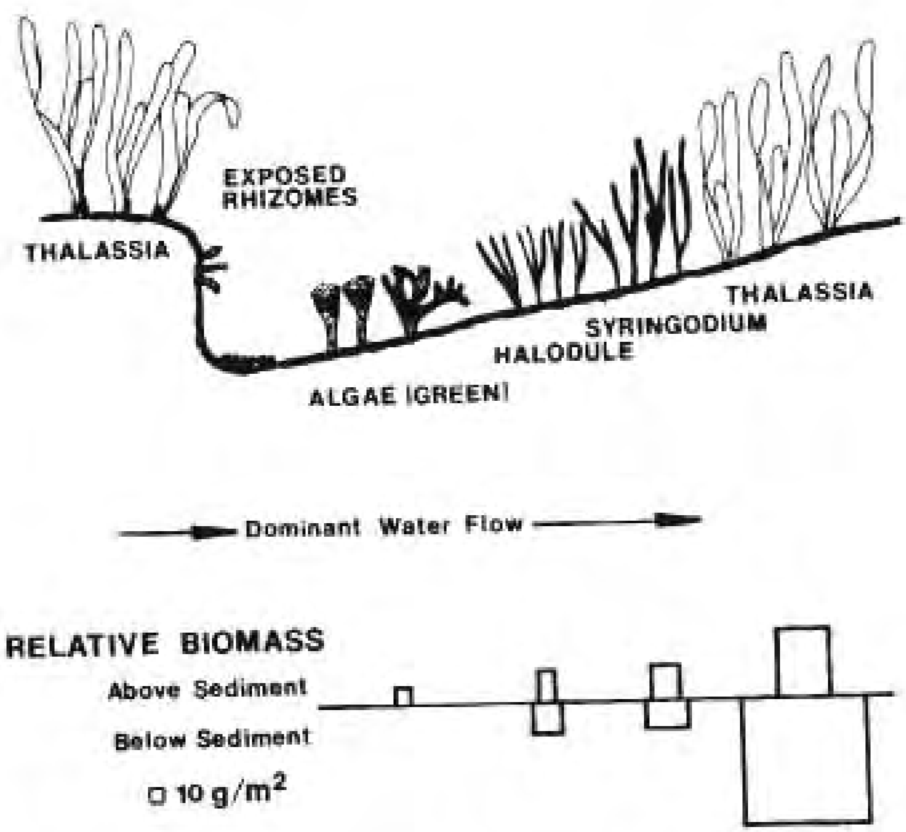

Figure 82. Idealized sequence of seagrass recolonization and growth in a large disturbance (after Zieman 1982).

Table 36. Surface area of major water bodies and most recent seagrass distribution estimates for the Panhandle water bodies (a = McNulty et al. 1972, b = Savastano et al. 1984).

Water body	Bottom area (ha)	Grassbed area (ha)	Source
Alligator Harbor	1,637	261	a
St. George Sound	30,762	3,392	a
East Bay	3,981	1,434	a
Apalachicola Bay	20,960	1,125	a
St. Vincent Sound	5,540	10	a
St. Joseph Bay	17,755	2,560	b
St. Andrew Sound	1,906	151	a
East Bay (St. Andrew)	7,557	464	a
St. Andrew Bay	10,615	1,029	a
West Bay	7,118	626	a
North Bay	2,704	417	a
Choctawhatchee Bay	34,949	1,252	a
Santa Rosa Sound	9,947	1,897	a
East Bay (Pensacola)	14,906	0	a
Escambia Bay	9,754	0	a
Pensacola Bay	16,435	627	a

(4) St. Joseph Bay (Figure 83). The seagrasses nearly circumscribe the entire inner shore of the bay. The figures of McNulty et al. (1972) show that it contains the most seagrass coverage (on a per area basis) of any single bay in the Panhandle. A more recent aerial survey and reported local observations (Savastano et al. 1984) reveal that seagrass distribution has remained unchanged from 1972–78 with apparent stability of community species types.

(5) St. Andrew Bay System (includes St. Andrew Sound, East Bay, St. Andrew Bay, West Bay, and North Bay). In total acreage this system contains the largest seagrass stock in the Panhandle (McNulty et al. 1972). Unfortunately, there have been no published reports since 1972 giving precise seagrass areas in the system, and therefore it is impossible to document any change that may have recently occurred in the bay. Seagrass composition has been noted at certain stations in a more recent study (Grady 1981). *Halodule* was the dominant species at intertidal stations on the shore of the East Arm of St. Andrew Bay. The north shore of the East Arm was nearly devoid of seagrasses, except for *Halodule* near Pitt Bayou. *Halodule* was predominant on the north shore of the West Arm, while a few stations dominated by *Thalassia* were found on the south shore. Since this system is offshore of the fast-growing Panama City area, it would be prudent to take an inventory as soon as possible in order to assess current damage and provide a base for the future assessment of impact on the system.

(6) Choctawhatchee Bay. The vegetation of the bay was studied most recently by Burch (1983a), who documented changes in coverage over the past 30 years. The only seagrass species present is *Halodule wrightii*. Beds are concentrated in the western section of the bay (Okaloosa County) and grow primarily at depths of 1 to 2 m and in areas of abrupt depth change from 2 to 5 m. Six major areas support significant seagrass populations (i.e., bottom coverage greater than 40%): Hogtown Bayou, Moreno Point from the Okaloosa-Walton County line to Joe's Bayou, East Pass, the Santa Rosa Sound entrance, Black Point, and, White Point. Five major areas contain beds with less than 40% bottom coverage: Far Mile Point, east of the Okaloosa-Walton

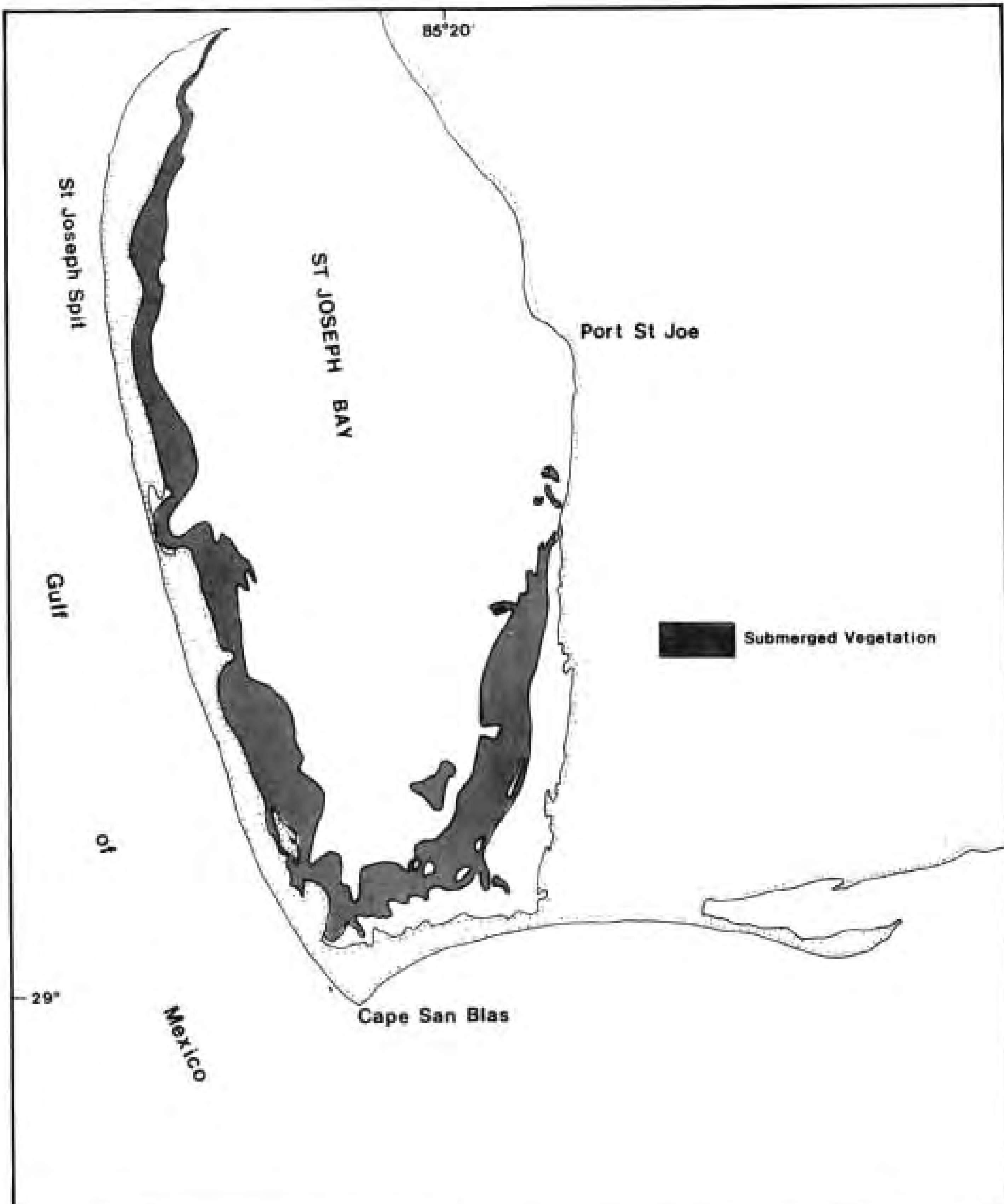

Figure 83. Seagrass distribution in St. Joseph Bay in 1981 (after Savastano et al. 1984).

County line, northwest of Destin, Smack Point, and, Eglin Village north to Rocky Bayou. No submerged vegetation is present west of Stake Point on the north shore or west of Live Oak Point on the south shore. In general, the western part of the bay appears more favorable for seagrass growth in terms of salinity, temperature, and light levels than does the eastern portion.

Burch (1983a) concluded there has been little change in submerged vegetation coverage in the past 10 years since McNulty et al. (1972) reported their findings. However, there were significant declines from 1949 to 1982 (Burch 1983a). A formerly dense patch off White Point is no longer present. Declines were noted around the east end of East Pass Bridge, out from Destin, southwest of Buccaroo Point and west of Starke Point. One major dieback was noted in 1982 in the area of Ben's Lake, which had been dredged since 1955 and another around Bear Creek to the northeast.

(7) Pensacola Bay System (includes Pensacola Bay, Escambia Bay, East Bay, and Santa Rosa Sound, Figure 84). This system is the most impacted by human activity of all the watersheds in the Panhandle. Escambia Bay, which in 1949 had extensive seagrass beds along all shores except for sparse areas along the southwest shore (Rogers and Bisterfield 1975), has been decimated of seagrass over the past 25 years (Olinger et al. 1975). There was a gradual loss between 1949 and 1966 and by 1974 all of the seagrass had disappeared (Rogers and Bisterfield 1975).

East Bay was reported to contain one major stretch of seagrass in the northeast area between Escribano Point and Miller Point. However, recent reports from local residents reveal that this bed disappeared approximately 2 years after Rogers and Bisterfield concluded their study.

Seagrass disappearance has been noted in Pensacola bay since 1951 (Rogers and Bisterfield 1975). Several small beds near the north side of the Pensacola Bay Bridge were gone by 1960, probably because of the dredging for enlargement of the Port of Pensacola; Phase I involved extensive dredging and filling. Other beds adjacent to the bridge and nearby Bayou Texar had disappeared by 1961.

The south shore of Pensacola Bay west of the Bay Bridge has not been historically mapped, but the area east of the bridge was sporadically mapped. East of the bridge, a nearly continuous 22.5 km long grassbed extended to Tom King Bayou in 1960. The dominant species was *Thalassia testudinum*, beginning in Butcherpen Cove and extending eastward 1

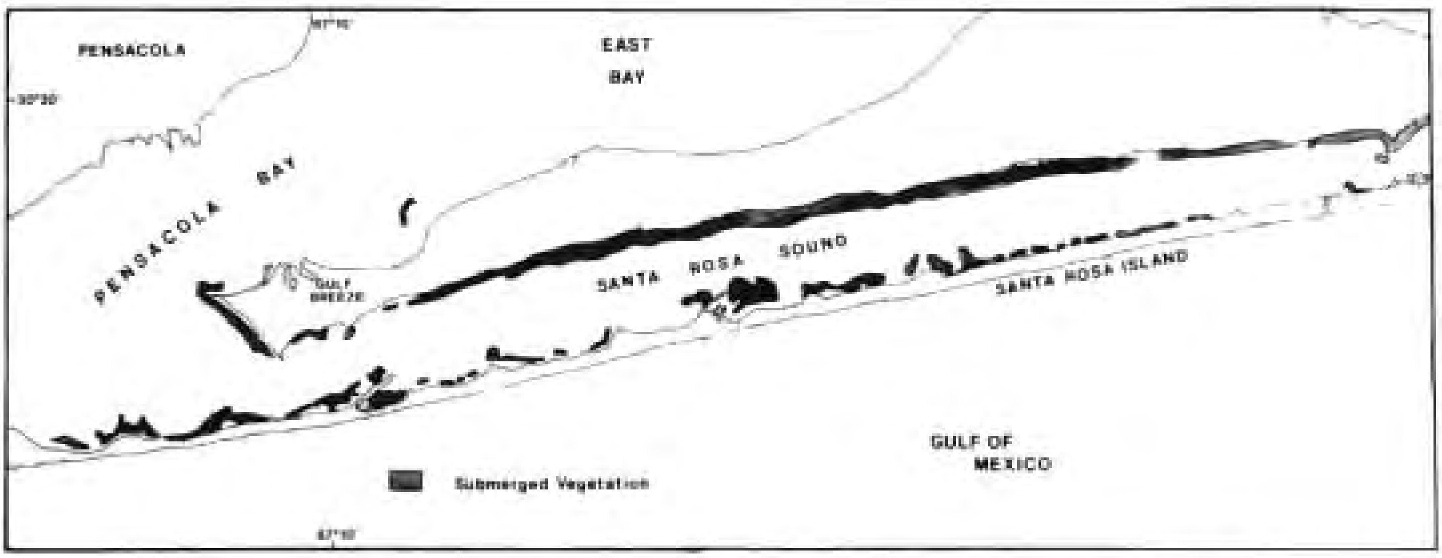

Figure 84. Seagrass distribution in a portion of the Pensacola Bay system (from McNulty et al. 1972 and Williams 1981).

km. At some point eastward toward Tom King Bayou, *Halodule* replaced *Thalassia* as the dominant species. From 1949–66, seagrass coverage declined by approximately 50%. From 1966–74, losses accelerated, and in 1974 no significant stands were left.

The Santa Rosa Sound was most recently surveyed by Winter (1978) and Williams (1981). Using divers, Winter surveyed beds between the sewage treatment plant and Range Point on Santa Rosa Island along five transects at 610, 457, 304, and 153 m from shore and along the 1 m depth contour. A total of 26.1 ha of viable seagrasses were located. Three species, *Thalassia testudinum*, *Syringodium filiforme*, and *Halodule wrightii*, were present. Near development on the shore, seagrass coverage was severely reduced and only immature beds were identified . This was interpreted as resulting from disturbances caused by heavy boat traffic and by a fill project that may have covered over some of the beds. Turbidity was postulated as a primary cause of the decline because deeper beds were dead whereas deep beds off Fort Pickens and the National Seashore, where there is no development, were still present and viable. A further increase in water turbidity was identified as the most serious potential impact to the future success of seagrasses in the Sound (Winter 1978).

f. Associated flora and fauna. The classification of the biotic components of the seagrass meadow habitat follows Kikuchi (1980). In this scheme, the flora and fauna are divided into the following three categories on the basis of the microhabitat structure and the mode of existence of the organisms.

(1) epiphytic organisms that grow on the seagrass blades (Table 37) including:
(a) micro- and macroalgae and the micro- and meiofauna associated with these algae.
(b) sessile fauna attached to the leaves.
(c) mobile fauna crawling on the leaves.
(d) swimming fauna which rest on the leaves.

(2) highly mobile fauna that swim within and over the leaf canopy (Table 38)—decapod crustaceans and fishes that may be either diurnal or seasonal transients or permanent residents.

Table 37. Dominant epiphytic organisms (flora and fauna) that grow on the seagrass blades (Dennis 1981, K. Sherman pers. comm.).

Group	Species
Microalgae	
Macroalgae	
Nematoda	*Chromadora nudicapitata* *Epsilonema* sp. *Sphiliphera paradoxa* *Syringolaimus striatocaudatus* *Viscosia macramphidia*
Copepoda	*Altheotha* spp. *Ectinosoma* spp. *Idomene* spp. *Laurinia* spp. *Metis* spp. *Parategastes* spp. *Pholetiscus* spp. *Porcellidium* spp. *Tegastes* spp. *Zaus* spp.
Polychaeta	Serpulidae
Porifera	*Haliclona permollis* *Halicometes perastra* *Mycale cecilia*

(3) epibenthic and infaunal invertebrates that dwell on or within the sediments (Table 39). Many of these species may display nocturnal vertical migration patterns between the sediment and the blades of the seagrasses. Rather than being endemic to the seagrass habitat, they appear to be an extension of the benthic community that lives on and in the adjacent unvegetated substrate.

The functional categories are all intimately linked to the seagrass and exhibit shifts in abundance in response to changes in seagrass density as well as to seasonal fluctuations in environmental parameters. Thus, within any specific meadow, there is considerable temporal variation in the composition and density of associated flora and fauna.

Table 38. Dominant mobile fauna within the seagrass leaf canopy (Abele 1970, Eidemiller 1972, Sheridan and Livingston 1983).

Group	Species name
Decapoda	*Alpheus heterochaelis*
	Callinectes sapidus
	Clibanarius vittatus
	Epialtus dilatatus
	Eurypanopeus depressus
	Hippolyte pleuracantha
	Hippolyte zostericola
	Libinia sp.
	Neopanope packardii
	Neopanope texana texana
	Pagurus bonairensis
	Pagurus longicarpus
	Palaemon floridanus
	Palaemonetes intermedius
	Palaemonetes pugio
	Palaemonetes vulgaris
	Pelia mutica
	Penaeus duorarum
	Tozeuma cardinense
	Upogebia affinis
Tanaidacea	*Hargeria rapax*
Isopoda	*Lironeca ovalis*
Fish	*Bairdiella chrysoura*
	Cynoscion nebulosus
	Lagodon rhomboides
	Orthopristis chrysoptera

There are also horizontal variations within the structure of the seagrass meadow. Silt-clay content, organic matter, and nitrogen pools are lowest outside the meadows and increase in magnitude toward the center of the bed. Shoot density and the standing crop of leaves and of root-rhizomes also increase from the edge to the inside. The faunal community may reflect this edge to center gradient, but existing data are inadequate to prove that hypothesis.

g. Trophic dynamics and interactions. Seagrasses with their attached flora (i.e., epiphytes—macroalgae attached to the blade; periphyton—microalgae such as diatoms, algal sporelings, and bacteria that coat the blade) provide food for other organisms through (1) direct herbivory, (2) detrital food webs within the beds, and (3) exported material—macroplant material or detritus—(Zieman

Table 39. Dominant epibenthic and infaunal invertebrates that live on or within the sediments of seagrass meadows (Shier 1965, Kritzler 1971, Osborne 1979, Saloman et al. 1982b, Sherman, personal communication).

Group	Species name
Nematoda	*Chromaspirinic* spp.
	Theristus spp.
Polychaeta	*Aricidea taylori*
	Axiothella mucosa
	Ceratonereis mirabilis
	Exogone dispar
	Heteromastus filiformis
	Hobsonia florida
	Neanthes acuminata
	Nereis pelagica
	Onuphis nebulosa
	Platynereis dumerilii
	Scyphoproctus platyproctus
	Spio filicornis
	Streblosoma hartmanae
	Syllis cornuta
Mollusca	*Caecum floridanum*
	Cardita floridana
	Crepidula maculata
	Mitrella lunata
	Modiolus americanus
	Modiolus demissus
	Neritina reclivata
	Ostrea frons
Crustacea	*Ampelisca vadorum*
	Ampelisca spp.
	Cymadusa compta
	Cymadusa sp.
	Lysianmopsis sp.
Oligochaeta	
Hydroids	

1982). The primary energy pathway appears to be direct herbivory on the algal epiphytes rather than the detrital food web (Kitting et al.1984). However, detritus is still a major energy pathway. Grazing on the more refractory seagrass blades is not extremely important and is limited to only a few organisms (Montfrans et al. 1984).

Annual epiphyte production can approach 20% of the seagrass production. Several factors control seagrass epiphytic communities (Figure 85). Epiphytic grazers include a wide diversity of organisms: gastropods (the most prominent), amphipods, isopods, decapods, echinoderms, and fish. Some organisms (e.g., sea urchins and fish) remove large portions of the seagrass blade along with the attached algal epiphytes. Periphyton grazers, in most cases, remove only loosely adhered diatoms and algal sporelings, but leave the grass blade intact.

The organisms that live among the epiphytic algae may be an important food source (Alvis 1971). Crustaceans and nematodes are the dominant forms.

A number of fish feed on the infauna living in the sediment in the grassbed. Stingrays actually excavate the sediment, creating pits during feeding. Rays have been noted to concentrate their feeding along the seagrass meadows fringe where the rhizome mat is not as heavily developed (Reidenauer, pers. observ.).

Many fish feed on epifaunal organisms as juveniles and are piscivores as adults, for example the bonnethead shark (*Sphyrna tiburo*) and the lizardfish (*Synodus foetens*).

Besides predation and grazing, other interactions among seagrass and its associated community

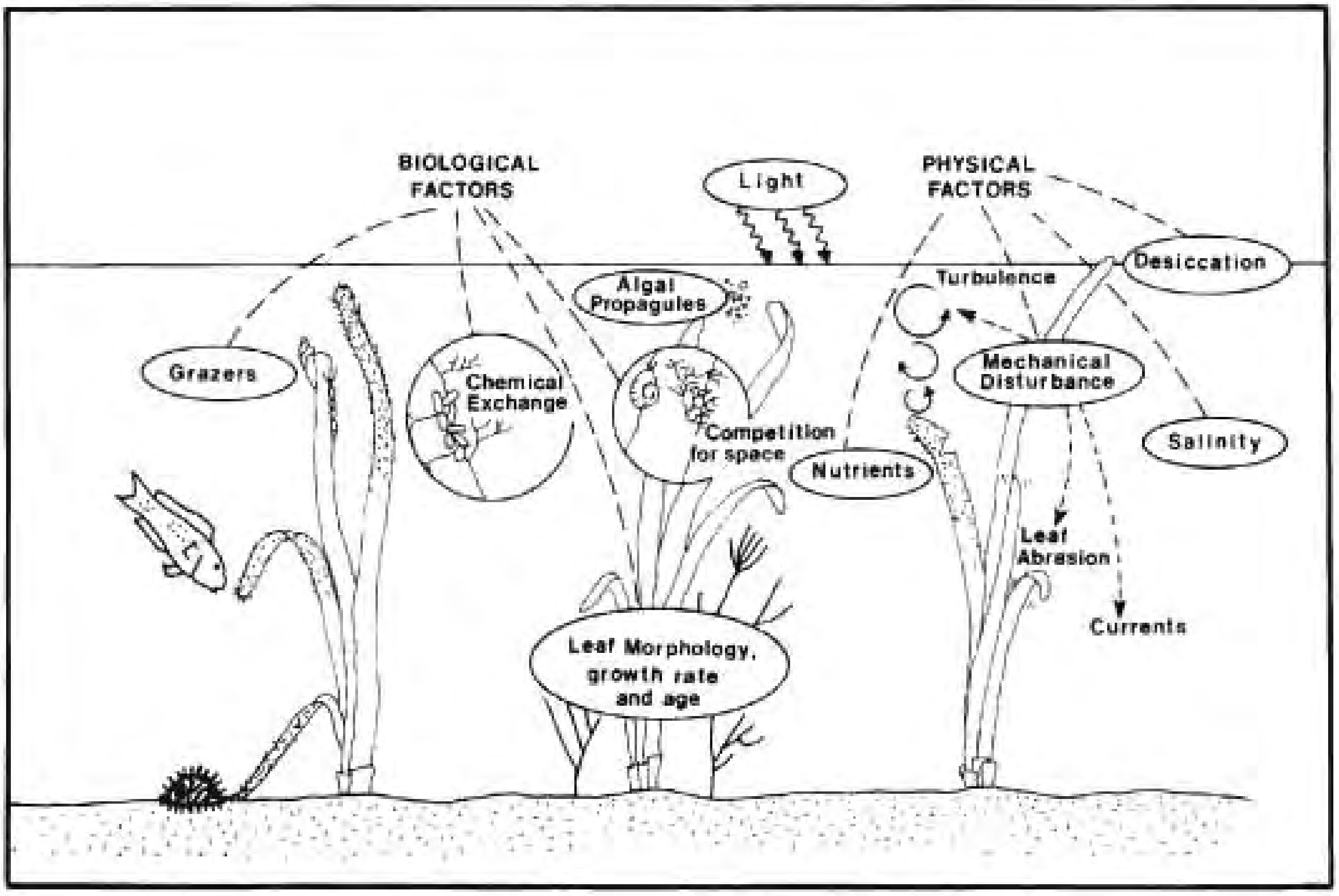

Figure 85. Schematic view showing the numerous seagrass epiphyte interactions that occur in a seagrass bed and the important physical factors affecting the interactions (after Montfrans et al. 1984).

have been examined. The epiphyte-seagrass association is a complex one (Figure 85). Epiphytes may benefit seagrass in a number of ways: reduction of desiccation during low water through entrapment and retention of moisture, protection against damage from ultraviolet radiation, and selective removal of the highly epiphytized and senescent leaf tips, which causes minimal damage to the plant itself and increases light penetration through the seagrass canopy. The distal portions of the blades are the oldest and generally most heavily epiphytized.

Epiphytes may also damage seagrasses by competing for similar wavelengths of light, shading, suppressing carbon (HCO_3^-) and phosphorus (PO_4) assimilation, and causing diurnal changes in pH and oxygen content of the surrounding water limiting plant growth and killing seagrass-associated fauna. In addition, light attenuation by epiphytes is thought to cause premature senescence in seagrasses.

The infaunal communities, especially the meiofauna community, in seagrass beds have been examined (e.g., Ruddell 1976); harpacticoid copepod abundances are significantly higher in the sediment surrounding isolated seagrass blades (Thistle et al. 1984). The physical structure of the blade may offer a refuge from fish predation (Dennis 1981). In addition, sediment microbe abundance around the blade is significantly higher than in unvegetated sand, possibly attracting meiofauna to the enriched food source.

h. Commercially important species. Scallops are common in and around seagrass beds in the Panhandle. Two scallop species occur in the region, bay scallops (*Argopecten irradians*) and calico scallops (*A. gibbus*) (Sastry 1961). The bay scallop is the most common species associated with nearshore Panhandle seagrass beds. St. Joseph Bay is a popular scalloping area in the region because of its lush seagrass beds and clear waters. Scallops spawn in the fall in north Florida. The larvae are planktonic for a few weeks and then attach to seagrass blades for several weeks before metamorphosis into adults. Maximum life span is about 2 years. Many die after one spawning season (12–14 months old). Adults are filter feeders on phytoplankton, primarily diatoms. There is no closed season on bay scallops for public harvest. Commercially, they may not be harvested before August 1 because this is when maximum size is attained.

Blue crabs are also abundant in Panhandle seagrass beds. Juvenile blue crabs are commonly found in shallow seagrass beds (Oesterling 1976). Adults are generally found in muddy sediments up to 35 m deep. Females migrate to higher salinity waters offshore to spawn. Juveniles migrate from offshore back into the estuaries. Blue crabs reach commercial size (7.7 cm carapace width) within 1–1.5 years and live up to 3–4 years. Adults feed on live prey such as small fish, oysters, and clams, and they are also scavengers. There is no closed season on blue crabs in the Panhandle, but they must be 7.7 cm across the carapace and females must not be egg-bearing.

i. Natural impacts. Hurricanes and severe tropical storms are common along the Panhandle coast (see Chapter 3). Seagrass beds can withstand hurricane force winds with little sediment erosion and minimal damage (i.e., primarily leaf damage), while adjacent unvegetated areas experience extensive erosion. Damage may occur, however, from indirect effects such as reduced photosynthesis caused by increased water turbidity and heavy sedimentation within the bed from the increased sediment load in the water column.

All seagrass species have an upper and lower temperature tolerance (McMillan 1979) beyond which they may be destroyed. The levels vary with local populations. It appears that seagrasses form photosynthetic and phenological biotopes that are adapted to local temperature ranges and these, in turn, control the entire ecosystem. However, it is difficult to generalize about responses to temperature.

Salinity fluctuations do not appear to have the extreme effects on seagrasses that temperature fluctuations may have, although the species seem to have a range of salinity tolerances.

j. Human impacts. Dredging and filling prove the greatest threat to the seagrass ecosystem (Thayer et al. 1975, Zieman 1975, Phillips 1978). The plants themselves are physically removed and the entire biological, chemical, and physical structure of the ecosystem is changed. The extent of area directly affected by dredging depends on the tidal range, current strength, and sediment texture in the area.

The sediments stirred up by dredging bury plants away from the actual project, but more importantly they also drastically reduce plant density by effecting water clarity (Zieman 1982). During dredging, light penetration through the water column is reduced, and productivity and chlorophyll content of the grasses decreases. The reduction in seagrass density caused by suspended silt increases the erosion of the bottom sediments and further affects additional areas. The redox potential of seagrass sediments is also upset by dredging, which reverses the entire nutrient-flow mechanics of the ecosystem.

Fill produces four major impacts on seagrass meadows: (1) direct covering and smothering of the grass, (2) indirect covering of the grass by drifting sediment, (3) reduced light penetration because of an increase in water turbidity, resulting in a reduction in or cessation of photosynthesis, and (4) damage by depletion of oxygen caused by BOD of the fill materials.

There is evidence that even small-scale dredging projects in some areas may cause a severe perturbation on seagrass ecosystems (Zieman 1975).

Attempts have been made to revegetate dredge spoil areas with seagrass, especially with *Halodule wrightii* plugs in St. Joseph Bay (Phillips et al. 1978). The projects have not been very successful because of physical factors (i.e., cold temperatures and storms) that could not be predicted or controlled. More intensive studies should be conducted on seagrass vegetation because of the great need to restore estuaries in the Panhandle.

Agricultural clearing of uplands, real estate development, logging, and channelizing streams may increase the rate of erosion of sediments, detritus, and mineral nutrients and may cause high inputs of sediments into estuaries and coastal areas (Thayer et al. 1975).

The direct impact from oil on subtidal seagrasses is not as severe as it is on intertidal plants (i.e., salt marsh grasses) because the majority of the oil will float over the beds. However, oil spills can inflict severe damage on grass beds. Direct contact with oil can cause mortality. Probably of greater long-range concern is damage caused when oil-sediment particles that have conglomerated elsewhere accumulate as grass beds reduce current velocity and sediments settle out of the water column. A surface oil sheen can also reduce light penetration and indirectly affect seagrass beds. Laying pipe for oil can directly destroy beds. In areas of low energy, seagrasses are buried and smothered by mud cuttings and fluids and are affected indirectly by turbidity from suspended drilling effluents (John Thompson, Continental Shelf Associates; pers. comm.).

Pollution from toxins and heavy metals has not been implicated in the direct, major destruction of seagrass beds. Evidence exists that roots of seagrasses may accumulate metals such as zinc (Zieman 1982). Concentrated metals may be passed along the food chain through the seagrasses.

In many shallow water Panhandle environments (e.g., St. Joseph Bay and Santa Rosa Sound), the physical destruction of seagrass beds by boat propellers is easily observed. *Thalassia* beds are especially affected since this species does not spread its rhizome mat very rapidly. Propeller cuts can be very persistent features, lasting for 3 years or more (Zieman 1976). If the leaves of *Thalassia*, for example, are slightly damaged rapid regrowth will be unlikely. Rhizome growth is extremely slow and if roots are cut, regrowth may never occur. Trawling by commercial fishermen can tear up grassbeds.

Effluent discharge (particularly nitrogen and phosphorus compounds and suspended solids) can cause a decline in seagrass coverage as a result of heavy growths of phytoplankton and filamentous algae and higher turbidity. These growths reduce the available light and nutrients for seagrasses and also reduce oxygen levels for seagrass respiration during nighttime hours.

7.2.11 Subtidal Leaf Litter

a. Introduction. The leaf-litter habitat in the Panhandle is basically detritus dominated by pine needles and oak leaves. It is generally concentrated near river mouths in the estuaries. The habitat is ephemeral, existing at peak abundance when river flow is great and terrestrial macrophytes are dying off.

Leaf litter contains a unique and definable assemblage of organisms that are closely tied to the decaying vegetation for food and shelter. Omnivorous and detritivorous organisms usually dominate.

Physical factors (e.g., salinity and temperature) are important determinants in the distribution of the leaf-litter faunal community. Biological factors such as predation also appear to play an important role.

b. Associated fauna and flora. Livingston (1984) reported on the common organisms present in Panhandle leaf-litter habitats (Table 40). Abundances of leaf litter macrofauna peak in late winter (March) and early fall (September) (Livingston 1984) (Figure 86). These peaks are strongly correlated to the availability of detritus. Other important factors within the estuaries that affect the leaf-litter fauna are temperature and salinity. Highest abundances are generally associated with higher salinity waters.

The microbial community associated with Panhandle leaf litter has been investigated in depth by Morrison et al. (1977) and White et al. (1979). Microbial biomass correlated strongly with substrate type rather than other physical factors. Bacteria are initial colonizers of the plant litter and are subsequently replaced by more complex forms such as fungi and algae.

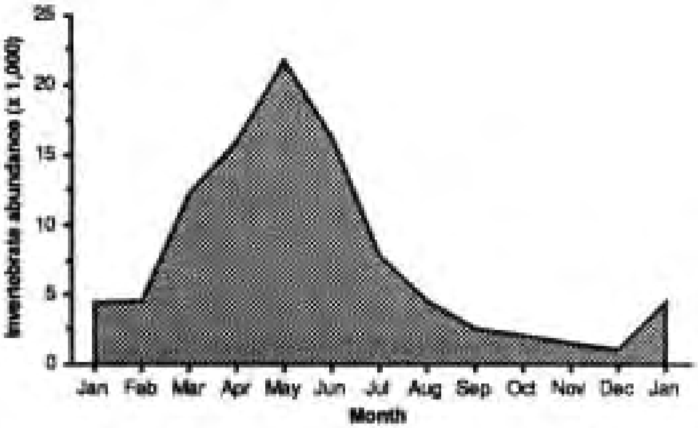

Figure 86. Seasonal abundances of leaf-litter associated invertebrates from the Apalachicola Bay system in 1976 (after Livingston 1984).

There are no published reports on the meiofauna of Panhandle leaf-litter communities.

Table 40. Common fauna of Panhandle leaf-litter habitats (from Livingston 1984).

Common name	Scientific name
Amphipods	*Corophium louisianum*
	Gammarus mucronatus
	Gitanopsis spp.
	Grandidierella bonnieroides
	Melita spp.
Isopod	*Munna reynoldsi*
Decapods	*Callinectes sapidus*
	Palaemonetes pugio
	Palaemonetes vulgaris
	Penaeus setiferus
Gastropod	*Neritina reclivata*

c. Trophic dynamics and interactions. The leaf-litter fauna is primarily omnivorous and detritivorous. Macrofaunal distribution is positively correlated with numbers, biomass, and species richness of the detritus-associated microfauna (Livingston 1984). The macroinvertebrates appear to seek out microbial populations rich in anaerobic or microaerophilic bacteria. Distinct macrofaunal populations may prey upon specific microbes. The macrofaunal detritivores are an important link between the microbial producers living on the leaf litter and commercially important estuarine fish and invertebrates (Livingston 1984).

d. Natural Impacts. Storms wash away detritus, making leaf-litter habitat ephemeral and patchily distributed. Temperature and salinity fluctuations affect faunal distributions.

e. Human Impacts. Artificial perturbations that affect other estuarine habitats, such as unvegetated soft bottoms, also impact leaf litter. Water quality parameters such as lowered DO, increased nutrients, and heavy metals can produce reductions in fauna.

7.3 Marine Habitats

7.3.1 Hard Substrates

a. Introduction. As in the estuarine system, there are not many naturally occurring hard substrates present in the Panhandle marine intertidal regions. Most of them are artificial (e.g., pilings, jetties, offshore platforms, and boat bottoms). Although limited in area, the habitat is discussed because it contains a unique and ecologically interesting fauna. Community development on structures is economically important because of biofouling problems. For example, marine fouling reduces ship propulsion efficiency by increasing frictional drag and destroys wharf pilings. It is also a problem on buoys and other structures in the marine environment.

b. Associated flora and fauna. Marine algae on platforms tend to be small and inconspicuous. Two colonial forms are present: *Enteromorpha* and *Chaetomorpha*. Generally the dominance follows this order: green, red, blue-green, and brown algae (Salsman and Ciesluk 1978). For photosynthetic reasons, algal biomass is concentrated near the surface waters. Algae are usually one of the first colonizers of new or open solid surfaces.

There is considerable variation in biofouling communities in the type of organisms present and in their size and density (Hastings 1972). The system is dependent on season, water depth, distance from shore, and larval availability (Pequegnat et al. 1967, Pequegnat and Pequegnat 1968). The nature of the substrate also plays a major role. The settlement rate of larvae is often determined by surface contour, texture, composition, and color. Light levels, water currents, and tidal range are also important.

There appears to be a predictable sequence in the development of a Panhandle fouling assemblage (Salsman and Ciesluk 1978): (1) initial settlement and rapid development of pioneer species; (2) a rapid and then more gradual increase in species diversity; (3) an early increase in size and density of nearly all individuals; (4) a decrease in the abundance of some species with the local extinction of others; and (5) the persistence of a few species, which facilitates the settlement of later arriving species.

The pioneer "guild" includes a community of bacteria, diatoms, and blue-green algae that produce a slime-like surface. During the first week of exposure, barnacles, hydroids, and gammarid amphipods usually appear. Most of these are primarily suspension feeders. Other trophic types settle later.

Three species of acorn barnacles (*Balanus venustrus*, *B. improvisus*, and *B. eburneus*) are typically encountered in the Panhandle (Hulings 1961). *Balanus venustrus* is usually the most abundant species.

Five species of gammarid amphipods are also present (Salsman and Ciesluk 1978). Twenty-three species of hydroids are present in the lower intertidal to subtidal range.

The most prominent difference between Panhandle estuarine and marine biofouling communities is the dramatic decrease in organism settlement and growth found in estuaries during the winter months (November–March).

Offshore petroleum structures represent unique artificial habitat areas. They may act as islands of hard substrate in otherwise soft-bottom habitats. Gallaway et al. (1981) delineated three distinct biofouling assemblages that are present in the northern Gulf of Mexico region: coastal (0–30 m), offshore (30–60 m), and bluewater (> 60 m). Coastal platforms are typically dominated by barnacles with hydroids, bryozoans, and sponges also abundant. Oysters may be present too. Offshore communities are similar but are dominated by bivalves instead of barnacles and usually have lush populations of octocorals (e.g., *Telesto* spp.) and algae near the surface. Bluewater biofouling assemblages have the lowest biomass of the three types. Algae and stalked barnacles dominate near the surface with bivalves more abundant at greater depth.

Because of the extensive biofouling communities, petroleum platforms are subjected to increased frictional drag from wave and current action. For economic and structural reasons, biofouling communities are extremely important. They tend to decrease the longevity of the platforms and hence increase the cost of offshore operations. Organisms on platforms are usually restricted to a particular depth range, and communities found in the near-surface intertidal range are similar to those from the nearshore intertidal environment.

7.3.2 Sandy Beaches

a. Introduction. The marine sandy beaches in the Panhandle are located on the gulfward-facing shores of the barrier islands (Dog, St. George, St. Vincent, Shell, and Santa Rosa Islands) and on the mainland shores from Cape San Blas to Pensacola. These intertidal habitats experience the highest wave-energy levels of any habitat type in the Panhandle saltwater environment. This beach habitat includes the swash zone (the sloping surface of the beach face that is created by the runup of water) down to the mean low water (MLW) mark.

Panhandle beach sediments are composed almost exclusively of fine quartz grains with a median diameter of 0.1 to 0.2 mm (Salsman and Ciesluk 1978). Their extreme white color makes them attractive to tourists. The aerobic zone (i.e., depth of oxygenated sediment) in beach sediments is very deep because of tidal flushing and the relatively large interstitial pore spaces. This allows organisms to live far down within the sediment and escape the pounding of the waves. The majority of beach organisms tend to be suspension feeders, using the rushing water to constantly carry food in and waste material away.

b. Beach zonation. Panhandle beaches are typical marine beaches and can be divided into specific zones (Figure 87). Typically, there are two offshore sandbars, the first located approximately 15–25 m offshore at a depth of 0.3–1.0 m, and the second 130–140 m offshore in 2–2.5 m of water.

c. Associated fauna. The macrofauna component has been the most intensively studied (Abele 1970, Hayden and Dolan 1974, Saloman and Naughton 1978, Saloman and Naughton 1984) (Table 41). Polychaetes dominate numerically. Amphipods (also called "sand fleas") and ghost crabs (*Ocypode quadrata*) are also important members of the community.

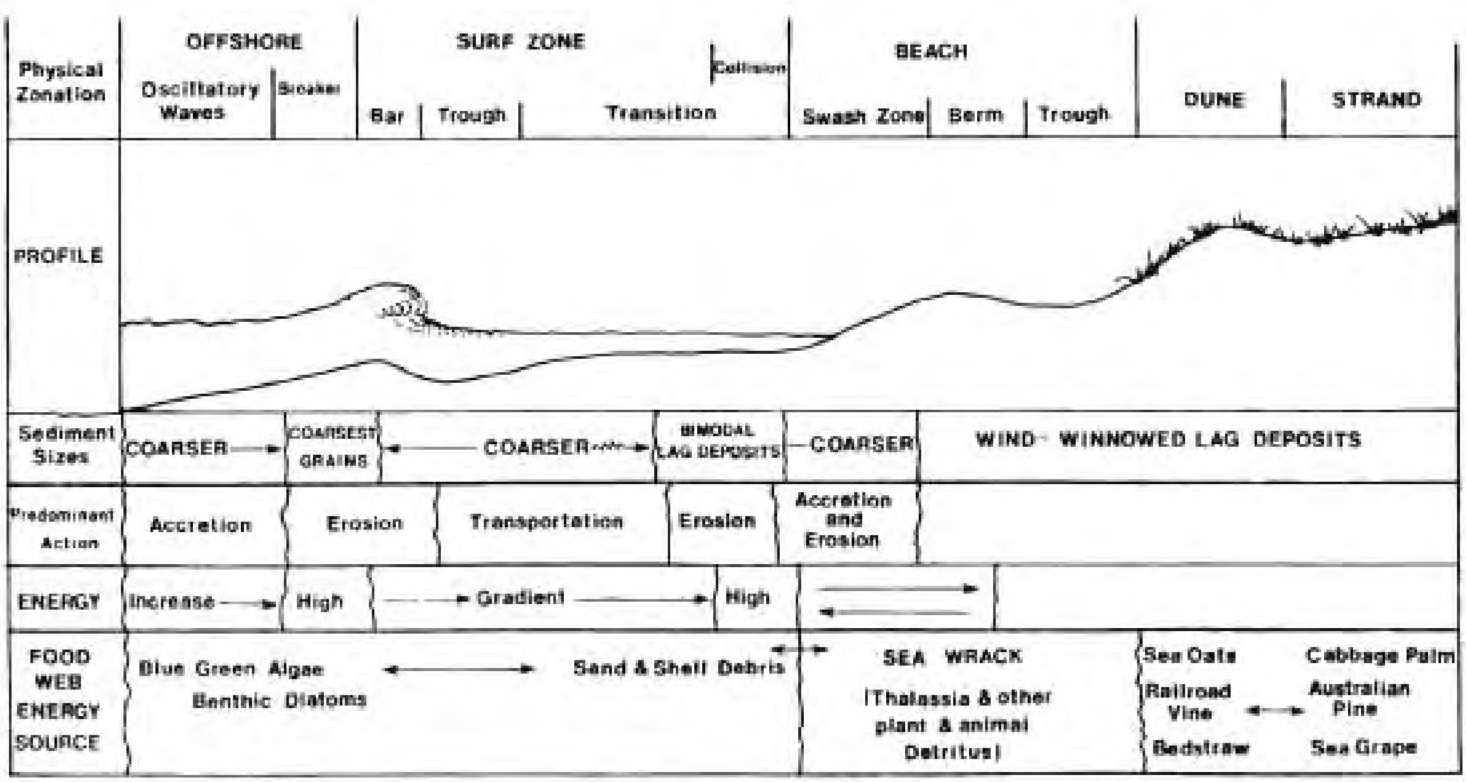

Figure 87. A high-energy beach community, showing major zones relating to sand motion (adapted from Riedl and McMahan 1974).

Table 41. Common macroinvertebrates present on Panhandle beaches (Hayden and Dolan 1974; Saloman and Naughton 1978, 1984).

Species name	Common name
Along wave line:	
Emerita talpoida	mole crab
Lepidopa benedicti	decapod
Callianassa islagrande	decapod
Arenaeus cribrarius	decapod
Scolelepsis squamata	polychaete
Haustorius spp.	amphipod
Upper portion of beach:	
Ocypode quadrata	ghost crab

One meiofauna group, the tardigrades (or "water bears"), are usually very abundant in beach sediments. A common Panhandle species is *Batillipes mirus*.

Birds are conspicuous members of the beach habitat and nearshore gulf waters. Common Panhandle sea- and shorebirds include: pelicans, cormorants, gulls, terns, sandpipers, plovers, stilts, skimmers, and oystercatchers (see Table 42).

d. Species of special concern. The Cuban snowy plover (*Charadrius alexandrinus tenuirostris*) is the only bird species in Florida that relies solely on the sandy beach for nesting and foraging habitat (Kunneke and Palik 1984). It is listed as an threatened species by the Florida Game and Fresh Water Fish Commission. It requires isolated, expansive sandy beaches for nesting. Breeding occurs from April to June. Its eggs (usually three) are laid in a shallow depression, which the parents occasionally line with seashell fragments. The mammals, the Choctawhatchee beach mouse (*Peromyscus polionotus allophrys*) and Perdido Key beach mouse (*P. polionotus trissyllepsis*), were listed as endangered by the Federal government in 1985.

Panhandle beaches are nesting grounds for sea turtles. The Atlantic loggerhead (*Caretta caretta*), nests yearly (August through October) on the beaches from St. George Island to Okaloosa County.

e. Trophic dynamics and interactions. Most of the organisms such as mole crabs (*Emerita talpoida*) are suspension feeders. Some, such as the ghost crab, are also scavengers.

Birds prove an intricate part of beach food-chain dynamics. They represent the top trophic group in the beach system, feeding on crustaceans, polychaetes, mollusks, and fish.

Table 42. Common seabirds and shorebirds present along Panhandle beaches (Lowery and Newman 1954, Sprout 1954).

Common name	Scientific name
American oystercatcher	*Haematopus palliatus*
Black skimmer	*Rynchops nigra*
Common tern	*Sterna hirundo*
Double-crested cormorant	*Phalacrocorax auritus*
Eastern brown pelican	*Pelecanus occidentalis carolinensis*
Laughing gull	*Larus atricilla*
Least tern	*Sterna antillarum*
Royal tern	*Sterna maxima*
Sandwich tern	*Sterna sandvicensis*
Snowy plover	*Charadrius alexandrinus tenuirostris*
Wilson's plover	*Charadrius wilsonia*

f. Natural Impacts. Morton (1976) and Chiu (1977) reported the effects of Hurricane Eloise on Panama City beaches. The storm occurred in September, 1975, and caused extensive beach erosion, primarily by storm surge, wave setup, and beach scour (Figure 88). Wind and flood damage to the beach were minimal. Sediment was transported westward. The effects of Eloise on the benthic beach fauna was reported to be minimal and temporary (Saloman and Naughton 1977). Numbers of benthic individuals were approximately the same before and after the storm. Numbers of species increased just after the storm but rapidly returned to prestorm levels.

Beach erosion is affected by fluctuations in sea level, wave conditions, longshore currents, atmospheric conditions, and human activities. The current sea-level rise of 0.5–1.0 cm/yr corresponds to a rate of shoreline retreat of about 0.3–1 m/yr. Shoreline erosion is not a constant, gradual process but appears to take place most severely during periods of intense wave activity, storm tides, and storm surges such as occur during hurricanes and other tropical storms (Ho and Tracey 1975, Walton 1978).

Dredging navigational channels through inlets below their natural depths may enhance beach erosion by increasing the capability of the channel to flush sand out of a bay system. A channel can also act as a barrier to sand transported along the coast by longshore drift and deplete the supply to downcurrent beaches. In a similar manner, structures such as jetties at inlets can cut off the natural supply of sand and direct it offshore. Beach erosion is a problem in Bay County in areas such as Biltmore Beach and Mexico Beach, where erosion rates of 1 m/yr have been documented.

g. Human Impacts. Trash, noise, and sediment disruption are the major disruptions created by recreational beach users. The Panhandle has over 900,000 linear ft of recreational beach coastline.

The effect on the benthic fauna from sand deposition during beach restoration is reported in only a few instances (Thompson 1973, Hayden and Dolan 1974, Culter and Mahadevan 1982). Results of a study on a Panhandle beach (Panama City Beach) appear consistent with other reports (Saloman and Naughton 1984). The deposition of offshore sand

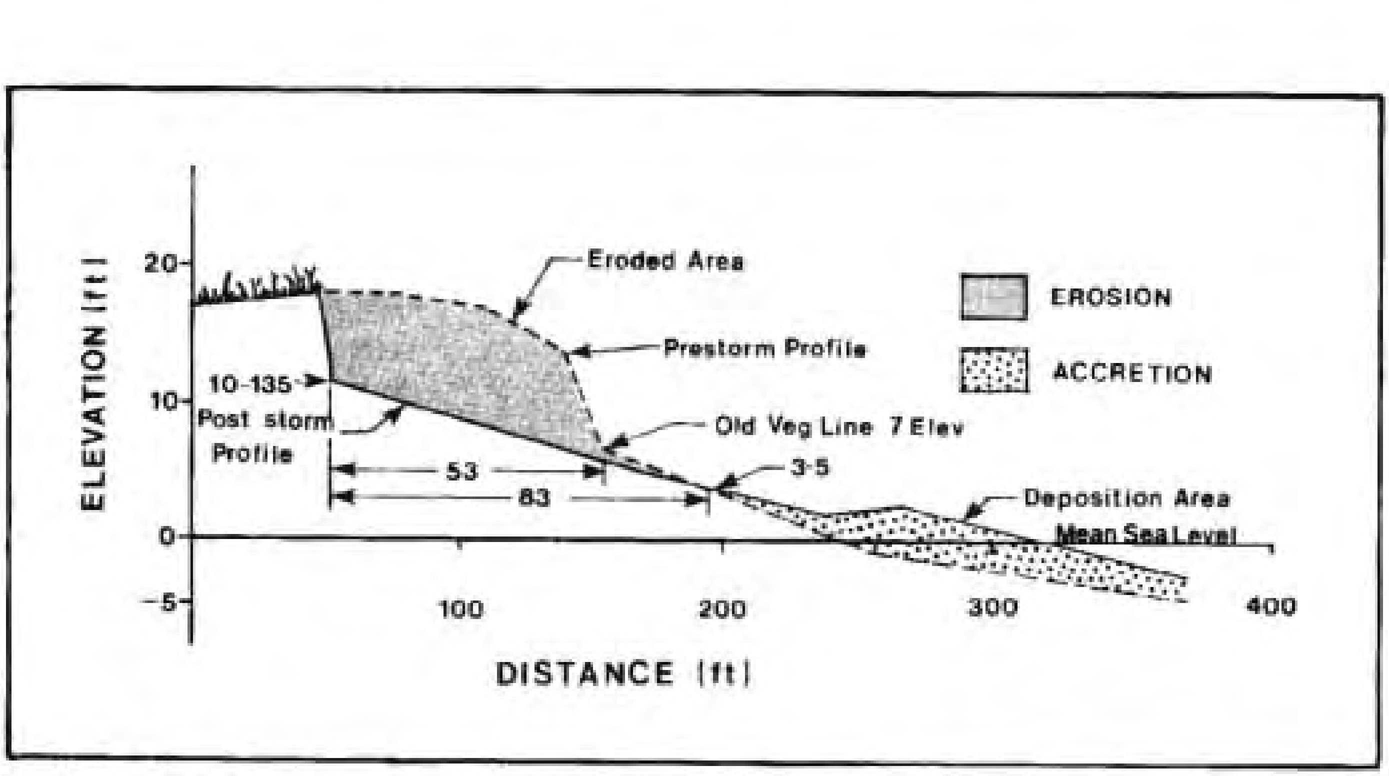

Figure 88. Change in Panama City beach profile after Hurricane Eloise in September 1975 (after Morton 1976).

onto the beach produces only short-term minor effects on the benthic fauna. For five to six weeks after deposition, species numbers and densities decrease in the swash zone. After this period, populations return to pretreatment levels and stabilize. Overall, the beach fauna appear relatively resilient to this type of disturbance. There have been no reports of the effects of beach renourishment on higher trophic organisms such as birds.

Renourishing beaches with offshore dredged sediments costs an estimated $1 million/mi of restored beach initially and requires about $25,000/mi/yr to maintain (Kunneke and Palik 1984).

Artificial structures such as seawalls, offshore breakwaters, groin fields, rock revetments, and jetties tend to aggravate beach erosion rather than slow or stop it.

7.3.3 Marine Open Water

a. Introduction. The nearshore and offshore marine open water habitat is physically stable compared to that of the estuaries. Salinity varies very little throughout the year and temperatures do not fluctuate as much or as quickly in the marine system.

Primary productivity in marine open waters of the Panhandle is lower than that of estuaries since the nutrient input is lower. Trophic dynamics are basically similar. There is overlap in the species present in the two systems. Many fish use the estuaries as nursery areas and migrate to deeper marine waters as adults, eventually to spawn. This habitat includes the prized sport and commercial fish such as grouper (*Mycteroperca* spp.), Spanish mackerel (*Scomberomorus maculatus*), king mackeral (*S. cavalla*), dolphin (*Coryphaena hippurus*), and billfish (Istiophoridae), and invertebrates such as the brown shrimp (*Penaeus aztecus*).

b. Species present. The reduction in primary productivity in marine open waters is accompanied by a higher phytoplankton species diversity (Steidinger 1973) and characterized by more holoplanktonic forms than spore-forming meroplanktonic forms. Many of the diatoms and dinoflagellates that occur in the estuaries are also present in the nearshore marine system (Table 43), but in smaller numbers. Dinoflagellate diversity may exceed diatom diversity in the marine system.

Table 43. Common plankton present in the marine open water habitat of the Panhandle (Steidinger 1973).

Group	Species
Phytoplankton	
Diatoms	*Chaetoceros compressum*
	Guinardia flaccida
	Hemiaulus hauckii
	Plagiogramma vanheuckii
	Rhyzarolenia imbricata
	Rhyzarolenia robusta
	Thalassiothrix faruenfeldii
Dinoflagellates	*Ceratium carriense*
	Ceratium furca
	Ceratium fusus
	Ceratium massiliense
	Ceratium trichoceros
	Peridium spp.
Blue-greens	*Oscillatoria erythraea*
Zooplankton	
Copepods	*Eucalanus monachus*
	Nannocalanus minor
	Terma spp.
	Undinula vulgaris
Chaetognaths	*Sagitta elegans*
Decapod Larvae	
Mysids	*Bowmaniella dissimilis*
	Mysidopsis almyra
	Taphromysis bowmanni

Phytoplankton demonstrate vertical stratification because of photosynthesis requirements (Steidinger 1973). Grazing zooplankton generally peak in abundance in areas of concentrated phytoplankton patches. The plankton are also seasonal in abundance (Figure 89).

c. Recreationally and commercially important species. To the west of Cape San Blas the Continental Shelf is relatively narrow, and numerous pelagic species are found relatively close to shore. Important commercial and recreational species in

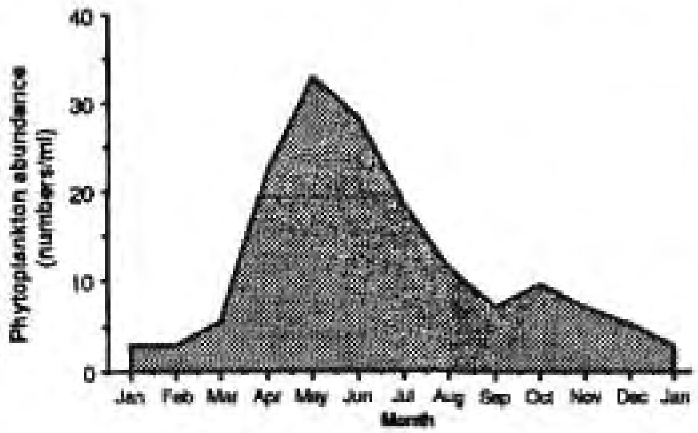

Figure 89. Seasonal phytoplankton abundances in the northeast Gulf of Mexico (after Steidinger 1973).

this region include brown shrimp, white shrimp (*Penaeus setiferus*), and pink shrimp (*P. duorarum*), Atlantic bonito (*Sarda sarda*), greater amberjack (*Seriola dumerili*), crevalle jack (*Caranx hippos*), blue runner (*C. crysos*), sharks, spot (*Leiostomus xanthurus*), Atlantic croaker (*Micropogonias undulatus*), sand seatrout (*Cynoscion arenarius*), gulf menhaden (*Brevoortia patronus*), bluefish (*Pomatomus saltatrix*), Spanish and king mackerel, Atlantic thread herring (*Opisthonema oglinum*), Spanish sardine (*Sardinella anchovia*), and the billfishes—blue marlin (*Makaira nigricans*), white marlin (*Tetrapturus albidus*) and sailfish (*Istiophorus platypterus*) (Pristas 1981) (Table 44). Five marine turtles with special status are also found in this region (Table 45).

Inshore trolling grounds off Panama City are important summer sportfishing areas for Spanish and king mackerel, Atlantic bonito, and dolphin. The area off the entrance to Pensacola Bay is a popular summer sportfishing area for Spanish and king mackerel, bluefish, and cobia (*Rachycentron canadum*)(Trent and Anthony 1978).

In the Panhandle, a number of charter sportfishing boats, numerous private boats, and party boats (also called head boats) fish the nearshore marine waters during the warmer months (Fable et al. 1981, Kunneke and Palik 1984) (Table 46). Trolling techniques are usually used with king mackerel, Spanish mackerel, bluefish, blue runner, little tunny (*Euthynnus alletteratus*), Atlantic bonito, and dolphin. These seven species make up a majority of charter boat catches. Yearly species composition during the 1970's were king mackerel (61%), Atlantic bonito (15%), bluefish (5%), blue runner (5%), little tunny (5%), Spanish mackerel (4%), and dolphin (4%). Trolling effort in the Panhandle is greatest offshore of Panama City and Destin. Historically, the sport fishery has been mostly dependent on king mackerel catches (Brusher et al. 1976, Fisher 1978).

Dramatic changes in the landings, species composition, and sizes of fishes in the summer of 1977 and 1978 in the charter boat pelagic fishery off Panama City have been correlated to large changes in air temperatures during the preceding winters (Fable et al. 1981). During 1970–76 and 1979, king mackerel generally dominated the catch, ranging from 57.2% (1979) to 92.9% (1970) (Figure 90).

Table 44. Common fish species present in marine open waters of the Panhandle.

Species name	Common name	Species name	Common name
Caranx crysos	Blue runner	*Pomatomus saltatrix*	Bluefish
Coryphaena hippurus	Dolphin	*Rachycentron canadum*	Cobia
Epinephelus morio	Red grouper	*Rhomboplites aurorubens*	Vermilion snapper
Euthynnus alletteratus	Little tunny	*Sarda sarda*	Atlantic bonito
Istiophorus platypterus	Sailfish	*Scomberomorus cavalla*	King mackerel
Lutjanus campechanus	Red snapper	*Scomberomorus maculatus*	Spanish mackerel
Makaira nigricans	Blue marlin	*Sphyraena barracuda*	Great barracuda
Mycteroperca microlepis	Gag	*Tetrapturus albidus*	White marlin
Pagrus pagrus	Red porgy	*Thunnus thynnus*	Bluefin tuna

Table 45. Marine turtles with special status that occur in Panhandle marine waters.

Common name	Species name	Status
Atlantic green turtle	*Chelonia mydas mydas*	Endangered
Atlantic hawksbill	*Eretmochelys imbricata imbricata*	Endangered
Atlantic leatherback	*Dermochelys coriacea*	Endangered
Atlantic loggerhead	*Caretta caretta caretta*	Threatened
Atlantic ridley	*Lepidochelys kempi*	Endangered

Table 46. Charter and party boat principal ports of call (Schmied 1982, Waterway Guide, Inc. 1982).

County	Ports of call	Number of charter boats	Number of party boats
Escambia	Pensacola	5	0
Santa Rosa	Gulf Breeze	5	0
Okaloosa	Destin Harbor	51	4
	Ft. Walton Beach Harbor	4	0
	Shalimar Harbor	3	0
	Santa Rosa Beach	2	0
Walton	—	0	0
Bay	Panama City	73	7
	Mexico Beach	6	0
Gulf	—	0	0
Franklin	—	2	0
Total		**151**	**11**

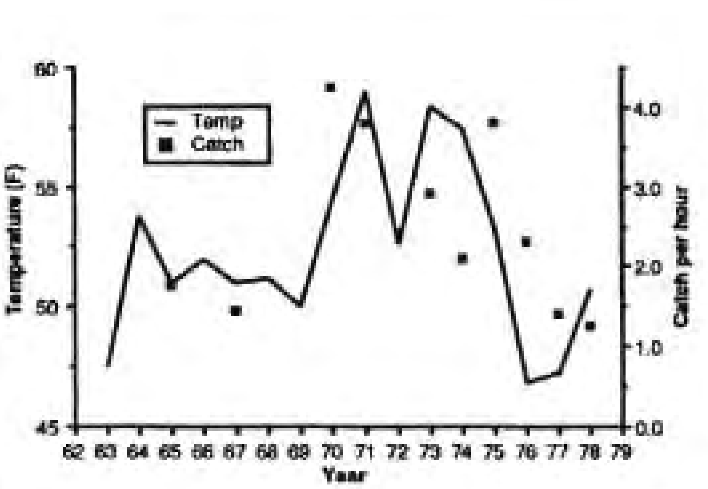

Figure 90. Correlation of pelagic fisheries to changes in air temperatures off Panama City (Fable et al. 1981).

Atlantic bonito ranged from zero to 7.1% during the same time periods. In the summers of 1977 and 1978, king mackerel made up only 38.7% and 18.9%, respectively, of the total catch, while Atlantic bonito comprised 29.5% and 47% of the totals. These changes corresponded to unusually low temperatures during the 1976–77 and 1977–78 winters. Successful king mackerel migration into Panhandle waters, therefore, appears dependent upon water temperatures that are not far below normal.

In general, king mackerel are available to the fishery in the Panama City area in April, are abundant during June to November, and are most abundant, or catchable, in September. The king mackerel in this region winter off the southeast coast of Florida (Sutherland and Fable 1980). Of the remaining six species, Atlantic bonito, blue runner, little tunny, and dolphin have been most abundant in the catches during June or July, while bluefish have been most abundant in May and November, and Spanish mackerel in March (Fable et al. 1981, Goodwin and Finucane 1985).

The size of king mackerel caught off Panama City varies seasonally. Generally, mean lengths are greatest at the beginning of each fishing season, decline to a seasonal low in August, and then increase in September or October.

The billfish sport fishery began in the mid-1950's off the Panhandle. Sportboats originate primarily from Pensacola, Destin, and Panama City. In Destin, sailfish were caught as early as 1955, but the first white marlin was landed in 1959 and the first blue marlin in 1962 (Nakamura and Rivas 1974). An early history of the development of the billfish sport fishery in the Panhandle region is included in Siebenaler's (1965) work.

A major billfish area is located off Pensacola near the Desoto Canyon. Typically, white marlin are more abundant in July and sailfish are more abundant during the latter half of September, while blue marlin do not have an especially abundant period. Usually, the bluer the water, the greater the relative abundance of billfish. Off the Panhandle, blue marlin prefer mullet as bait, sailfish prefer bonito, and white marlin show no preference (Nakamura and Rivas 1974).

The habitat and dietary preferences of the major sport and commercial fishes are summarized below.

(1) King mackerel. The diet of king mackerel includes fish from 31 families (Saloman and Naughton 1983). Clupeidae are the dominant prey. Other families of importance include Carangidae, Sciaenidae, Engraulidae, Trichiuridae, Exocetidae, and Scombridae. The round scad, *Decapterus punctatus*, is the most important prey species in the diet of king mackerel caught in the Panhandle. Squid are the dominant invertebrate prey. King mackerel are primarily piscivorous, feeding heavily on schooling fishes. They are also opportunistic feeders, as evidenced by the nonschooling or nonaggregating species, such as synodontids and triglids, found during gut sampling. Since it usually bites or chops the prey in half, a whole fish is rarely found in a king mackerel stomach.

(2) Dolphin. Dolphin appear in Panhandle waters from April to December with May and August being the peak months. Their maximum lifespan is approximately 4 years. Dolphins tend to form close-knit schools. They are prey to a wide variety of ocean predators and are cannibalistic. When hooked, a dolphin rarely tries to escape by diving downward. Vertical distribution is generally limited from the surface to approximately 30 m.

(3) Brown shrimp. Brown shrimp are reported to spawn primarily in open gulf waters deeper than 18 m and possibly up to 140 m. The spawning season extends from September to May. Two reproductive peaks may occur in nearshore Panhandle marine waters: September–November and April–May. Fishing begins in May, peaks in June and July during their seaward migration, and continues through November in offshore waters.

All feeding stages are omnivorous. Larvae feed in the water column on both phytoplankton and zooplankton. Postlarvae live and feed in the estuaries. Shrimp larger than 65 mm that live in deep water are more predaceous than small individuals, with occasional detritus and algae being ingested. Prey items include polychaetes, amphipods, nematodes, and ostracods. The shrimp itself is prey to a host of fish species, many of which are commercially important.

d. Species of special concern. Five species of marine turtles (Table 45) and three species of whales—finback whale (*Balaenoptera physalus*), sperm whale (*Physeter catodon*), and humpback whale (*Megaptera novaeangliae*)—that occasionally occur in Panhandle waters are threatened or endangered.

e. Natural impacts. Some phytoplankton species can cause large fish kills and are toxic to shellfish. These species cause what are termed red tides because of the discoloration of the waters. Marine coastal red tides in the Panhandle are primarily associated with population blooms of the dinoflagellate *Ptychodiscus brevis* (formerly *Gymnodinium breve*) or *Gonyaulax monilata*. Usually concentrated within 48 km of the coastline, these species produce a neurotoxin that, in sufficient concentration, is capable of paralyzing and killing a number of fish species. The effects on larval invertebrates is not well known. Most major red tides last 2–4 months. In addition to having an effect on nearshore fisheries, red tides can also affect tourism along a coast because of the odor of decaying fish.

f. Human Impacts. Oil drilling activities (i.e., boat traffic, mud cuttings, spills, etc.) can have a variety of effects on water column species. Many larger pelagic species such as fish can avoid oil spills, but small planktonic species are vulnerable to direct effects.

Offshore oil spills pose a potential impact for sea turtles, especially juvenile turtles. Floating oil could increase the mortality rate of turtles directly by contacting the turtles when they surface to breathe and indirectly by affecting food sources.

Dolphins have been observed swimming and feeding in oil slicks and oil apparently does not adhere to their smooth skin (Geraci and St. Aubin 1982). It appears unlikely that dolphins inhale oil into their blowholes while breathing. Some hydrocarbon-contaminated food or water could be ingested; however, the effects of hydrocarbon ingestion by marine mammals is unknown.

7.3.4 Artificial Reefs

a. Introduction. Artificial reefs are objects of human or natural composition that are placed on selected sites in the aquatic environment to attract and stimulate the growth of larger fish and invertebrate populations. The primary purpose is the promotion of sport (and in some cases commercial) fishing by attracting food and game fish to a location easily accessible to fishermen and sport divers (i.e., spear fishermen). Artificial reefs benefit anglers and the economy of the nearby shore community, in the latter case by attracting out-of-city fishermen into the community.

The purpose of the artificial reef is to duplicate conditions of naturally occurring reefs or hard bottom areas. Numbers of fish species and abundances on an artificial reef can mimic those on a natural reef within 8 months of placement (Stone et al. 1979). In addition, they can effectively improve an already existing rough-bottom habitat and provide a functional management tool for reef fish resources. They also are potential nursery grounds for various species because they provide shelter from predators.

The reef provides the inhabitants with a refuge from predation and, in some instances, strong currents. In addition, the fouling organisms that encrust the reef become food items for small foraging fish that, in turn, attract larger predatory fish. If large enough, artificial reefs may increase the primary productivity of an area by creating an upwelling effect that causes nutrient-rich bottom water to mix with upper water layers.

Artificial reefs may be of two types: high profile or low profile. High-profile reefs are usually the most productive because they attract bottom species such as grouper, sea bass, and snapper and also pelagic forms such as Spanish mackerel, cobia, and amberjack. The high profile reefs, however, require greater depths to prevent them from becoming navigation hazards. Low-profile reefs are more useful in shallower inshore areas and are effective in attracting demersal fish.

Florida has initiated more reef construction than all the other Southeastern States combined (Seaman 1982). The Panhandle region is one of the primary artificial reef areas in the State (Seaman and Aska 1985). Artificial reef construction in the area reflects a number of influences: (1) the vast amount of coastline, (2) an increase in population growth along the coast, (3) a leisure-oriented population along the coast with a number of party and charter boats (Table 46), motor-powered boats, and marinas and boatyards. Besides the large number of verified artificial reefs in the Panhandle, there are a number of unauthorized "private" reefs in use.

The artificial-reef program in Florida is administered by the Florida Department of Natural Resources, Division of Marine Resources (Section 370.013 of the Florida Statutes). Panama City has an artificial-reef program directed by the Panama City Marine Institute that began in July 1978.

Establishment of the first documented artificial reef in Florida was in the Panhandle region off Pensacola in 1920 (Seaman and Aska 1985). During the next 50 years there was only sporadic construction. However, in the early 1970's activity greatly accelerated.

Artificial reefs are constructed from very diverse materials. Nearly all Panhandle reefs are comprised of ships (e.g., barges), automobiles, tires, or concrete rubble. Most reefs can be classified on the basis of a single predominant material. In some cases, it is difficult to assign a reef to one category on the basis of composition because some established reefs are being expanded with new and different materials. There is a trend toward longer-lasting, denser materials such as tires and automobiles as well as toward improved methods of placement.

b. Distribution. There are at least 61 verified reefs within the Panhandle region (Kunneke and Palik 1984, Seaman and Aska 1985)(Figure 91). The average distance offshore is approximately 12 km. Average depth is approximately 20 m.

Panhandle artificial reefs have been placed principally in oceanic locations with a few exceptions, such as one in Choctawhatchee Bay near Fort Walton Beach. Depth and distance from shore is variable. Because the Continental Shelf is relatively shallow at great distances from shore, it is not unusual that a reef be placed 24–32 km offshore to approach a 10–20 m depth.

Like planned artificial reefs, shipwrecks attract fish by providing structure on an otherwise flat sea floor. The National Ocean Survey maintains updated information on all known shipwrecks in U.S. coastal waters. Table 47 gives a list of major shipwreck sites in the Panhandle region.

c. Associated fauna. Fish are the most intensively studied group associated with Panhandle artificial reefs (Table 48). Other groups such as the encrusting and free-living invertebrate communities (e.g., sponges, gorgonians, and bryozoans) are not well documented.

Fish communities on artificial reefs are very diverse. Sanders (1983) reported 72 species associated with eight artificial reef sites off Panama City. The fish community can be divided into three classes (Chandler 1983): resident species, semi-resident species, and transient species. Resident species generally make up the largest of the three groups and are dependent upon the reef for food and shelter. The semi-resident group includes fish that are not dependent upon reefs for food and shelter and do not maintain permanent residency on the reef. This group is typically represented by schooling pelagic species (e.g., jacks) or suprabenthic species (e.g., vermilion snapper *Rhomboplites aurorubens*). Semiresident fish generally do not use the reef for protective cover but as a visual reference point or food source. Transient species form a catchall category that includes species found infrequently on the reef and whose dependence on the reef is unknown.

The complexity of a reef surface is an important factor for determining the abundance and diversity of the resident fish community. Chandler (1983) concluded from two artificial reefs (barges) off Panama City that the more complex structure had a larger and more diverse fish assemblage. The primary factors appeared to be the greater availability of space and food resources (i.e., epifaunal invertebrates and biofouling communities) on the more complex structure. Contributing to increased abundance and diversity is the vertical relief of an artificial reef. Greater vertical relief offers additional space, and also represents a stronger visual marker or cue for nonresident or transient species.

Water temperature appears to be the single most important factor that controls species composition in Panhandle artificial reef fish communities (Sanders 1983). Increasing temperatures in the spring and summer usually mark the appearance of typically tropical species such as the white grunt *Haemulon aurolineatum*, cocoa damselfish *Pomacentrus variablis*, and painted wrasse *Halichoeres caudalis*.

Chandler (1983) reported that seasonal changes in the structure of resident fish communities in Panhandle artificial reefs were affected primarily by recruitment of new members during the summer and by higher predation and mortality rates in the winter.

County	#	Year Built	Latitude	Longitude	Depth (ft)
Wakulla	1	1964	30°00'00"	84°09'15"	20
	2	1964	29°55'42"	8413'06"	21–30
	3	1964	3000'06"	8417'06"	15
Franklin	4	–	2924'54"	8421'54"	–
	5	1981	2930'48"	8422'06"	60
	6	1981	2932'12"	8437'06"	70
	7	1982	2931'05"	8439'25"	70
	8	1979	2917'55"	8436'48"	105
	9	1980	2917'06"	8436'48"	105
	10	1973	2924'24"	8451'48"	85
	11	–	2931'12"	8507'36"	45
Gulf	1	1964	29°50'24"	85°29'18"	40
	2	1971	29°53'15"	85°32'00"	44–70
Bay	3	1979	29°54'06"	85°31'55"	54
	4	1979	29°58'07"	85°48'49"	100
	5	1974	29°59'03"	85°42'20"	74
	6	1979	30°02'23"	85°43'18"	71
	7	1978	30°02'49"	86°05'32"	105
	8	1978	30°04'16"	85°48'53"	77
	9	1978	30°05'01"	85°44'02"	65
	10	1980	30°07'05"	85°49'29"	75
	11	1979	30°09'32"	85°53'33"	72

County	#	Year Built	Latitude	Longitude	Depth (ft)
Walton	12	1972	30°24'38"	86°08'48"	9
	13	1972	30°25'56"	86°14'18"	13
	14	1972	30°27'58"	86°14'34"	13
	15	1972	30°24'36"	86°17'35"	7
Okaloosa	16	-	30°09'08"	86°19'07"	102
	17	1977	30°22'00"	86°25'00"	43–71
	18	1976	30°21'00"	86°29'05"	85
	19	1977	30°21'04"	86°29'06"	85
	20	-	29°55'01"	86°34'09"	-
	21	1976	30°22'03"	86°35'04"	65
	22	1977	30°21'04"	86°35'07"	68
	23	1977	30°18'09"	86°36'02"	85
	24	1979	30°09'04"	86°43'06"	118
Santa Rosa	25	1980	30°12'46"	86°48'20"	70–80
Escambia	26	1982	30°00'00"	87°04'00"	175
	27	1978	30°17'02"	87°07'06"	85
	28	1973	30°18'08"	87°07'30"	60
	29	1976	30°16'03"	87°09'07"	67
	30	-	30°19'56"	87°13'12"	20
	31	1974	30°17'25"	87°13'13"	45
	32	1920	30°17'42"	87°18'42"	exposed
	33	-	30°16'54"	87°25'36"	20

Figure 91. Artificial reef locations in Panhandle waters (after Aska and Pybas 1983).

Table 47. Shipwrecks in Florida Panhandle waters (Beccasio et al. 1982).

Ship name	Latitude	Longitude	Depth (ft)
Unknown	30° 15' 00"	87° 34' 00"	-
Unknown	30° 14' 45"	87° 33' 00"	-
Eastern Light	30° 18' 54"	87° 19' 30"	-
Anna Pepina	30° 19' 06"	87° 18'48"	-
Bride of Lorne	30° 17' 30"	87° 18' 42"	-
Unknown	30° 25' 30"	86° 19' 20"	7
Unknown	30° 13' 45"	85° 49' 40"	27
Unknown	30° 17' 35"	85° 51' 20"	55
Unknown	30° 09' 30"	85° 47' 50"	49
Unknown	30° 05' 25"	85° 46' 00"	62
Unknown	30° 06' 30"	85° 41' 00"	24
Unknown	30° 03' 00"	85° 37' 30"	25
Vamar	29° 54' 00"	85° 27' 54"	-

Table 48. Some resident reef fish from eight artificial reefs off Panama City, Florida (Chandler 1983, Sanders 1983).

Common name	Scientific name	Common name	Scientific name
Bandtail puffer	*Sphoeroides spengleri*	Scrawled cowfish	*Lactophyrys quadricornis*
Black sea bass	*Centropristis striata*	Sheepshead	*Archosargus probatocephalus*
Blennies	Family Blenniidae	Spotfin butterfly-fish	*Chaetodon ocellatus*
Cocoa damselfish	*Pomacentrus variabilis*	Twospot cardinal-fish	*Apogon pseudomaculatus*
Gag	*Mycteroperca microlepis*	White grunt	*Haemulon plumieri*
Jackknife-fish	*Equetus lanceolatus*	Yellowtail reeffish	*Chromis enchrysurus*
Orange filefish	*Aluterus schoepfi*		
Reef butterflyfish	*Chaetodon sedentarius*		
Scamp	*Mycteroperca phenax*		

Semiresident species emigrate from a reef as water temperatures drop.

d. Trophic dynamics and interactions. Trophic dynamics on artificial reefs in the Panhandle are not well documented. Most likely they are not much different from those of natural tropical reefs. The biofouling or encrusting community probably represents an important food resource to many reef residents. In turn, top carnivores such as the barracuda (*Sphyraena barracuda*) and jacks feed on the smaller schooling species.

7.3.5 Subtidal Rocky Outcroppings/ Natural Reefs

a. Introduction. Subtidal rocky outcroppings are areas of hard, rugged bottom relief, usually comprised of limestone (Jordan 1952, Salsman and Ciesluk 1978). These areas have been called "live bottoms" by the State of Florida in its designation of regions that are sensitive to oil drilling activities. They are scattered throughout the area in depths of 18–70 m of water; some lie as close as 1.5 km from shore. Most of them protrude less than a meter above the surrounding sediment. Occasional small, isolated outcrops are also known nearshore in the St. George Sound area (e.g., Dog Island Reef).

This habitat represents a contrasting environment to an otherwise soft-sediment dominated system. The hard substrate offers an attachment surface for a variety of organisms such as sponges and algae.

b. Associated flora and fauna. Offshore rocky outcroppings are usually areas of fish concentrations (Saloman and Fable 1981, John E. Chance and Associates, Inc. 1984) (Figure 92). An area known as the Timberholes is an important recreational and commercial red snapper (*Lutjanus campechanus*) ground. Vermilion snapper, red grouper (*Epinephelus moria*), gag (*Mycteroperca microlepis*), and red porgy (*Pagrus sedecim*) are also taken. This ground is the inshore edge of Desoto Canyon, a submarine canyon in open gulf waters. Desoto Canyon is one of the major billfish sportfishing areas in the eastern Gulf of Mexico. Some of the major species caught include blue marlin, white marlin, and sailfish. A diverse sponge fauna is usually present (Little 1958). Red algae are usually attached to the hard substrate. Common species include *Euchema acanthocladum*, *Botryicladia uvaria*, and *Callithamnion byssoides*.

The relief is sometimes augmented by recent coral growth. Coral growth has been reported on a rocky outcrop 3 to 12 km offshore between Panama City and the Choctawhatchee Bay entrance. Nonhermatypic corals such as *Madracis asperula*, *Cladocora* sp., and *Paracyathus* sp. are common. Red algae are usually attached to the hard substrate. Nonhermatypic corals such as *Madracis asperula*, *Cladocora* sp., and *Paracyathus* sp. are common.

7.3.6 Subtidal Soft Bottoms

a. Introduction. As with the estuarine system, the marine soft bottom habitat constitutes the largest environment (on an area basis) within its system. There have been numerous surveys of the fauna in this habitat (e.g., Salsman and Tolbert 1965 and Loftin and Touvila 1981), but very little experimental work because of access problems. Most samples are taken from ships with remote devices such as box cores, dredges, trawls, and epibenthic sleds. As a result, most reports are descriptive and little is known about the mechanisms and interactions that are important in any given location.

The habitat ranges from the mean low water mark offshore and includes practically all the area offshore except rocky outcroppings. However, for this report, only the region to the Continental Shelf break is covered, with the inshore areas stressed.

b. Physical description. The nearshore zone is comprised of fine quartz sand (0.1–0.2 mm median diameter) that extends out across the shallow barrier bar and to a depth of 15 to 18 m, where the fine sediment becomes interspersed with a coarser brown sand containing shell fragments (Salsman and Ciesluk 1978). The coarser sediment has a median diameter of 0.3 to 0.5 mm. Wave-produced sand ripples with heights up to 2.5 cm and wavelengths of 7.5 to 12.5 cm are present much of the time in the shallow areas directly off the beaches (Salsman and Tolbert 1961). Sand dollars are capable of flattening these ripples less than 24 hours after their formation (Salsman and Tolbert 1965). Large storm waves can produce ripples in the coarser sand found in deeper waters. Sand ripples with heights up to 15 cm and wavelengths of 1 to 1.2 m that persist for up to 2 months may be produced (Salsman and Ciesluk 1978).

c. Fauna present. A number of investigations have reported species collected from offshore soft sediments (e.g., Salsman and Tolbert 1965, Saloman 1976, Saloman 1979, Loftin and Touvila 1981, Saloman 1981, Uebelacker and Johnson 1984). As in the estuarine system, the marine soft-bottom organisms can be classified into a variety of functional groups based upon life-position, motility, and feeding mode. These classifications often make data easier to interpret when taxonomic problems or other constraints arise.

The offshore Panhandle marine meiofauna are not well documented. However, there is probably some overlap between the nearshore marine assemblages and estuarine ones. The meiofauna, especially the polychaetes, have been examined (Uebelacker and Johnson 1984). Common species are given in Table 49 along with other common organisms.

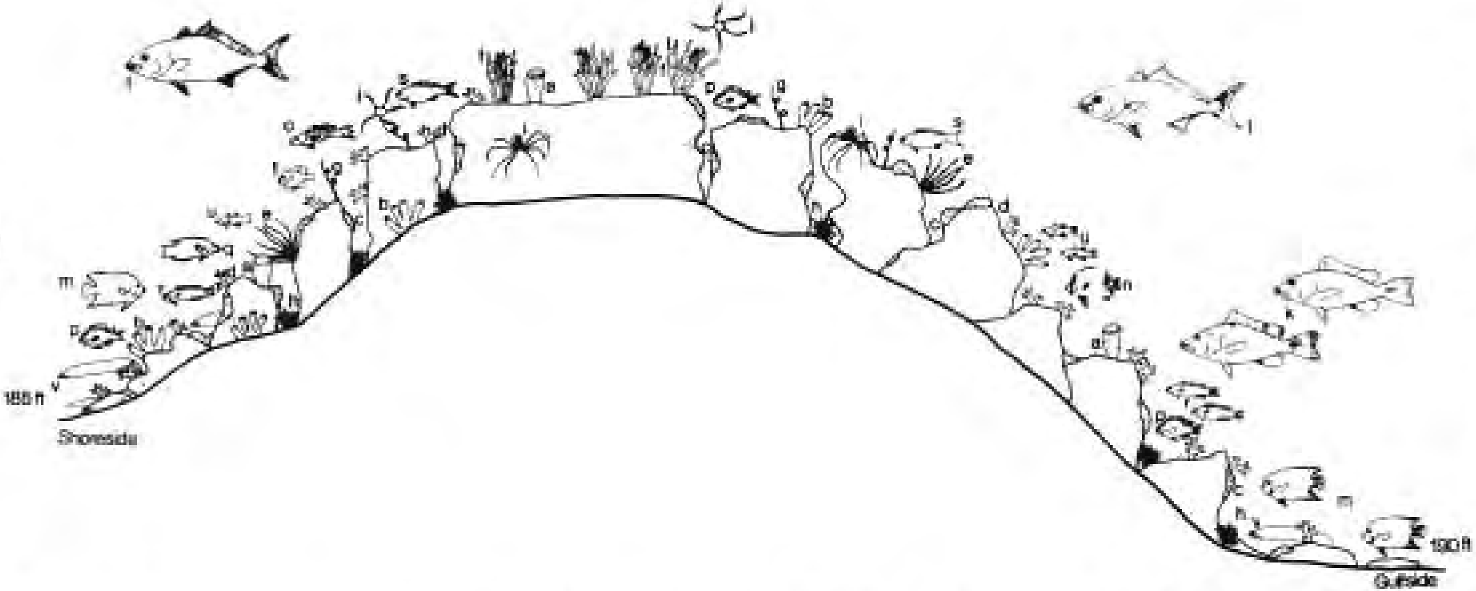

Figure 92. Cross-sectional view through a typical rocky outcropping off the Panhandle coast (John E. Chance and Associates, Inc. 1984).

Table 49. Common invertebrates present in nearshore soft-bottom habitats in the Panhandle (Saloman 1976, Saloman 1979, Loftin and Touvila 1981, Uebelacker and Johnson 1984).

Group	Species name	Group	Species name
Polychaetes	*Aricidea* spp.	Amphipods	
	Armandia agilis		
	Dispio unicinata	Cumaceans	*Spilocuma salomani*
	Microphthalmus spp.	Decapods	
	Nephtys bocera	(caridean shrimp)	*Ambidexter symmetricus*
	Nephtys picta		*Ogyrides alphaerostris*
	Onuphis eremita		*Processa hemphilli*
	Paraonis fulgens		*Processa vicina*
	Prionospio spp.		*Tozeuma cornutum*
	Scolelepsis squamata		
	Spiophanes bombyx	Echinoids	*Encope mitchelli*
	Syllidae		

d. Trophic dynamics and interactions. The trophic dynamics of marine soft-bottom communities in the Panhandle are not well studied, primarily for logistic reasons. The general patterns are probably similar to those of estuarine soft bottoms.

e. Natural impacts. The deeper offshore soft-bottom habitat is relatively free from natural impacts. Only the shallower nearshore areas are subject to occasional storm disruptions. Panhandle-specific research in this area is nonexistent.

f. Human impacts. Localized impacts can occur from oil-drilling rigs placed on the bottom and from dredging, especially dredging for sand for beach renourishment projects (Saloman and Naughton 1984).

Chapter 8. SUMMARY

8.1 The Panhandle In Review

The Florida Panhandle has a varied subtropical climate with hot, humid summers and brief periods of below freezing temperatures in winter. Rainfall is abundant, averaging approximately 152 cm per year. This rain falls primarily during two rainy seasons, late winter and early spring (February through April) and summer (mid-June through mid-September). Winter rains are primarily a product of passing cold fronts; summer rains are primarily in the form of convective thunderstorms. Winds are normally out of the south to southeast during the summer and constantly change in the winter, being most commonly out of the north to northwest or the south to southeast. Tropical storms and hurricanes occasionally cause substantial damage from high winds and storm surge.

Seven major rivers, the Ochlockonee, Apalachicola, Chipola, Choctawhatchee, Yellow, Blackwater, and Escambia, traverse the Panhandle on their way to the coast. The rivers of the western Panhandle tend to be highly colored, of low turbidity, and nutrient poor. Those of the eastern Panhandle are generally alluvial (sediment carrying) and nutrient rich. All originate out-of-State in either Georgia or Alabama. Changing land use and effluent discharges in these states, which practice less stringent water-quality regulation than does Florida, are hindering Florida's attempts to maintain or improve the quality of water in Panhandle rivers. In particular, out-of-State pollutants are affecting the Ochlockonee, Apalachicola, and Escambia Rivers.

The flood plains of Panhandle rivers are largely undeveloped at this time. Periodic flooding has been shown to be an important step in recycling nutrients in riverine ecosystems and to be responsible for much of the productivity of coastal estuaries. Damming rivers for flood control or other purposes prevents the transport of much of these nutrients to the estuaries, the nutrients are trapped in lakes behind the dams where they speed up the eutrophication of the lakes. Experience in other parts of Florida and elsewhere in the United States shows that restricting development in flood plains is the best and most cost effective means of flood prevention. This prevents not only flooding of the developments in the flood plain, but also flooding in areas outside the flood plain which become more flood prone as a result of the altered hydrology associated with development.

Most of the ground water used in the Panhandle is contained within two aquifers: the Floridan Aquifer east of Okaloosa County and the Sand and Gravel Aquifer from Okaloosa County west. The Floridan Aquifer is contained in a porous limestone matrix and is characterized by alkaline water with a moderately high level of dissolved solids. Beginning near Okaloosa County the Floridan Aquifer is increasingly deeper as one proceeds west and it becomes increasingly mineralized. The Sand and Gravel Aquifer is found above the Floridan in this western region and is more commonly used because of its better water quality.

The terrestrial vegetation of the Panhandle was mostly open pine woods on rolling hills and flat lands before human alterations began. In the valley bottoms of the hill lands and along creeks in flatwoods a series of hardwood forest types were found. Regularly occurring natural fires that burned through the pinelands were extinguished downslope where soil moisture increased, keeping the fire-tender hardwood species from seeding under the pines and taking over the uplands. Today, most of the dry land and even all the wetlands have been logged, often more than once. The natural fire cycles have been stopped or severely altered, and the woodlands of

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Seven major rivers, the Ochlockonee, Apalachicola, Chipola, Choctawhatchee, Yellow, Blackwater, and Escambia, traverse the Panhandle on their way to the coast. The rivers of the western Panhandle tend to be highly colored, of low turbidity, and nutrient poor. Those of the eastern Panhandle are generally alluvial (sediment carrying) and nutrient rich. All originate out-of-State in either Georgia or Alabama. Changing land use and effluent discharges in these states, which practice less stringent water-quality regulation than does Florida, are hindering Florida's attempts to maintain or improve the quality of water in Panhandle rivers. In particular, out-of-State pollutants are affecting the Ochlockonee, Apalachicola, and Escambia Rivers.

The flood plains of Panhandle rivers are largely undeveloped at this time. Periodic flooding has been shown to be an important step in recycling nutrients in riverine ecosystems and to be responsible for much of the productivity of coastal estuaries. Damming rivers for flood control or other purposes prevents the transport of much of these nutrients to the estuaries, the nutrients are trapped in lakes behind the dams where they speed up the eutrophication of the lakes. Experience in other parts of Florida and elsewhere in the United States shows that restricting development in flood plains is the best and most cost effective means of flood prevention. This prevents not only flooding of the developments in the flood plain, but also flooding in areas outside the flood plain which become more flood prone as a result of the altered hydrology associated with development.

Most of the ground water used in the Panhandle is contained within two aquifers: the Floridan Aquifer east of Okaloosa County and the Sand and Gravel Aquifer from Okaloosa County west. The Floridan Aquifer is contained in a porous limestone matrix and is characterized by alkaline water with a moderately high level of dissolved solids. Beginning near Okaloosa County the Floridan Aquifer is increasingly deeper as one proceeds west and it becomes increasingly mineralized. The Sand and Gravel Aquifer is found above the Floridan in this western region and is more commonly used because of its better water quality.

The terrestrial vegetation of the Panhandle was mostly open pine woods on rolling hills and flat lands before human alterations began. In the valley bottoms of the hill lands and along creeks in flatwoods a series of hardwood forest types were found. Regularly occurring natural fires that burned through the pinelands were extinguished downslope where soil moisture increased, keeping the fire-tender hardwood species from seeding under the pines and taking over the uplands. Today, most of the dry land and even all the wetlands have been logged, often more than once. The natural fire cycles have been stopped or severely altered, and the woodlands of most of the Panhandle are second-growth mixtures of pines and encroaching hardwoods, where timber has been cut and allowed to regenerate naturally, or has been converted to pine monoculture, agriculture, and urban and suburban development.

The Florida Panhandle is a crossroads where animals and plants from the Gulf Coastal Plain reach their eastward distributional limits, where others from the Atlantic Coastal Plain reach their southwestern limits, and where northern species, including many Appalachian forms, reach their southern limits. There is also a contribution of species from peninsular Florida. So many species of plants and animals flourish in the wet, temperate climate of the Panhandle that the region may support the highest species diversity of any similar-size area in the U.S. and Canada.

Because the Panhandle has high annual rainfall and low, gently sloping terrain, wetlands abound. The bogs, marshes, swamps, wet prairies, and wet flatwoods provide a diversity of wetland types that support numerous species of animals and plants, including many endemic species and races. Wetlands seem to vary considerably depending upon slope, soil type, water chemistry, and fire cycle and there is a need for a more thorough investigation and classification to understand the significance of the differences.

The seven Panhandle estuaries are, with the exception of Ochlockonee Bay, bar built (i.e., separated from the Gulf of Mexico by a sand bar or barrier island). They are nearly evenly distributed along the coast and are formed at the mouths of rivers, except for the two lagoonal estuaries, St. Joseph Bay and Alligator Harbor. The western Panhandle has a higher energy regime along its coast than the eastern portion as is evidenced by the associated sandy beaches. This situation arises because of the closer proximity of the edge of the Continental Shelf and the longer fetch, allowing the prevailing winds to generate greater wave energy.

Seagrass beds cover a greater area in the eastern Panhandle than in the western. This results from the more suitable conditions for seagrass promulgation provided by the lower energy conditions along the coast in the east. Within the estuaries, this difference is correlated with the greater industrial development in the western Panhandle. Extensive losses in seagrass habitats in the western Panhandle estuaries have been documented and tied to human development (i.e., industrial discharges and dredging). Panhandle salt marshes are prevalent and more evenly distributed than the seagrasses, though they are not nearly as extensive as those formed in the lower energy conditions along the adjacent Florida Big Bend coast.

Oyster reefs are found in all the Panhandle estuaries, but those in the western estuaries tend to be unusable by humans because oysters concentrate the contaminants introduced to the waters by surrounding development. Apalachicola Bay contains the largest concentration of commercially important oyster reefs. These relatively unaffected (by pollution) beds are presently experiencing potential contamination from septic tanks on nearby St. George Island. Oyster reefs in the Choctawhatchee and Pensacola Bay systems have experienced the most impact from industrial development in the nearby coastal regions and the majority of reefs are not harvestable.

The Florida Panhandle is lightly populated except for an intensively developed and increasingly industrialized region along the coast from Pensacola eastward to Panama City. This area has continued to develop rapidly from the densities indicated by the 1980 census (Figure 93). The only other population pressure in the area is from the State Capitol, Tallahassee, alongside the Panhandle's eastern border. The primary land use outside these two areas is forestry and farming. The Apalachicola National Forest, Blackwater River State Forest, Apalachicola Estuarine Sanctuary, St. Vincent Island and St. Marks National Wildlife Refuges, Gulf Islands National Seashore, and the St. Joseph Peninsula (T.H. Stone Memorial) and St. George Island State Parks as well as numerous smaller State forests and parks are located within the Panhandle.

8.2 Panhandle Findings

The estuaries and nearshore marine habitats of the Florida Panhandle are some of the greatest natural and economic assets of the region. There is

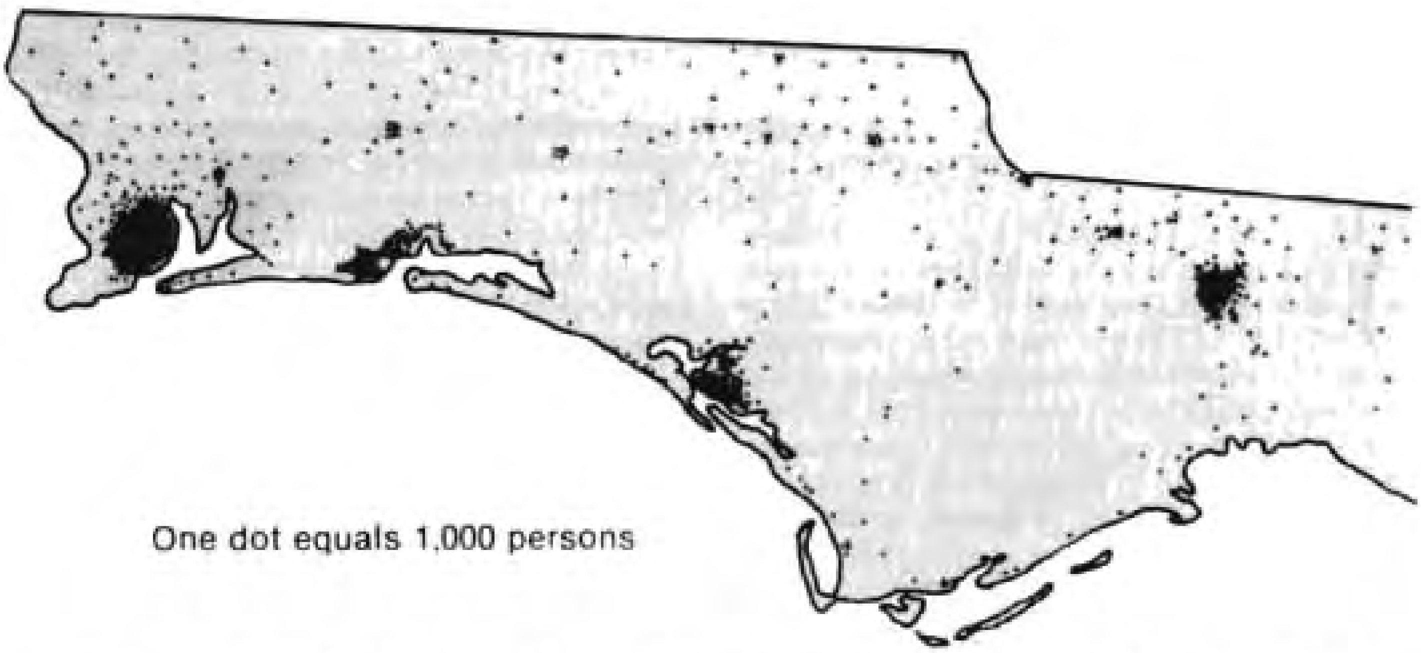


Figure 93. 1980 Florida Panhandle population distribution (Winsberg and Primelles 1981).

little dispute that the majority of the present population growth experienced within the region is concentrated along the coastal zone. People are especially attracted to the clear, blue gulf waters and the white, sandy beaches of the western Panhandle. In addition, many of the estuaries harbor important commercial organisms, such as oysters, fish, and shrimp, that provide a livelihood to Panhandle residents.

Only recently has the importance of viewing a region as a complete entity been realized. It is critical to understand that a far-reaching domino effect exists in the area environment. Terrestrial alterations affect terrestrial habitats and the quality of the surface water and ground water. These changes affect the freshwater and troglobitic (cave) habitats and, in turn, the estuarine and marine water quality and habitats are affected. Because of this chain of interactions, an estuary tends to be the repository for all pollution that occurs in its drainage basin. Estuaries have remarkable assimilative and recuperative abilities. However, their capacity to absorb human perturbation may be approaching a threshold.

There is good evidence that Panhandle Florida may well have more species of animals and plants than any equivalent area of temperate North America. Unfortunately, the region has been poorly studied. New species of plants, invertebrates, and even vertebrates have been described in the past 5 years, and more are known and under investigation. The Florida Panhandle is so biologically diverse that there are at least 4 major centers of endemism containing both relict and indigenous species.

Results of several noncoordinated studies in the western Panhandle have recently revealed that a center of endemism exists in southern Okaloosa and Santa Rosa counties. This region should be explored and inventoried biologically to more fully appreciate its natural resources. A plan should then be developed to insure protection of the endemics through some sort of specific action. The same purposeful effort should be directed to the Apalachicola Lowlands center of endemicity. The Apalachicola Lowlands appear to have more indigenous races, species, and genera than any other area of the State, and possibly more than the entire coastal plain.

The most famous of the Panhandle centers of endemicity is the Apalachicola Bluffs and Ravines area. These have been the focus of conservation activity in the past 5 years and most of the important habitats of this area have been purchased by the State or by nonprofit conservation organizations. One significant area remains, however, that ought to be purchased: the limestone bluffs and ravines in the vicinity of Aspalaga Landing.

The Panhandle has high species richness in acid bog plants; possibly more carnivorous plant species occur in the Panhandle than in any similar size area in the world. These unique wetlands should be specifically inventoried for their biological composition; bogs are so variable that there may be several distinct types of bogs, each of which may need to be brought into the statewide inventory of publicly owned lands.

Lacustrine environments of the Panhandle are diverse and mostly unstudied. They range from temporary ponds in low places and sinkhole depressions to large, permanent lakes with relatively deep water. An inventory, including a census of the animal and plant components, is urgently needed and a categorization based on hydrology, water chemistry, and biota is long overdue.

The Panhandle possesses unique stream valley types called steepheads; these should be recognized for their uniqueness and inventoried for their biological components. It is likely that some, at least, may contain endemic forms of life.

The lands under the influence of the navigable freshwater bodies of the Panhandle are sovereign, belonging to the State, but for almost no navigable river or lake has the boundary between State owned lands and the upland riparian ownership been determined by survey. This causes acute environmental problems. Most of the floodplains of the Panhandle have been logged by the adjacent landowners and continue to be affected. These publicly owned lands should be recognized as such and managed to preserve the riverine ecosystems in their natural state. The detritus that originates in the floodplain forests is one of the main forcing functions of the estuarine productivity that is so important to the Florida Panhandle's seafood industry.

Native upland ecosystems are the most altered ones in the Panhandle because these are the sites on which people live. There is not a good representation of the upland habitat types in public ownership, partly because there are few patches left that are undisturbed, and partly because these sites are targeted for development. We call for a review of the acreage of the important terrestrial communities remaining, and for an effort to set aside a representative selection to maintain species diversity and for posterity to enjoy.

Two habitats of great importance in the Panhandle coastal region are salt marshes and seagrass beds. Salt marshes are critical nursery, feeding, and refuge areas for many commercially important estuarine organisms such as fish and crabs. The economic value of an acre of marsh has been estimated at 4 to 5 times that of the most productive farmland. The balance between a rising sea level and the sediment supply is being upset by human encroachment in nearby upland habitats, thereby directly and indirectly affecting the marshes. This habitat is one that requires very stringent monitoring for future protection.

Seagrasses are vital to the coastal ecosystem because they form the basis of a structurally complex, three-dimensional habitat. Few other systems are so dominated and controlled by a single species as is the climax *Thalassia* meadow. If seagrasses are destroyed, more erosion occurs and the associated flora and fauna disappear, including commercially important species (e.g., fish, crabs, and scallops). Primary productivity and detrital production decrease dramatically, and this affects other habitat systems, such as unvegetated bottoms, that rely on organic import for the basis of their food chain.

Despite extensive studies on seagrass productivity and on temporal and spatial variability in the biological composition of seagrass communities, little is known of the general principles on which the ecosystem functions and of the factors controlling ecological success in the community. Therefore, subtle changes that may be caused by human activities generally pass unnoticed or are ascribed to natural variation. An example is changes in turbidity levels. Light levels are extremely important for the seagrasses and over time, if light is decreasing, grass beds will slowly die off. Only gross damages, such as the tearing up of beds by dredging, are described in the literature. However, it may be subtle changes in light levels that eventually take the largest toll on this habitat.

It became painfully obvious during the writing of this document that intensive studies have often been conducted at great expense, but the resulting recommendations have not been implemented into area management plans or reflected in local ordinances and policies where they would be effective. The regulatory mechanisms in place often are inadequate to protect environmental resources. Additionally, studies sometimes duplicate previous efforts. There should be a more concerted effort toward coordinating research efforts to get the most information for the dollar.

We further note the need to establish further standards for Outstanding Florida Waters (OFW's) and Aquatic Preserves as well as for their adjacent upland areas. Assigning one of these designations to an area without knowledge of its ecological state or the intent to gain this knowledge hinders enforcement of the regulations that are supposed to protect them. In some instances, the protective regulations and enforcement authority are not even in place, rendering the designation token at best.

Though it has been so often repeated that it is sometimes regarded as an excuse, the ability to formulate effective, balanced management plans for the Florida Panhandle is in many instances fatally hindered by the lack of information on which to base the necessary decisions. During our review of Panhandle ecological literature, we noted many areas which have not been investigated. Questions concerning some of these information gaps may safely be answered using studies performed on similar areas elsewhere. However, experience has shown that the operations of ecosystems are so poorly understood that, at present and in the foreseeable future, the ecology of local ecosystems must often be regarded as unique. Even systems that appear identical may have achieved the external similarity in response to the synergy of altogether different driving forces.

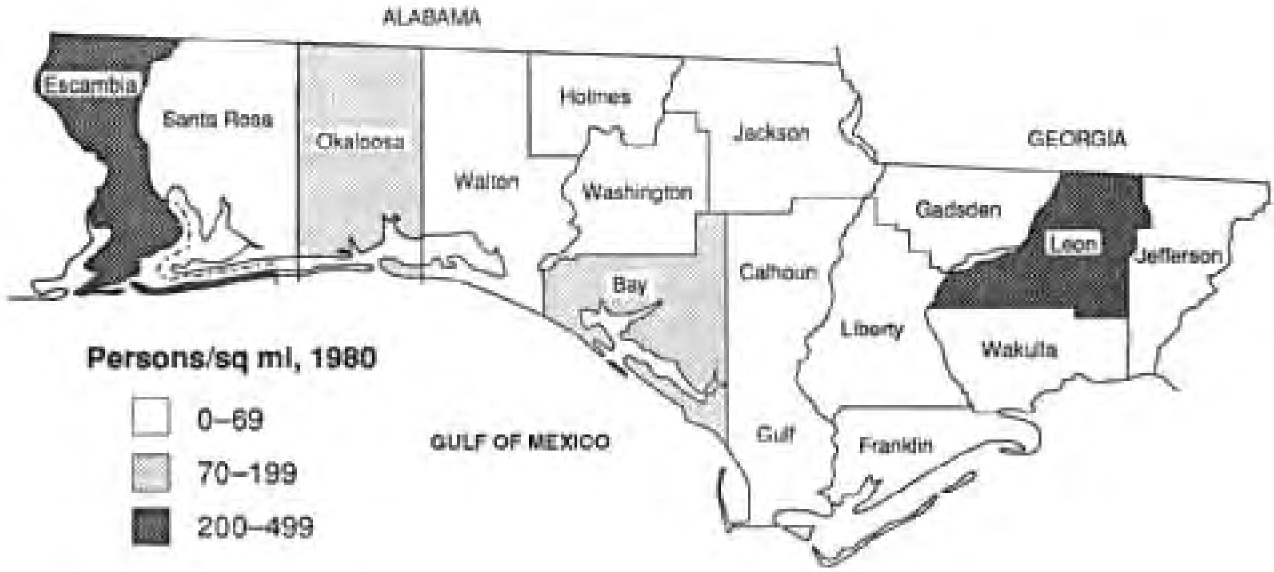
Data gaps that were identified include:

(1) biological baseline studies of estuaries (except Apalachicola Bay; a study is also underway of Choctawhatchee Bay), of rivers (one–year studies are underway for the Ochlockonee and Choctawhatchee Rivers), and lakes. These studies need to be several years in duration in order to provide a hint of the natural variability from annual climatic differences. Without these studies, documenting changes in the river habitats caused by pollutants is nearly impossible, a fact that has prevented effective enforcement of no–degradation policies in many instances. Physical baseline studies do not provide the data necessary to determine the effects of most pollutants on the most important aspect of the habitat—the biota;
(2) pollutant assimilative capacities of individual estuaries;
(3) fish stock assessments;
(4) fishery data in general, e.g., habitat and dietary preferences of major species;
(5) mapping of aquifers, transmissibility of confining layers, and movement of water within the aquifers;
(6) ground water pollution into estuaries;
(7) effects from acid rain;
(8) local impacts of rising sea level.

8.3 The Panhandle Tomorrow

Population growth and development and the environment should not be competing forces because they are different parts of one ecosystem. Florida Panhandle growth must be carefully integrated into the ecosystem or undesirable repercussions are certain to occur.

The Panhandle is coming under increasing growth pressures as the population influx to Florida continues and overcrowding in many south Florida areas decreases the desirability of living there (Figure 94). The justifiably famous white sand beaches of the western Panhandle have so far borne the brunt of the development. Belated local and State efforts to control and plan for this growth (e.g., the Resource Management Committees in the Choctawhatchee and Pensacola Bay Systems) are meeting with limited success, but many of the factors which make this region attractive have been severely damaged. Development of most of the barrier islands and beach areas is already far along. Regulation of



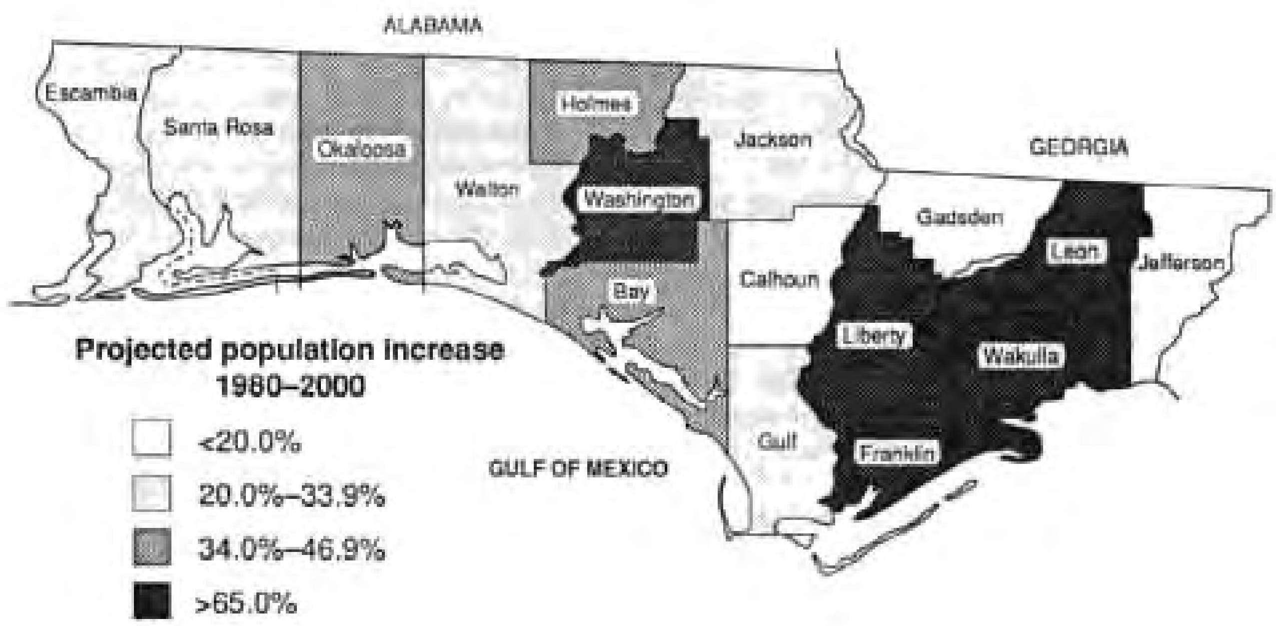


Figure 94. 1980 Florida Panhandle population density by county (after Winsberg and Primelles 1981) and projected population increase 1980–2000 (after Fernald et al. 1981).

growth has been hindered by local groups and governments who see the financial rewards of development as a quick solution to their economic wants or needs. Other parts of the Panhandle will be coming under increasing growth pressure. We hope that the growth management legislation recently adopted by the State Legislature and presently being fine tuned and put into action will work to direct growth in a manner minimizing Panhandle environmental damage.

Efforts should be made to protect the estuarine resources of the State as soon as possible. Approximately 90% of all fish species in Florida coastal waters spend at least a portion of their lives in estuaries. This use can be related directly to commercial and sport fishing dollars. Economic development can become economic loss because of decreased productivity. For example, filling in marshland for development is an economic asset for a few developers while the loss of nursery habitat and subsequent loss in fish production is an economic cost which the general public pays. Maintenance of the fishing sport and industry which attract many people to the coastal region requires that estuarine resources not be lost and that fisheries data (e.g., stock assessments, habitat preferences, etc.) on which to base management decisions be collected.

Areas within the Panhandle which are most sensitive to development and where it should be prevented or minimized include:
(1) river floodplains;
(2) coastal wetlands;
(3) barrier islands and nonwetland coastal areas where damage from the rising sea level and from storms is probable (i.e., most areas within a few hundred meters of the water);
(4) estuaries still in good condition (e.g., Apalachicola Bay, Choctawhatchee Bay, St. Joseph Bay). Subtidal seagrass beds within the various Panhandle estuaries, as well as along the coast, should be protected and preserved to the fullest extent possible.

Areas which can support development if care is used to address ecological "Achilles' heels" include:
(1) Major aquifer recharge areas (e.g., large parts of Jackson and Washington Counties);
(2) Areas where ground water is easily contaminated (studies are underway to help define these areas; they are likely to include much of the Panhandle).

Panhandle areas with unique properties that should be preserved for the future include:
(1) seagrass beds;
(2) salt marshes;
(3) old-growth forest types, including the longleaf pine forest on Eglin Air Force Base, the stunted cypress forest on clay soils in the western half of the Apalachicola National Forest, and floodplain hardwood forests;
(4) steephead areas along Econfina Creek and the Choctawhatchee River;
(5) caves in the Marianna Lowlands, particularly those providing access to ground water filled passages and the various aquatic cave species. Few of the caves within Marianna Caverns State Park provide this access.

In addition to these unique areas, we suggest that locations of the more important common habitat types be identified and that habitat preserves be set aside for each. There is a tendency to overlook the common while it is being developed, only to find later that what was once common can no longer be found, or is found with so many changes that it is functionally different.

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Appendix A
FEDERAL, STATE, AND LOCAL ENVIRONMENTAL CONTROL AGENCIES AND THEIR RESPONSIBILITIES

Federal Agencies

1. **Army Corps of Engineers**

   Concerned with all activities which affect or modify navigable waters of the United States. Primarily concerned with construction in navigable waters and with dredge and fill permits. They are also involved in permitting the placement of dredge and fill material into navigable waters and adjacent wetlands, and they provide some funding for aquatic plant control in navigable and public waters.

2. **Coast Guard**

   They have authority to respond in an emergency to hazardous waste releases and to force responsible parties to clean up.

3. **Department of Commerce—National Oceanic and Atmospheric Administration**

   The administrator of NOAA is currently directing a ten-year effort to develop and implement a program to deal with acid precipitation.

4. **Environmental Protection Agency**

   This is the main Federal agency responsible for "clean water." Areas covered by EPA include: hazardous waste cleanup, public drinking water systems, all point-source pollutant discharges into waters of the United States, and protection and restoration of the environment. EPA also reviews Corps of Engineers permit activities, and sets guidelines for State environmental programs.

5. **Department of Interior**

   Functions performed by this agency include reviewing proposed activities which impact threatened or endangered species, reviewing Corps of Engineers' permits for effect on fish and wildlife, and managing all Federal public lands. Under this department the U.S. Geological Survey conducts research on water resources and the U.S. Fish and Wildlife Service manages and restores sport fish and wildlife populations and conducts research on the effects of pollution on fishery and wildlife resources. The Mineral Managements Service is responsible for the regulation of oil and gas wells on the Outer Continental Shelf.

6. **Department of Agriculture**

   The Soil Conservation Service promotes the use of conservation practices to reduce soil losses, including techniques to reduce runoff and thus improve water quality in waterways. The U.S. Forest Service promotes watershed management, wildlife habitat management, and reforestation programs. The Agricultural Stabilization and Conservation Service, through many programs, helps protect wetlands and helps solve water, woodland, and pollution problems on farms and ranches.

Florida Agencies

1. **Department of Agriculture and Consumer Services**

   This department regulates the purchase and use of restricted pesticides and helps in soil and water conservation through activities of the Soil and Water Conservation Districts and the Division of Forestry.

2. **Department of Community Affairs**

   This department is responsible for reviewing local comprehensive plans and has jurisdiction over "Developments of Regional Impact" (DRI).

These concern developments which could have a substantial effect upon the health, safety, or welfare of citizens of more than one county.

3. **Department of Environmental Regulation**

   The DER is the lead agency involved in water quality, dredge and fill, pollution control, and resource recovery programs. The department sets water quality standards, pollution discharge loadings, and has permit jurisdiction over point- and nonpoint-source discharges, dredge and fill, drinking water systems, powerplant siting, and many construction activities in waters of the State. The department also interacts closely with other Federal and State agencies on water related matters.

4. **Florida Game and Fresh Water Fish Commission**

   The purpose of the Commission is to manage, protect, and conserve wild animal life and freshwater aquatic life. Its efforts include sport and commercial fishing, fishery and habitat management, lake drawdowns, and fish and wildlife stocking.

5. **Department of Health and Rehabilitative Services**

   HRS is responsible for septic tank system permitting through its county health departments, mosquito control coordination, and investigations into threats to the public health.

6. **Department of Natural Resources**

   The DNR is highly involved in water related problems. Besides administering all State lands, including parks and aquatic preserves, DNR serves as the enforcement agency for the Florida Endangered and Threatened Species Act and the Oil Spill Prevention and Pollution Control Act. DNR is also responsible for coordinating aquatic plant research and control in the State. DNR issues permits for transport of aquatic plants, herbicide spraying, and other plant control methods in aquatic environments. DNR also has lake management extension services.

Other Agencies

1. **Water Management Districts**

   The five multipurpose water management districts in the State are concerned with water use, lake levels, dredge and fill, water quality, and other water-related management programs. These districts can hold, control, and acquire land and water bodies which affect water storage.

2. **Regional Planning Councils**

   The 11 regional planning councils in the State act in an advisory capacity to local governments in matters concerning water resources, recreational areas, and Developments of Regional Impact.

3. **Soil and Water Conservation Districts**

   These districts are supervised to a limited degree by the Department of Agriculture and Consumer Services and carry out preventive measures for flood prevention and soil erosion.

4. **Miscellaneous**

   Many local counties and municipalities have environmental and planning agencies which can be involved in environmental management. Local governments can also pass pollution control laws, zoning and land use laws, and many other ordinances which can be effective in preventing environmental problems.

Many of these agencies perform functions which overlap on the State, Federal, and local level. There are also many Memoranda of Understanding between agencies which allow sharing of overlapping functions. Local, State, and Federal agencies interact extensively on programs because of mutual benefits and cost sharing agreements.

Appendix B
PANHANDLE REGULATORY AGENCY LOCATIONS AND ADDRESSES

Florida Department of Environmental Regulation:
Main Office
2600 Blair Stone Rd.
Tallahassee, FL 32399-2400
(904) 488-4805

Northwest District Office
160 Governmental Center
Pensacola, FL 32399-3000
(904) 436-8300

Florida Department of Natural Resources—Regional Biologists
Northwest Region
3900 Commonwealth Blvd., Rm. 304
Tallahassee, FL 32304
(904) 488-5631

Florida Game and Fresh Water Fish Commission
Main Office
620 S. Meridian St.
Tallahassee, FL 32399
(904) 488-1960

Northwest Regional Office
Rt. 4, Box 759
Panama City, FL 32405
(904) 265-3676

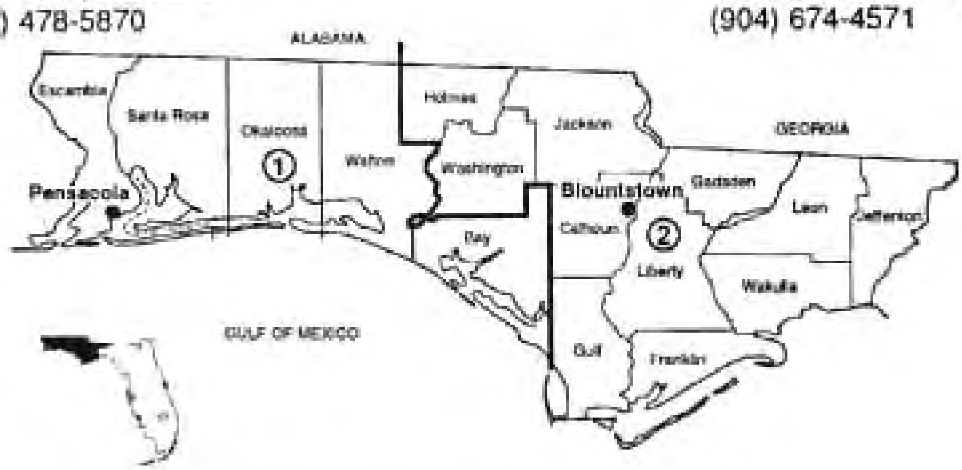
Northwest Florida Water Management District
Rt. 1, Box 3100
Havana, FL 32333
(904) 487-1770

U.S. Army Corps of Engineers
Panama City Field Office
P.O. Box 151
Panama City, FL 32401
(904) 785-9366

Regional Planning Councils

(1) West Florida RPC
P.O. Box 486
Pensacola, FL 32593
(904) 478-5870

(2) Apalachee RPC
P.O. Box 428
Blountstown, FL 32424
(904) 674-4571



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15. Supplementary Notes

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16. Abstract (Limit: 200 words)

The Florida Panhandle extends from the Ochlockonee River basin west to the Florida-Alabama border and north to the Georgia and Alabama borders; it contains some of the most rapidly developing regions in the entire State. Because of the damaging effects of development, some attention must be given to the region's estuaries, coast, wetlands, and to habitats of endemic species. Development has already damaged some of these areas as well as the seagrass beds and oyster reefs of the western panhandle area. Other potentially affected areas include native upland ecosystems, salt marshes, river floodplains, and steephead areas.

Research, growth management legislation, and consideration of the Florida Panhandle ecosystem as a whole are all necessary to ensure the futures of the different Florida Panhandle areas. No steps can be taken or decisions made for their longevity until certain data gaps are filled; the gaps range from biological baseline studies of estuaries to the local impacts of rising sea level.

17. Document Analysis a. Descriptors

b. Identifiers/Open-Ended Terms

estuaries	development	seagrass beds	habitats
floodplains	growth management legislation	salt marshes	endemic species
Florida Panhandle	ecosystem	bogs	

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As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interest of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. Administration.