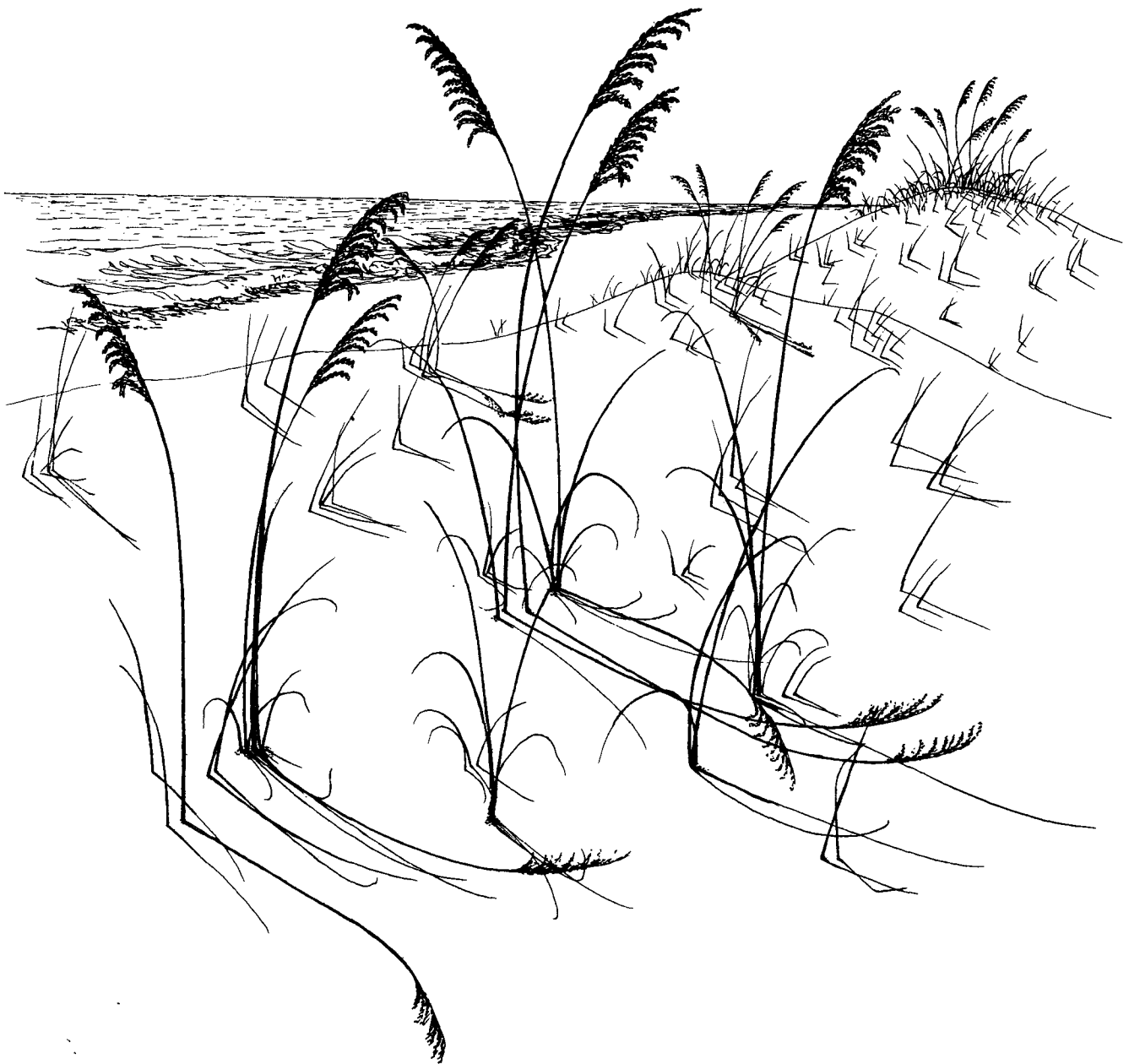


Santa Rosa

Island Beaches



TEACHERS' GUIDE

TO

GULF BEACH NATIONAL ENVIRONMENTAL STUDY AREA

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Environmental Studies Center
Gulf Islands National Seashore

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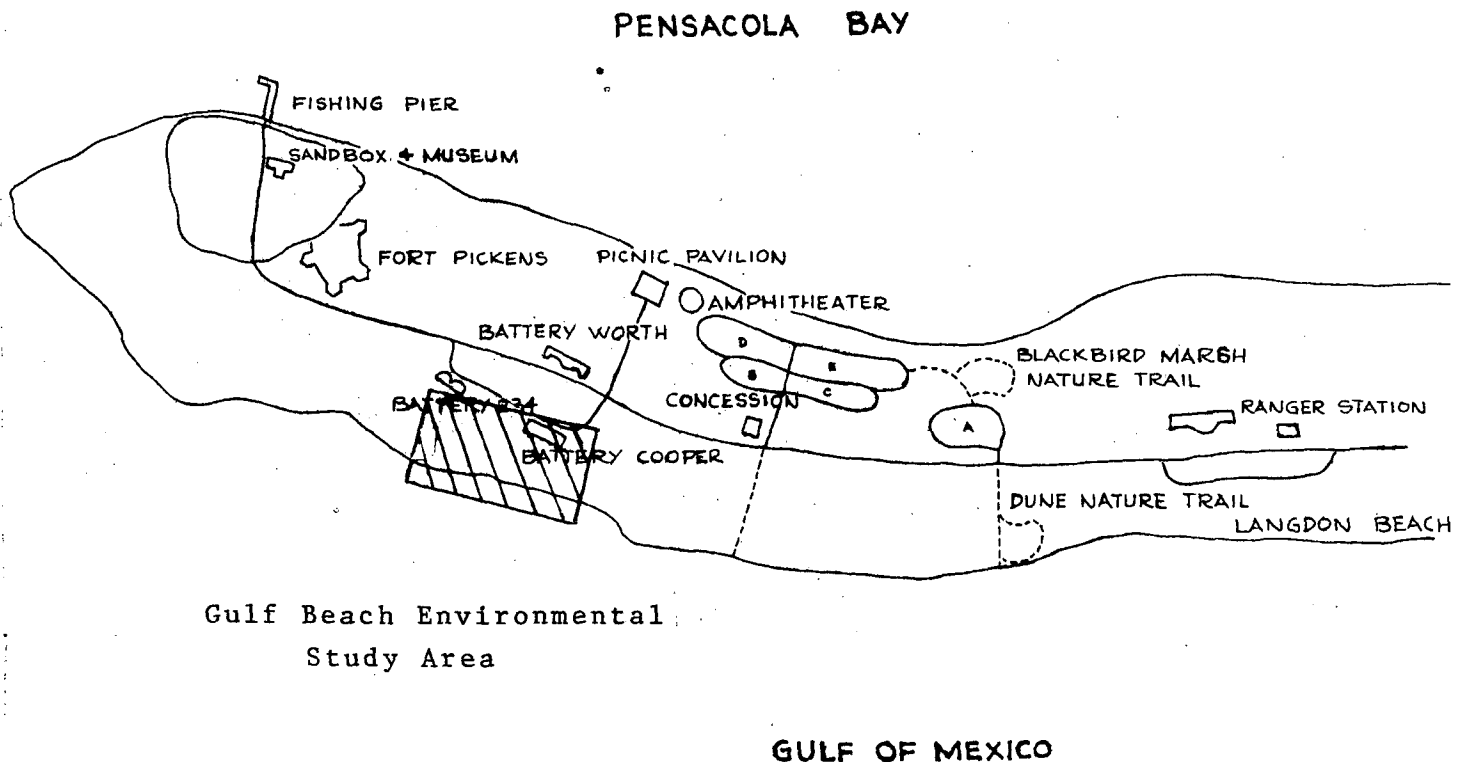
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INTRODUCTION

This guide was written primarily to provide the teacher with reference material on the nearby beaches and a few suggested pre-trip, on-site, and follow-up classroom activities.

It should be noted that this guide could easily be applied to almost any section of the Gulf Beach from Gulf Shores, Alabama, to Fort Walton Beach, Florida. However, the Gulf Beach National Environmental Study Area at Gulf Islands National Seashore, located one-fourth mile southeast of Old Fort Pickens, is available for your class at any time. The area is owned and administered by the National Park Service. This location provides excellent examples of active dunes and beaches. Restrooms and drinking fountains are available in the nearby picnic area.



THE WEB OF LIFE

All forms of life, including man, have changed and adapted continuously over the centuries. These continuous changes and adjustments have had to take all the other elements of the environment, living and non-living, into consideration. This has led to a situation where each element has grown to depend on the others for its own existence. This dependence must be maintained or something dies. Therein lies the threat to man; if too many other types of life are destroyed by the effects of man's careless destruction of the land, the rivers, streams, and lakes, and pollution of the air, will man himself be next?

The relationship of all living forms is referred to as the "Web of Life." This is the natural sequence of affairs, in which life, birth, and death all have their roles. The role is not always a gentle or pretty one, for the way of nature is often harsh, with many animals providing food for others, but this is essential to nature's system of checks and balances. There are constant changes in the web, but for thousands of years they have been so minor that most life forms have adapted and many survived. However, we know that in the past there have been some forms of life so set in their ways that they have disappeared: witness the dinosaur.

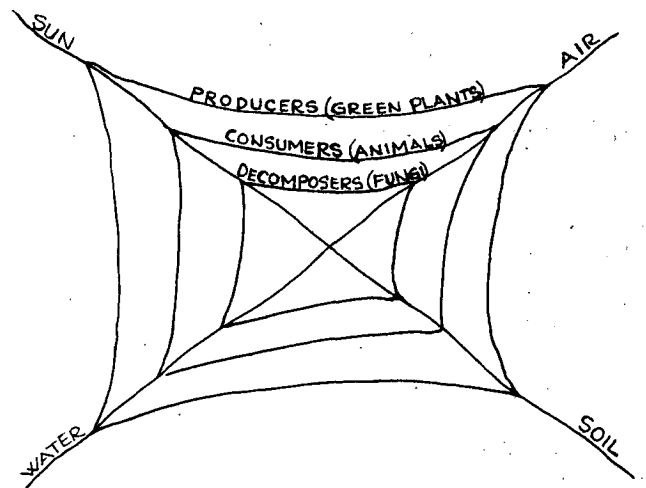
The basic strands needed to sustain life and continue the web are: Air, sun, water and soil.

When any population increases to the point where it exceeds any of these requirements, chaos results. There is war, starvation, and general social disruption. This is as true with rats as with man.

One of the differences that separates man from the rest of the animal world is that he can alter his environment. How he chooses to do this may be an improvement, or be destructive. In choosing to control his environment, man may also choose to control himself. This has been called the "ethic" or standard of behavior, in this case an environmental ethic. If we choose to adopt an ethic that will improve the environment it will be of lasting benefit not only to the generation now living, but also to generations to come.

Our failure to adopt a concern and care for our environment has been a failure of our society. Never has an environment changed so dramatically and so fast. Never have we been faced with so many problems and threats to our very existence.

Today more and more people are becoming concerned, and wish to do something about the threats facing us. When this happens progress can be made, not only in an increased hope for survival of all mankind, but for a life worth living. This is why we have an environmental education program.



WHY ENVIRONMENTAL EDUCATION?

The Gulf Beach National Environmental Study Area is simply a place where teachers can bring their students and study the environment firsthand. Before reading further it may be well to understand the objectives of the NESA program.

to introduce students to their total cultural and natural environment, past and present, and to help them realize they are a part of it.

to develop in students an understanding of how man is using and misusing his resources.

to provide an opportunity for students to work directly with environmental problem solving.

to equip students to be responsible members of the world they are shaping and that is shaping them.

These objectives can be met through the educational processes of awareness, knowledge and finally, action. As writer and naturalist Freeman Tilden might have explained it...

"...through education, awareness of the environment; through awareness, understanding; through understanding, protection of the environment."

THE ENVIRONMENTAL STUDIES CENTER AND MUSEUM

The Environmental Studies Center and Museum is designed to help teach ecology to the total population of Northwest Florida. A specialized library, a museum and laboratory equipment for reference and study is available to the public and teachers at 207 East Main Street (Main and Barracks) at the old L & N Marine Terminal building.

The Center reaches out into the community through the public schools providing field trip services to various nature trails in the area along with trips to the museum. Laboratory classes are provided for teachers on request during center trips. Films, filmstrips and records are used for further instruction in ecological concepts and problems of pollution.

The Environmental Studies Center is funded and operated by the Escambia County School Board. It was begun in 1970 with a Federal Grant under the ESEA Title III of The Elementary and Secondary Act of 1965. In August 1973, it became a total local effort.

GULF ISLANDS NATIONAL SEASHORE

Clear blue water, mild surf, gently sloping beaches and a rich history dating back to the 16th century Spanish explorations of the New World--this is Gulf Islands National Seashore. The Florida section of this new National Park System area consists of Johnson Beach on Perdido Key, a group of fort ruins on the mainland, Naval Live Oaks, and parts of Santa Rosa Island.

Gulf Islands National Seashore became part of the National Park System under legislation enacted in January 1971. Recreation facilities are being developed, and additional land is being acquired to expand the Seashore to its authorized total size (125,000 acres).

FIELD TRIP ARRANGEMENTS

WHEN TO COME?

Any weekday Monday through Friday, November 1 - May 15. We usually have more requests in the fall and spring than we can fill. A winter trip can be exciting (see "What to bring").

HOW TO ARRANGE?

Escambia County Public School classes can make arrangements through the Environmental Studies Center (438-1140). Teachers are requested to arrange a preliminary field trip briefing or attend a workshop. Other schools in Escambia and Santa Rosa Counties call 932-5307 for reservations. Please try to give us at least two (2) weeks' notice.

WHAT TO BRING?

Outdoor clothing suitable for weather (better too warm than not enough).

A change of clothing for those kids getting in the water.

Sunglasses and hats.

A notebook and pencil.

A bag to carry everything in.

*Equipment for activities can be arranged for during your pre-trip briefing.

SAFETY - PREPARING THE KIDS

- Sunburn.
- Things that sting: Jelly fish, Man-o-war.
- Things that bite: Crabs.
- Heavy surf.
- Broken glass.
- Obey all signs which designate safety hazards or closed areas.
- Use caution when on top of any batteries.
- Protect your feet--wear shoes.

HOW ABOUT LUNCH?

We have two large covered picnic pavilions with water fountains and restrooms.

FEES AND CHARGES

All trips are free of charge. Congress has authorized waiver of fee of bona fide groups using park resources for educational purposes.

WHO CAN I CONTACT ABOUT MORE INFORMATION?

Frank Walker, Park Naturalist, Gulf Islands National Seashore, 932-5307.

Anne Castellina Dudley, Park Historian, Gulf Islands National Seashore, 932-5307 or 932-5302.

Roy L. Hyatt, Director, Escambia County Environmental Studies Center, 438-1140.

FIELD TRIP CHECKLIST:

Your plans should include the following:

1. Contact Environmental Studies Center or Park to set up a date.
2. Make transportation and parental permission arrangements.
3. Attend workshop or briefing session.
4. Do some of the pre-site activities with your class.
5. Make definite assignments for class teams or individuals.
6. Arrange for teacher aides or interested parents to help out.
7. Arrange for students to bring lunch and drink for noontime.
8. Check for proper clothing.
9. Review safety aspects and park rules.
10. Assign "buddies" system to keep track of everyone.

As a minimum you should allow at least 1 hour/15 minutes to 1 hour/30 minutes for activities to make the trip worthwhile. A half day trip with a lunch break between activities is the best plan.

USE OF THIS GUIDE:

As we have stated, this guide is a teacher's reference to the area's beaches; and that's all it is. Many individuals contributed to the publication and we hasten to point out that it is not totally inclusive and the activities are merely suggestions to help you start in a general direction. Please take and use only those activities you feel will blend in with the subject you are now teaching.

If possible, after you become familiar with this guide, please attend one of the teacher workshops or briefings so you will feel "comfortable" with the site. Normally, depending upon the personnel available from the Environmental Studies Center and the park, each class is broken down into groups for the on-site activities, the teacher, the Environmental Studies Center and the park each taking one group. If the Environmental Studies Center staff or the park staff is not available, you may want to recruit teacher aides or parents.

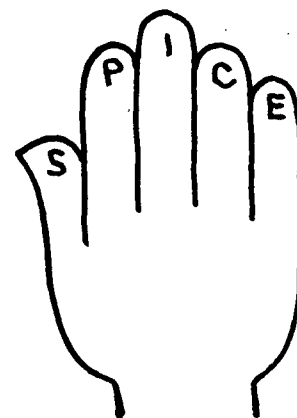
If, in working with this guide, you discover errors or techniques you wish to share, please let us know.

RULES TO REMEMBER:

1. As other classes will be following yours, please help us by leaving all facilities in as good a condition as they were found.
2. Except for reasonable amounts of seashells, collecting of historical or natural objects is prohibited.
3. Please keep off the dunes as much as possible. Follow established trails.

THEMATIC STRANDS APPROACH

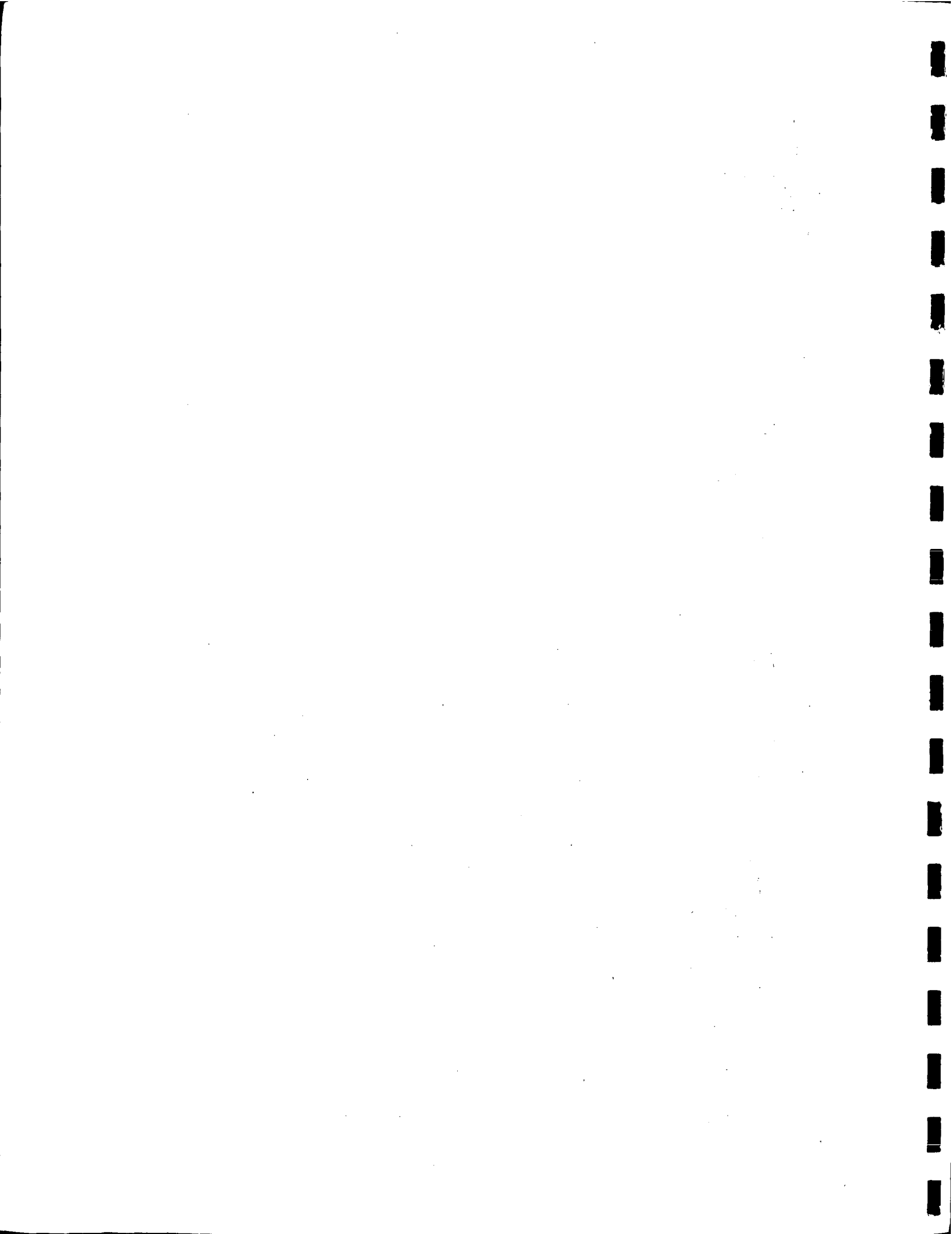
One way to use the Gulf Beach National Environmental Study Area is by using the thematic strands approach, sometimes called the SPICE method because it is so easy to remember--originally developed by the National Park Service. It now has widespread use wherever interpretation is called for.



CONSIDER YOUR HAND:

- S stands for similarities and differences. Look for ways in which the subject is like other things or how it is different. There are characteristics common to all organisms and no two things are exactly alike.
- P stands for patterns. Patterns deal with the order of things. Look at a pine cone or the bark of a tree. Think of how bees are organized and what they do. Look at the sky, the sand, leaves of plants, a spider web, or listen to your heart beat. In other words, use your senses to locate and study the order of nature.
- I stands for interaction or interdependence. Ask how plants depend on or interact with soil, soil with animals, animals with plants, animals with animals, and other combinations of one specific organism with another. Construct food webs or food chains--relate some of these to man.
- C stands for continuity and change. Look for change--growth, color, seasonal, temperature, light, moisture. Search for examples of the life history (cycle) of specific organisms.
- E stands for evolution and adaptation. A change in a trait (evolution in a species) does not take place unless there are large numbers of the organism, variety is present among these organisms, and environmental pressures are applied to the population. A considerable amount of time will pass before the new trait is apparent. *Example: On Santa Rosa Island hundreds of years ago, a population of mice (Peromyscus) somehow arrived from the mainland. If they were like those found on the mainland today, their color was brown. As the population grew, the darker varieties were caught and eaten by owls, their chief predator. The lighter colored ones (almost white) blended with the white sand background surviving to a greater degree. This breeding population became less and less dark since the survival trait (light color) is transmitted to the offspring. Try to locate several adaptations and see how they enable the organism to survive.*

ADDITIONAL INFORMATION ON THE STRANDS APPROACH MAY BE BORROWED FROM THE ENVIRONMENTAL STUDIES CENTER LIBRARY AS WELL AS ALL OF THE REFERENCES MENTIONED IN THIS BOOKLET.



BARRIER ISLANDS -- GROWTH AND CHANGE

Very soon you and your class may be making a visit to the seashore. It will be helpful if you'll look at a map with your class prior to the trip to see where Santa Rosa Island is located.

As most of you will be starting in Pensacola, you will travel across the Three Mile Bridge over Pensacola Bay. Then you will go through Gulf Breeze, across the Santa Rosa Sound bridge, and finally onto Santa Rosa Island--a fifty mile long barrier island in the northern Gulf of Mexico.

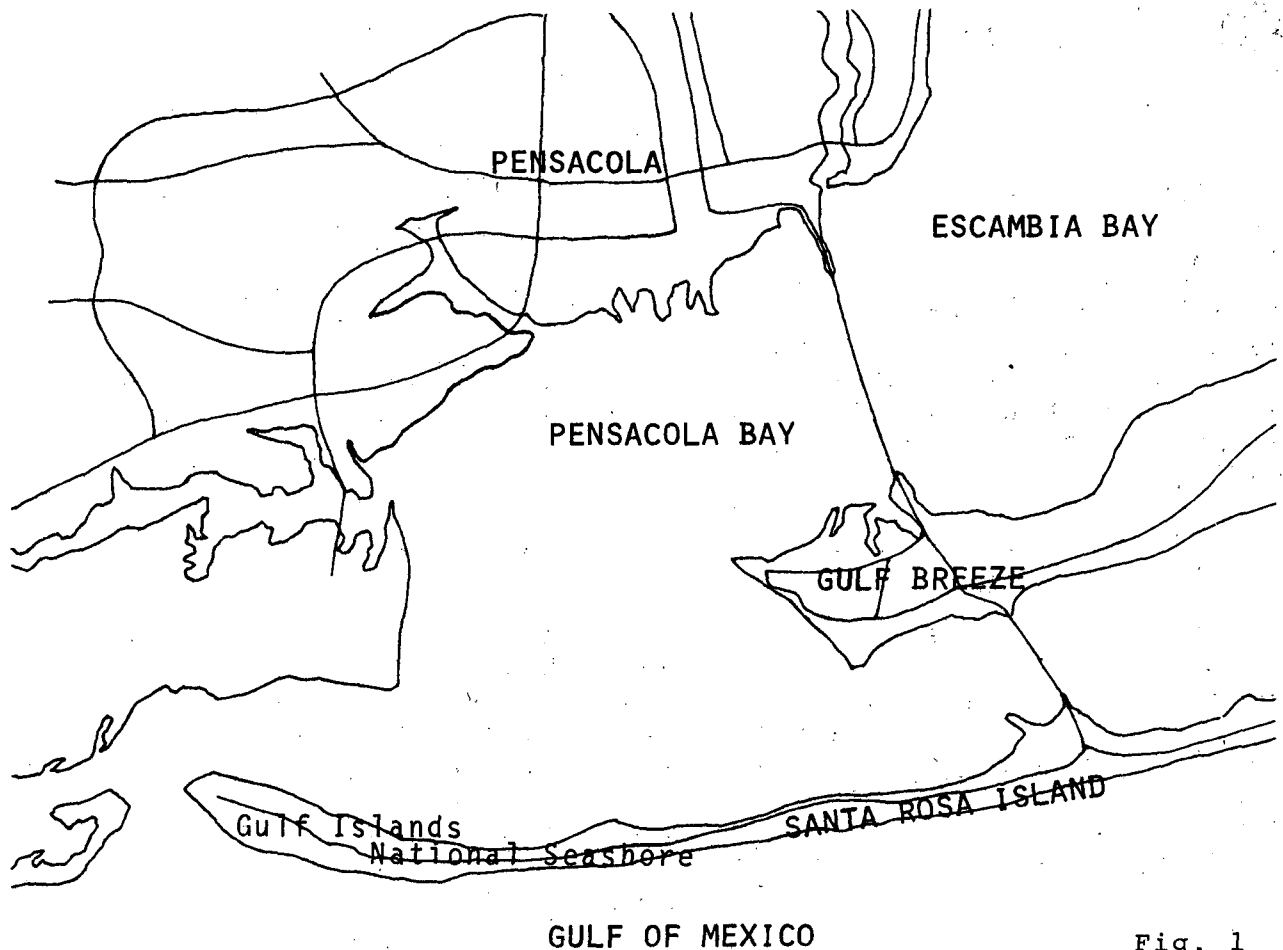


Fig. 1

Pensacola and Escambia Bays are alongside the mainland and both used to be deep rivers; however, as the sea moved in, they have become drowned river valleys. The "barrier" between these bays and the Gulf of Mexico is Santa Rosa Island, on which Gulf Islands National Seashore is located. This island lies off the coastal plain area of the United States and the whole region is rather low with few irregularities. The coastal plain extends eastward from Texas and northward as far as New York, and is made up mostly of sedimentary material eroded from the ancient Appalachian mountains found in the interior of North America. Imagine that most of the material that makes up this section

of Florida was once found in the ancient mountains of present day Georgia, Alabama and the Carolinas. Further evidence of this are the white sand bars on the rivers leading into these bays, such as the Blackwater River. Now let's look closer at the Gulf beach.

WHAT MAKES A BARRIER ISLAND LIKE SANTA ROSA? It is thought by some geologists that the island was born when the water receded from a long sand bar during the formation of the polar ice caps. The island is made up mostly of sand. It takes water and wind for growth and change.



Fig. 2

The sand is moved around by water and wind. Have you ever held a sand grain in your hand and looked at it? What you see is an irregular piece, very small--so small that you can't see it clearly with just the eye. Most of the sand on our beaches is just ground up rock. Rocks consist of a variety of natural materials. Some of these materials are soft and break down easily, while others such as quartz are very resistant. There was a great amount of quartz found in the mountains to the north of us; thus we find that our beaches are made up mostly of quartz, in fact, almost 99% pure quartz.

We need now to see how the water and wind cause the island to grow in length, width, and height.

First, let's see how the water in the ocean moves the sand to give us this long thin barrier island shape. To do this, we have to understand a little about wave movement. Generally, waves in this area are caused by wind; however, earthquakes and volcanic eruptions can also cause waves. Many times our waves are created by storms and winds far out to sea and are influenced by such things as wind speed, wind direction, and length of open water across which the wind blows. *The Gulf is only about a thousand miles across compared to the Atlantic's several thousand miles. Which has bigger waves?* As the wind whips up the water, these waves get started and head toward land. We see them break on our beaches in the form of surf.

Everyone is aware of what waves look like. (Fig. 3)

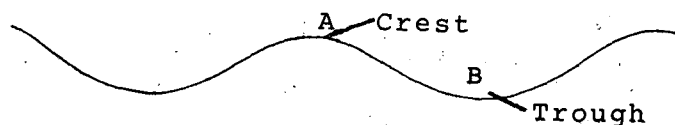


Fig. 3

Suppose you were swimming, bobbing up and down as the waves pass you. (Fig. 4) When the water is highest around you, the wave is at the crest. As it passes and the water reaches its lowest point around

you, you are in the wave's trough. The motion you have made as you follow each wave is in a circle. You may feel you have stayed in the same place, but the motion has actually carried you forward of the place where you started.

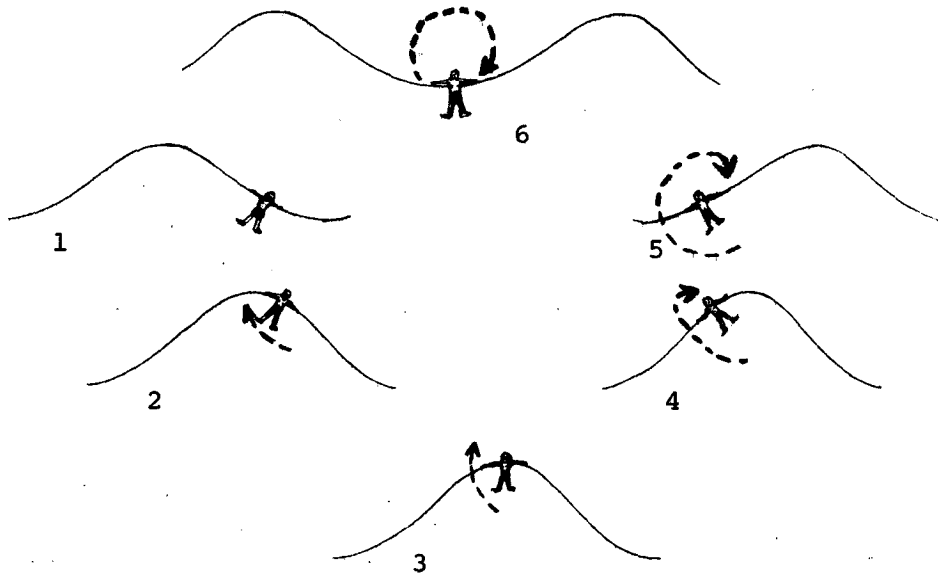


Fig. 4

Waves make a similar circle below the water surface. (Fig. 5). The movement slows down in deeper water until no movement occurs at all. This is the wave base. Far out to sea, the wave's circular movement is above the actual ocean bottom, and the wave is known as a deep water wave (A). As the wave comes closer to shore, and the water becomes more shallow, the circle may meet the floor evenly (B) or bend into an ellipse when the bottom is less deep (C). This contact with the bottom causes shallow water waves to move more slowly than deep water waves.

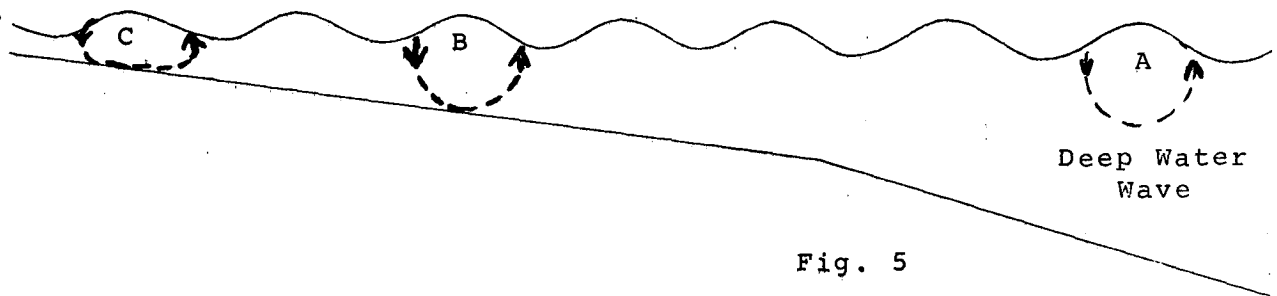
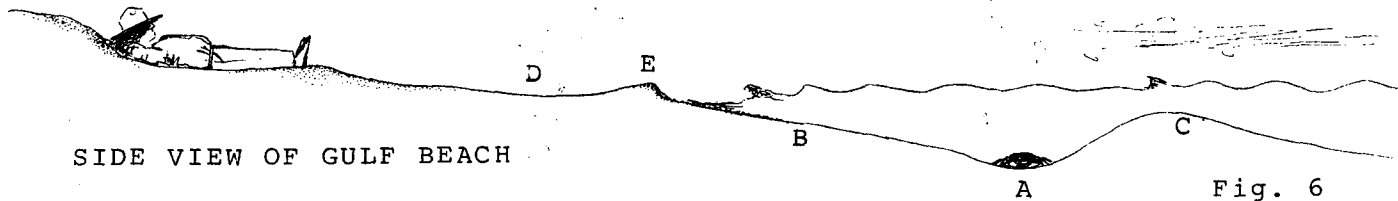


Fig. 5

As waves approach shallow water, they become steeper and steeper. Have you ever seen a wave stand straight? Finally, the wave cannot support itself anymore, so it topples over. As it crashes over and breaks, it is called SURF.

The depth of the water to the floor was shallow at the point the waves became so steep, so they broke. The roughness of the surf digs the TROUGH (A). (Fig. 6) You can imagine a lot of sand being stirred up. Some of the sand is carried up to the BEACH BASE (B) (remember there is always some forward movement), and some is washed back toward the sea. The washed back sand tends to pile up and form an offshore SANDBAR (C).

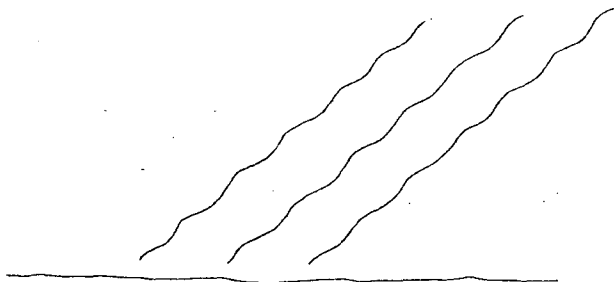
The waves continue toward shore, and as they regain movement over the trough, can break once more on the beachface (D).



Imagine spilling water on dry sand. Where does it go? It doesn't stay on top, but sinks into the sand. That is, it flows in between all the little grains of sand, and the water disappears. When the rough surf washes onto the beach, it carries quite a lot of sand. These are deposited when the water sinks into the beachface, and the grains are stranded. The stranded grains pile up and form a BERM CREST (E).

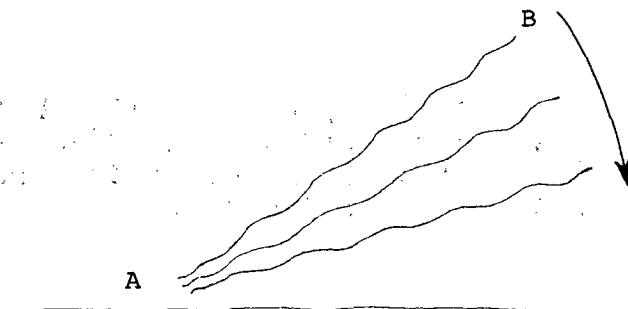
During hurricanes or very rough storms, the island can be completely "overwashed" by the sea. A considerable amount of sand is carried across the island during these periods, allowing the island to "grow" wider and still maintain its barrier island shape.

Now, let's look at waves from another point of view.



Waves do not usually approach the shore directly, but at an angle. (Fig. 7)

As they get closer to the beach, you might imagine that each wave has a shallow water wave end (in the shallow water) and a deep water wave end (in the deeper water). (Fig. 8)



When the shallow end (A) (Fig. 8) comes in contact with the bottom and slows down, the deep end (B) races ahead because in deep water waves move more quickly. The wave never completely straightens out, and as it breaks, there is a small forward movement of water. This water must go somewhere, so it turns and runs down the beach. This is LONGSHORE CURRENT.

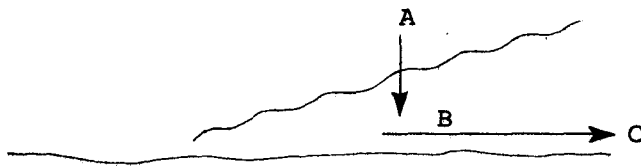


Fig. 9

You can imagine a sand grain picked up by the roughness in the surf (A), carried down the beach (B) and deposited (C). (Fig. 9) Of course, many grains of sand are moved this way, and that movement of sand is LONGSHORE DRIFT.

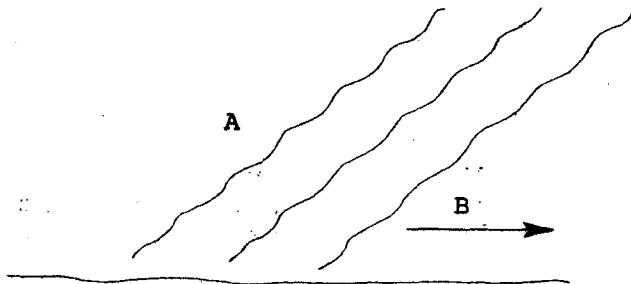


Fig. 10

On Santa Rosa Island, more often than not, storm winds blow the waves from the left (A) (from the southeast), so longshore drift is to the right (B). (Fig. 10) At times, storm winds come from the opposite direction and the sand moves back.

What happens when the sand reaches the end of the island? As waves come to the end, the deep water waves still move around (A). (Fig. 11)

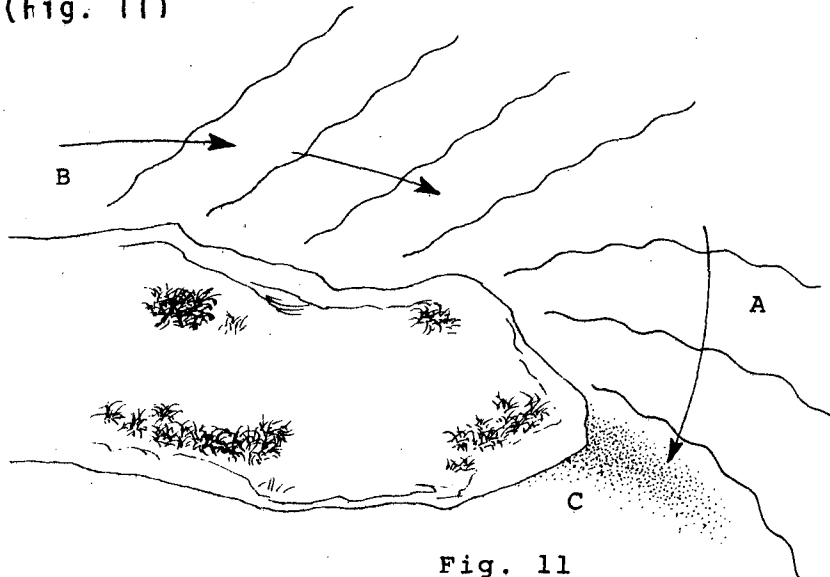


Fig. 11

Longshore current is still east to west (B) but as the speed of the water slows, it can no longer carry all the sand it has carried down the beach, and deposits the grains (C).

This is how an island grows in LENGTH.

(An excellent example of this is the fact that Fort Pickens, built in 1829-34 was only 400 feet from the pass and is now almost three-quarters of a mile from the pass. The end of Santa Rosa Island is

still slowly moving to the west; although dredging activity to keep the pass open will probably limit its movement much further.)

We've seen some of the effects of water; how about wind action? When most of the beach is exposed at low tide, wind takes over to blow the sand grains across the island onto the plants, eventually forming dunes.

Some very hardy types of plants which can take a lot of wind and the salt spray of the Gulf grow on the beach. (Fig. 12) As the wind blows across the island, sand catches on the plants and a dune is built up. Sea Oats is one of the main plants which holds sand and helps dunes grow larger. Plants continue to grow on both sides of the dune and soon more dunes are formed as the wind deposits more sand. This, besides oceanic overwash mentioned earlier, is also how an island grows in WIDTH.

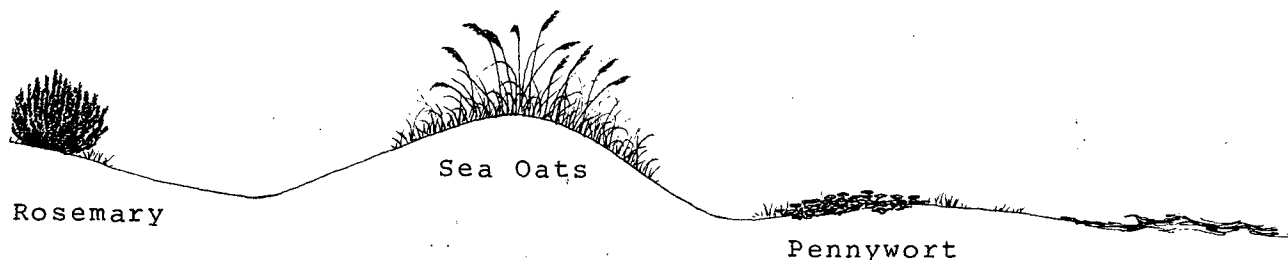


Fig. 12

As more sand continues to be caught by the plants, the dunes become taller. This is how an island grows in HEIGHT.

Thus, we've seen how an island, such as Santa Rosa, has grown in length, width and height through the effects of both wind and water on the sand.

THIS IS THE STORY OF THE BEACH. Rivers deposit the sand which has come from the mountains. The sand is carried downshore by long-shore current as the waves strike the beach at an angle. The island grows longer as the grains are dropped at the end. At the same time, the waves move into the shallow beach base and break into surf. The surf deposits sand onto the beach face, building up a berm crest. The wind then blows the sand across the island onto the plants and eventually dunes are formed.

On your trip to the beach, look for these things for yourself. You will discover even more, we're sure. Here are some of the most frequently asked questions concerning the Santa Rosa Gulf Beach. Perhaps they will assist in answering some of the many things students usually ask about.

FREQUENTLY ASKED BEACH QUESTIONS AND ANSWERS:

1. Where does the sand come from?

Most geologists agree that the sand comes from the Appalachian Mountain region, and that the island is probably made up of a combination of river derived sand material and material from the continental shelf.

2. Why is the sand so white?

The sand is composed almost entirely of 99% pure quartz, unlike many other beaches which consist of greater amounts of feldspar or ground sea shells.

3. Why does the sand squeak?

Due to the fact that almost all the sand grains are of the same size and composition, their rubbing together when you walk over them causes the squeaking sound.

4. What are the "stained" areas found occasionally?

Most of these are the heavy minerals such as ilmenite, pyrite, etc., which make up only a very small portion of the overall content of the beach. These are usually concentrated by storm-wave action.

5. Why are Sea Oats important to the dunes?

Sea Oats can live with the great amounts of salt spray coming off the Gulf and with its extensive root system, it can hold the dunes in place. The flowering tops of these plants cause accumulations of windblown sand which form natural dunes that serve as buffers against storm tides.

6. What causes the ledges (scarps or cuts) in the beach?

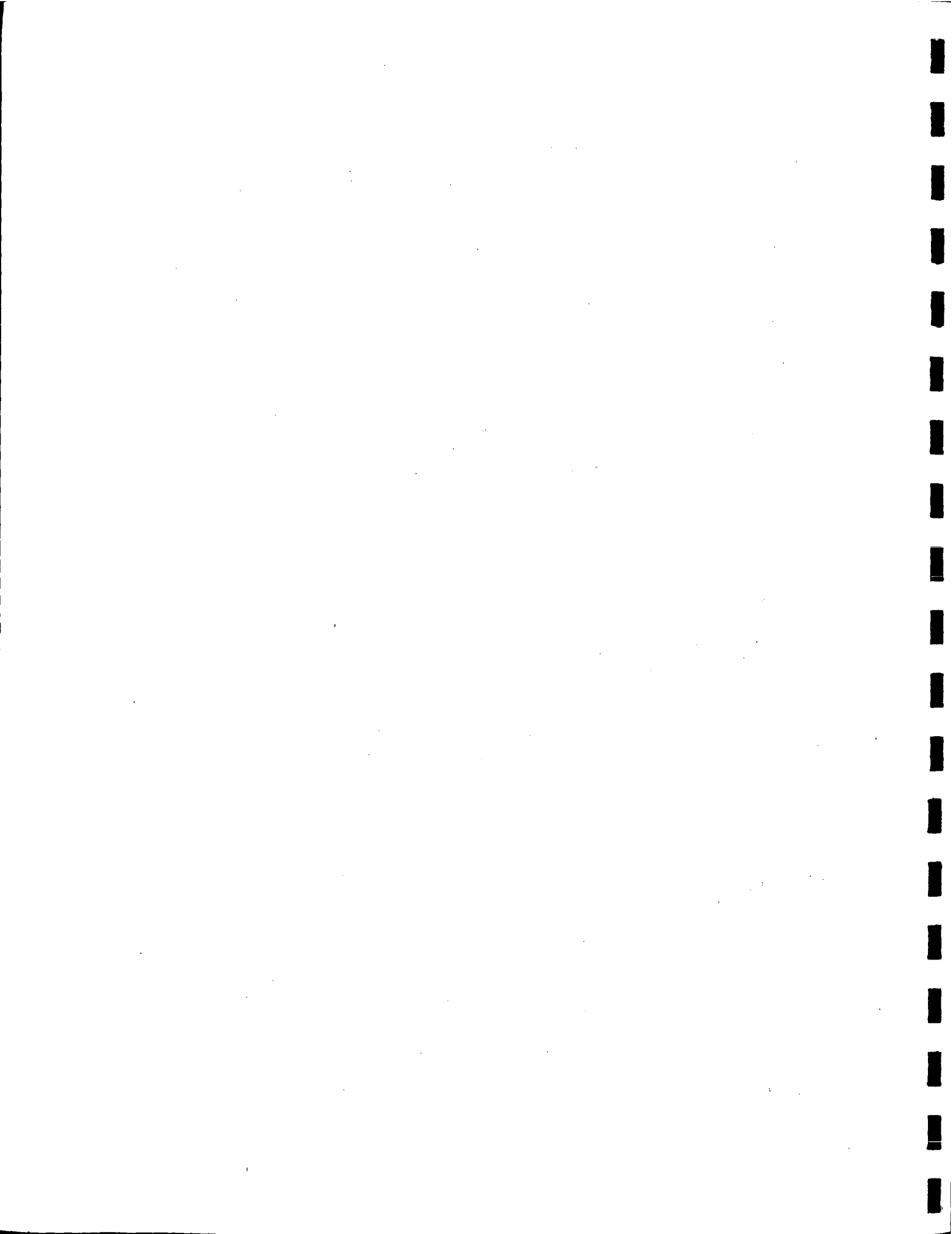
Most of these are caused by wave action during storms. During storms, large waves move great quantities of sand offshore to the offshore bar (approx. 575 ft.). The scarp formed is from this sand being carried offshore by the waves.

7. What are all the tiny holes in the sand? (Those approx. 1/16" in diameter.)

This is what is referred to as "bubble sand." When the waves pound on the beach, they force air into the beach. When the air escapes, it leaves tiny holes covering the beach. Larger holes are usually caused by the animals, such as the clams, worms, or even crabs.

8. About how many years old is Santa Rosa Island?

It is thought to have been formed between 5,000 and 10,000 years ago.



OPEN SANDY BEACHES

Sandy beaches, like those on Santa Rosa Island, which face directly into the ocean without the protection of offshore islands are areas of constant change and motion. Every wave lifts and moves quantities of the sand. The breakers pound the shoreline ceaselessly. The tides move up and down the beach in daily, monthly, and annual rhythms and progressions. Exposed sands are subjected to direct sunlight, drying, wind transport, rain, and freezing. Floating objects, masses of seaweed, and subtidal animals torn from their anchorages offshore by the turbulence of storms are cast ashore and pushed to the upper part of the beach by the waves of the highest tides. Each level of the beach is submerged and exposed for different amounts of time and at different times of day or night each successive day. High tides bring with them certain predators from the fringe of the sea, and low tides bring another set of hungry predators from the land.

Only specialized animals can live successfully and maintain themselves in this turbulent world, where even the sand itself displays something of the fluidity of water. Most of the animals found here are amazingly proficient burrowers and are relatively small in size.

SANTA ROSA ISLAND BEACH SAND

Generally sand beaches are composed largely of quartz and feldspar, the most abundant and hardest particles left from the weathering of rocks in the mountains. Geologists theorize that the origin of Santa Rosa Island sand may be from the weathering of metamorphic rocks thousands of years ago in the piedmont of the old Appalachian region and subsequently transported here by rivers. The sand on Santa Rosa Island is mostly quartz with a dozen or more species of heavy minerals and minute gem stones. It contains no gravel or silt and is famous around the world for its whiteness.

Waves and winds on a sandy beach move large quantities of sand along the shore, inland, and offshore. Not only do winds and waves transport and deposit sand, but they also sort the sand particles by size and density. For example, the barrier dunes have been formed by the prevailing wind, which lifts beach sand, especially the powdery dry sand, and carries it inland leaving the coarser particles behind. One can see this effect also in a wind "shadow" behind a rock or a bit of driftwood. Here, in the lee of the wind (the side opposite the direction the wind comes from), sand piles up in a long miniature dune.

The quartz grains in beach sand have either a polished-clear rounded appearance or a frosted-dull, chipped appearance. Geologists believe that the polished-clear grains have always been associated with water, or at least a film of water, and never wind blown; whereas the frosted-dull grains have been transported by the wind either inshore from off the beach and onto the dunes, or off the dune onto the beach.

Large waves during storms transport large quantities of sand seaward from off the beach and barrier dunes and deposit it as part

of a sand bar about 150 yards off Santa Rosa Island. Consequently, a portion of the sand comprising the sand bar was at one time part of the beach and at another time part of the barrier dune. Underwater, waves also sort sand grains, depositing the finest in the intertidal zone and leaving the coarser sand farther off the beach.

On more southern Florida beaches and wavy tropical beaches, the sand is not quartz but rather a calcareous material composed of broken-down shells, coral, and the substances left by live-depositing algae. Santa Rosa Island sand is a medium to fine sand, hard-packed, with somewhat rounded grains which makes a much better home for living things than a coarse, loosely packed calcareous sand with sharp, irregular edges and a tendency to crumble.

The size of the sand particles is one of the most important factors influencing the animals living in the sandy beach. Researchers have noted that sandy beaches composed of similar size sand grains have similar type animal communities associated with them regardless of their latitude. Intertidal sand of Santa Rosa Island has a grain size of 1.65Phi which classifies it as a medium sand according to the Wentworth grading scale. Sandy beaches on the West Coast of India have a similar grain size and therefore a similar type beach community as found locally.

(Continued on following pages.)

Barrier Dune Area

Intertidal Area

Subtidal Area

Succulent
Plants

Marram Grass

Sea Oats

Upper

Mid

Lower

High Tide

Low Tide

BEACH ANIMALS

Genus Common Name

Peromyscus Beach Mouse

Scavenger beetles

Ocypode ghost crab

Ocypode ghost crab

Donax coquina

Emerita mole crab

Terebra gray auger

Arenaeus speckled crab

Oliva lettered olive

Callinectes blue crab

Callianassa burrowing shrimp

Mellita sand dollar

Flounder

Skate

Whiting

Cobia

Sea Robin

Star Fish

Sea Cucumber

PENSACOLA BEACH PROFILE - ZONATION AND BEACH ANIMALS

MAIN AREAS OF THE GULF BEACH (Refer to Pensacola Beach Profile page B-3)

The beach which faces the open ocean like that of Santa Rosa Island can be divided into three distinct areas: The Barrier Dune Area, The Intertidal Area, and The Subtidal Area.

The Barrier Dune Area

The barrier dunes rise high above the flat beach and, as we discussed earlier, are formed from wind blown sand lifted off the beach. A barrier dune will contain a variety of vegetation types but most important are the marram grass and sea oats. Barrier dunes prevent rising sea water from flooding the more flat regions inland. This protection against flooding is the reason why restrictions have been placed on dune buggies and excessive human traffic. Any disruption of the sand may cause the dune to begin to wear away.

Sea oats help stabilize the sand and removal of them from the dune is in violation of the law. Oftentimes the buried stems of the sea oats, which interlace in the sand like reinforcement rods in concrete, can be seen on the exposed slope of a barrier dune facing the beach.

On the barrier dunes and seaward along the beach, quite a number of different looking markings and tracks can be observed. They tell a fascinating story; however, the trick is to read it. Numerous holes of varying size, representing either the home of a ghost crab or a beach mouse, are typical of the upper beach and barrier dunes.

The beach mouse, Peromyscus polionotus leucocephalus, is endemic to Santa Rosa Island--this means that they are found on this island and nowhere else in the world. These tiny rodents (adults are no more than 2 1/2 inches long and weigh less than an ounce) live in burrows in the sand dunes. The burrows and the tunnels leading to them may spread over several yards. Beach mice are nocturnal; this means they are active at night and remain in the burrow during the day. Their food consists mainly of sea oats and the other reeds and grasses that grow on the dunes. The most striking adaptation of the beach mouse is its protective coloration. They are almost entirely white except for a faint gray streak down the back. This makes it very difficult for owls or other predators to see them as they run across the white sand dunes. (See page B-7.)

Several species of succulent plants generally grow on the slope of the dune toward the beach. Also, insects such as scavenger beetles are common in this upper beach area and feed on dead material cast ashore by the high tide.

The Intertidal Area

Most of the exposed beach seaward from the barrier dunes is part of the intertidal area which is defined as extending from the lowest level uncovered by the tides up to the highest point washed or splashed by the waves during the highest tides. Simply stated, it is the part of the beach between high-tide mark and low-tide mark.

Generally, a high tide and a low tide occurs every day in the Pensacola area and therefore a portion of the intertidal area is exposed and covered every day. The time and the height of the tide changes daily as determined by the changing positions of the moon, earth and sun relative to each other. The moon-earth positioning having the greatest influence on the tides. The maximum annual tide range, taken as the vertical distance covered between the lowest low tides and the highest high tides, in Pensacola is about 2 1/2 feet. Such a tide range would be approached only a few times during the year. Locally the highest high tides occur in the summer (June) and the lowest low tides occur in the winter (January). When such a range of 2 1/2 feet in sea water level is spread out over the gradually sloping seashore it exposes and covers a considerable width of the beach, as much as 150 feet or more depending on the slope of the shore. This part of the beach is the Intertidal Area and it can be subdivided into upper, mid, and lower zones depending upon the differences in their daily periods of submergence. The term zonation is used to describe the organization of a habitat, such as the intertidal area, into more or less parallel bands of distinctive animal associations as a result of variations in environmental conditions.

The upper part of the intertidal area is submerged least of all during the year and consists of dry, loose sand which is hard to walk on. Beach umbrellas and sun bathing towels are generally spread in this upper zone. The extent of any daily high tide into this upper beach can often be identified by the "beach wrack" or dead seaweed, animal shells, and other debris deposited at the high-tide mark as the tide receded.

A major portion of the mid-intertidal area is submerged and uncovered every day. Here sand castles are constructed and crumble and it is the place where coquina clams, and mole crabs are active along with little boys and girls. The sand in this zone is more often wetted by the surf and "wash" and is therefore more firmly packed and easier to walk on.

The lowest part of the intertidal zone is almost always submerged rather than exposed and only uncovered during extreme lows of spring tides. In practical terms, this is generally the swimming area of the seashore and it extends for some yards off the shore. Fish, crabs, and sand dollars are active here.

The Subtidal Area

The subtidal area of the seashore begins immediately below the extreme low-tide mark. The animals typical of the lower part of the intertidal zone move freely into and out of this area which is always submerged. Off the Gulf beach, this area includes such topographical features as the longshore trough and sand bar. The trough is a depression located just before the sand bar and is a region where suspended material such as muddy water, algae, and debris collects. It is generally a barren area although crabs oftentimes feed on dead material that collects there.

The first sand bar which is located about 150 yards offshore is a fertile collecting ground for skin divers. Various species of

[illegible]

Animals Typical of the Gulf Beach Community

Mole crabs, coquina clams, ghost crabs, each in their own different way, have become adapted in structure, physiology, life cycle, and behavior patterns for life in the zones of open beaches. These are areas of pounding waves, ever-shifting sands, fluctuating tides, and exposure to wind, rain, sunlight, heat, and cold. The environmental stresses are so great, so diverse, and so variable that most organisms are prevented from establishing themselves there. Yet sources of abundant food are there--the plankton, the organic film and microscopic animals and plants to be found on and among the sand grains, and the flotsam continually thrown up on the beaches from the sea. Those few animals which have become adapted and are able to succeed in this difficult environment and exploit these food sources find themselves virtually without serious competition and can dominate their environment in overwhelming numbers.



Scientific Name:

Peromyscus polionotus leucocephalus

Common Name:

Beach Mouse



Habitat on Sandy Beach:

They live in burrows, usually away from the beach, coming out at night in search of seeds.

Special Adaptations:

Throughout most of their range they are dark colored. On the white sands of the offshore islands along Florida's West Coast they are white. Through natural selection the darker individuals are more vulnerable to predation and are more often removed from the population so that opportunities for breeding occurs mostly among members which are light in color. (Almost white.)

Predators:

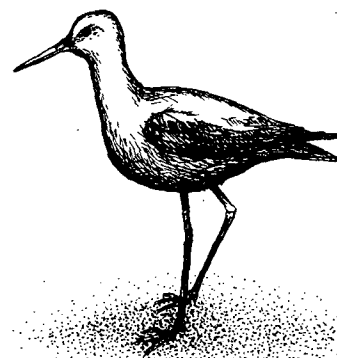
Their most common predators are night hunting owls.

Scientific Name:

Catoptrophorus semipalmatus

Common Name:

Eastern Willet



Habitat:

Willetts spend most of their time in salt marshes or along beaches and frequently in small colonies or several pair together.

Adaptations:

BILL - is long and straight for probing into the sand for food.
LONG LEGS - enable the willet to wade in shallow water.

Diet:

The willets eat mainly small crabs, mollusks, killifishes, beetles, crickets, and grasshoppers.

Predators:

Man is perhaps the most dangerous enemy of the willet as he has caused restriction of its breeding grounds. Natural enemies include high tides which can wash away nests and fish, crows and skunks will break and suck eggs.

Scientific Name:

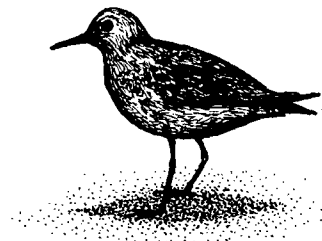
Crocethia alba

Common Name:

Sanderling

Habitat on Beach:

Sanderlings are found on almost every ocean beach in the world, spending most of their time following the water's edge as it moves toward and away from the beach--always probing for small animals. When resting, they hide against a background of dry, white sand. It does not breed here.



Predators:

It is thought that hawks are the most common predator here on the beach.

Scientific Name:

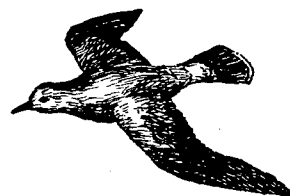
Larus atricilla

Common Name:

Laughing Gull

Habitat and Diet:

In Florida, laughing gulls make nests of dead grass in clumps of grass or drier marshes. For food it catches fish and shrimp in shallow water and crabs in mud flats. It is a coastal bird but sometimes is found inland.



Predators:

Eggs are eaten by skunks, raccoons, and other small mammals. Man takes a toll of gulls especially with his automobiles on bridges over local waterways.

Other gulls noted here in winter:

Herring gull
Ring-billed gull
Bonaparte's gull

Scientific Name:

Mellita quinquiesperforata

Common Name:

Sand dollar

Habitat on Sandy Beach:

Lower part of the intertidal zone and the immediate portion of the adjacent subtidal area.

Adaptations for Life on Sandy Beach:

1. SHAPE. The flat, disc shape of the animal aids it in sliding just under the surface of the sand. 2. BURY ITSELF IN SAND. The disc is covered with small movable spines which are used to push itself into the sand. It slides forward just under the surface of the sand until it is completely submerged.

Diet:

During burrowing, it feeds on minute organic particles trapped in mucus secreted on disc surface and moved to mouth in special grooves.

Predators:

Fish and crabs.

Scientific Name:

Oliva sayana

Common Name:

Lettered olive

Habitat on Sandy Beach:

Lower part of the intertidal zone and the immediate portion of the adjacent subtidal area.



Adaptations for Life on Sandy Beach:

1. SHAPE. The subcylindrical shape of the shell aids it in pushing itself into the sand. 2. LARGE FOOT. The snails foot is very large and extends laterally into lobes which curve back over the shell. The front of the foot forms a sort of "plow." 3. SPEED. The snail crawls rapidly over sand and can bury itself very quickly by plowing into the sand. 4. The individuals of this species group together in colonial fashion in shallow water. When they are moving about, the expanded mantle and foot exhibit the same color markings as the shell.

Diet:

Carnivorous feeding on small clams and worms.

Predators:

Shell collectors
Eagle rays

Scientific Name:

Donax variabilis

Common Name:

Coquina clam

Habitat on Sandy Beach:

Middle of intertidal area primarily in the "wash" zone.

Adaptations for Life on Sandy Beach:

1. SHAPE. The streamlined wedge-shaped shells help it push itself into the wet sand. 2. FAST AND EFFICIENT DIGGER. The clam "digs in" with remarkable speed using its wedge-shaped foot which projects forward at the more pointed end of the shell. The action of the foot in digging is a "jabbing" motion. The foot is also used as a "drag" to control the extent of the clams migration up and down the wet beach. 3. SIPHONS. The two whitish tubes which project from the blunt end of the shell are called siphons. They extend above the sand when the clam is buried and they direct water in and out from between the shells. 4. SENSITIVITY TO TIDAL RHYTHM. The clams sense or "feel" the acoustic shock of breaking waves and rise out of the sand to allow the waves to wash them up and down the beach with each change of tide.

Diet:

Plankton and organic material suspended in the water.



Scientific Name:

Terebra cinerea

Common Name:

Gray auger

Habitat on Beach:

Lowest part of the intertidal area in the shallow water.

Adaptations for Life on Beach:

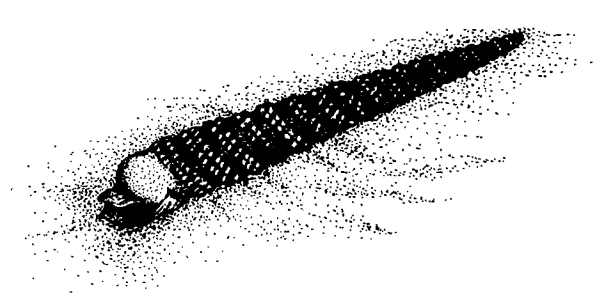
1. SHAPE. The slender, elongated and pointed shell helps it in pushing itself into the sand. 2. FOOT. An effective structure for crawling and plowing through the sand.

Diet:

Feeds on young coquina clams.

Predators:

Starfish of the genus *Astropecten*
Raji erinacea, the little skate



Scientific Name:

Callinassa islagrande

Common Name:

Mole shrimp, burrowing shrimp

Habitat on Sandy Beach:

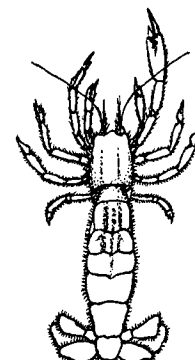
The lower zone of the intertidal area and the immediate adjacent subtidal area.

Adaptations for Life on the Sandy Beach:

1. Construction of deep tubular burrows which may branch under the sand. The burrows can be identified by the raised chimney like structures surrounding the burrow openings. 2. The body is elongate with appendages adapted for burrowing, carrying sand, sifting food, and pumping water for feeding and respiratory currents.

Diet:

Diatoms, algae, small invertebrates, and detritus.



Predators:

Swimming crabs such as *Arenaeus*, *Ovalipes*, *Callinectes*. Fish such as *Menticirrhus*, whiting; *Paralichthyes*, flounder; *Prionotus*, the sea robin.

Scientific Name:

Ocypode quadrata

Common Name:

Ghost crab

Habitat on Beach:

Barrier dune and near high-tide line.

Adaptations for Life on Beach:

1. Construct burrows 2-4 feet deep primarily for occupation during daylight hours. 2. Active at night (nocturnal). Cease feeding toward dawn--enter burrows during daytime--toward evening emerge to feed. 3. Color of crab imitates color of beach sand. Good camouflage. 4. Legs are used effectively in walking or running sideways with amazing speed (can outrun man). 5. Most terrestrial of our local native crabs; however, they must return to the water at intervals to moisten their gills and to reproduce.

Diet:

These crabs are scavengers (and cannibals) and tend to feed most actively along the "beach wrack," looking for beached fish or refuse and small bits of food buried in the top layer of sand.

Predators:

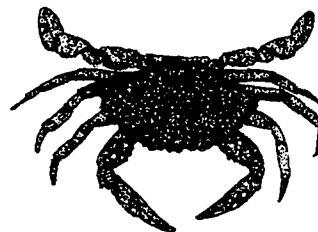
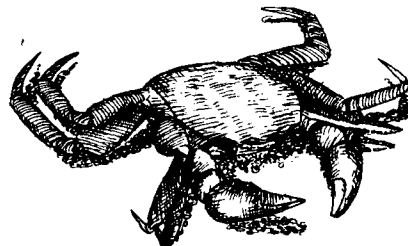
Raccoon
Sea Gull

Scientific Name:

Arenaeus cribrarius

Common Name:

Speckled crab



Habitat on Beach:

Low tide mark of the intertidal area and in the shallow water close to the shore.

Adaptations for Life on Sandy Beach:

1. This crab is rarely washed ashore because it is able to bury itself in the shifting sands of the surf zone. It pushes sand forward using its claws and "wiggles" in a manner so as to sink vertically into the sand. 2. A heavy coat of hair-like bristles on each side of the mouth parts keep out sand. 3. The color of the crab imitates the sand grains. 4. Adapted for life in the waves--the crab's last pair of legs are paddle-like enabling the crab to swim. 5. A large surface area to its gills gives the crab the ability to maintain strenuous activity in the breaker zone near shore.

Diet:

Donax, coquina clams
Emerita, mole crabs
Scavenger on dead fish, etc.

Predators:

Menticirrhus americanus, whiting or kingfish
Rachycentron canadum, cobia "the crab-eater"

Scientific Name:

Emerita talpoida

Common Name:

Mole crab



Habitat on Beach:

Middle of intertidal area in and below surf zone (where waves break beach).

Adaptation for Life on Sandy Beach:

1. SHAPE. The oval, streamlined shape of the mole crab helps it push itself into the shifting sand of the surf zone. 2. FAST AND EFFICIENT DIGGER. Its legs are used in a sculling fashion for burrowing backwards into the wet sand. 3. SPECIALIZED APPENDAGES. A pair of legs keep gills free of sand; a pair of antennae with thousands of tiny hairs unroll like a party favor and strain the backwash of waves like a sieve. 4. SENSITIVE TO TIDAL RHYTHM. They move up and down the beach with the tide following shallow waves toward the water or moving up the beach with deep waves.

Diet:

Plankton and organic matter in backwash.

Predators:

Sea gull and Sanderlings

Sandpiper

Swimming crabs such as: *Arenaeus*, speckled crab; *Ovalipes*, lady crab; *Callinectes*, blue crab.

Fish such as: *Trachinotus*, pompano; *Menticirrhus*, whiting or kingfish; *Paralichthys*, flounder.

Common Name:

Plankton

Habitat:

These tiny organisms live freely in water, subject to move only with the current since most are not equipped for much swimming.

Diet:

Plant plankton (phytoplankton) makes its own food by photosynthesis. Animal plankton (zooplankton), if a complete organism, catch other small animals or plants for food or act as scavengers on dead organic matter.

Predators:

They are eaten by everything from tiny arthropods and fish to the very large Blue Whale.



BEACH ECOLOGY

BEACH ZONES

A seashore provides one of the best localities for one to observe environment interactions--interactions that are obvious, logical and never ending. Climate, variable weather, salt, plants, animals, and man meet in a physical location. The continuing interaction results in a locality generally referred to as Pensacola Beach. If one would look at a more particular location within the Gulf Islands National Seashore Park toward the end of Santa Rosa Peninsula an environment could be found that would provide demonstrations of some of the natural responses of physical and biological phenomena.

For reasons of describing these various environmental events the shoreline, nearby sand dunes and the forest will be divided into arbitrary zones. (Fig. 1) However, one can easily observe that vegetation does occur in "zone" patterns beginning with the actual gulf shore and extending away toward a normal established tree line or forest.

ZONE A lies from the actual waterline across the beach to the second dune. This is the area of greatest environmental confrontation. The fury of the sea meets land and biological communities with an endless pressure for change. Only the strongest and best adapted plants and animals can survive. Sand is continually moving. Salt is ever present, sometimes in concentrations greater than that in sea water as the water evaporates on vegetation leaving salt crystals behind. Sea rocket and Iva are most commonly found in front of the first dune. Sea oats form the dominant vegetation on the first and second dunes.

ZONE B extends from dune 3 on back to dune 4 or 5. At this distance from the shore dune formation may become less distinct. Sea influences are very strong in here, but of course, less than that at the beach front. The major visible result of wind, water and spray is that grasses, small shrubs and dwarfed trees make up the vegetation. Conspicuous plants on dunes here are sea oats, yaupon, Florida rosemary, myrtle, Chapman and sand live oak, and dwarfed pine. Swales, the trough between dune peaks, will often accumulate enough moisture to support bog communities. Plants in these locations will include marsh plants, ferns and relatives, and peat moss. Wind and spray shaping is most easily seen in Zone B. If a plant should grow tall enough, it will be sheared back to shrub height by an occasional storm.

ZONE C is considered to be the last dune and the forest beyond. Plants on the dune will not appear as normal growing species, but will show some of the effects of wind and salt influence. They will exhibit dwarfing, some shaping, and appear as a desert (growth) plant. Plants behind the last dune will generally be growing as one would expect to see them in an inland forest. Some major influences remain however. Salt spray will

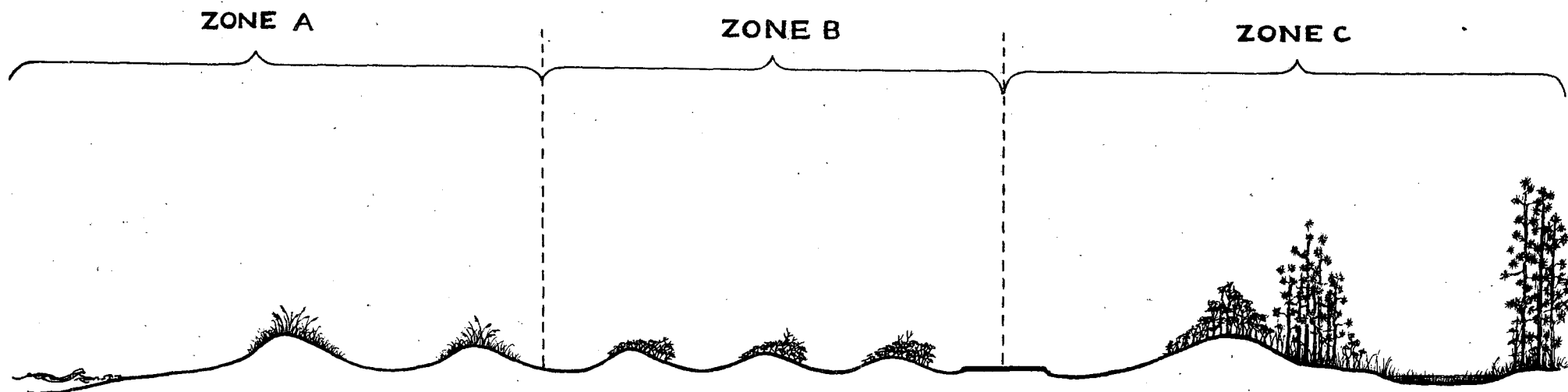


Fig. 1. Vegetational zonation in Gulf Islands National Seashore near Fort Pickens.

travel this far and more. Salt sensitive plants may not be here. Sand dunes can continue to move into the forest. At this distance from the shore sand movement is slower, but it still can occur. Severe storms will blow down trees, "slant" them in a single direction, and cause damage to leaves and stem tips because of heavy salt spray deposits.

SOIL

Soil--What is soil? Mineral particles that have been created through millions of years of rock grinding against rock, freezing and thawing, wind blowing particles against more rocks and particles, and water washing and wearing. The result is small sized grains. In a good farm soil the mineral particles are of many sizes (sand, silt and clay) and contains some organic material and living microorganisms. Beach sand is really sand, marine sand.

On sandy shorelines ocean currents and wind can cause the depositing of sand upon the beach and its movement into the dune area. Dune building is a natural result of these factors along such a sandy beach. Constant winds for a long duration tend to pile sand into a continuous strand, the dune. Over the years several dune lines can be produced. In a way, these dunes formed in parallel rows are much like the ripples of sand on the sea bottoms formed by currents. Dunes consist of crests, their peaks, and troughs, usually called swales. Dune crests and the upper slopes facing the sea are exposed to the greatest wind stress and sand movement. Swales are protected and accumulate moisture, more plant growth and eventually organic matter. Along Santa Rosa Peninsula all soils are marine in origin and wind blown into position.

CLIMATE

During spring and summer prevailing winds come from the sea and blow upon the land. Winds come from the north on many winter days. Even along the shoreline wind direction and pressure is not continually from the water. It is relatively constant from the sea during the spring growth season.

Rainfall occurs at about the average rate for the inland area. On some occasions sandy swales fill to a point where water stands for periods long enough to produce several generations of mosquitoes.

Temperatures are quite variable. With winds from the sea, temperatures are rather cool in the spring and summer. North winds seem to chill the area during the winter; but, due to the warming action of Santa Rosa Sound and Pensacola Bay, temperatures do not drop to the same low as occurs inland. There is a seasonal fluctuation sufficient to enforce the growth and dormant seasons for dominant plant species.

Light intensity is as great as can be found at sea level. Factors contributing to this include reflection from the water and the whiteness of the beach sand. Sparseness of vegetational cover contributes to this high intensity within the dune area. Plants requiring shade will not survive except in protected areas.

Storms produce extreme and regular disruptions over the years. Hurricanes can be expected occasionally.

MARINE INFLUENCES

In addition to the sand deposits upon the beach and the unusual wind forces, as compared to inland conditions, there are some additional factors to be reckoned with. Salt is a natural component of sea water. When wind and wave action combine there is a buildup of "surf" action. Waves pound down on the beach, spray rises and is carried by wind currents onto land and vegetation. Salt spray carried by wind can travel up to several miles. However, everyday surf provides enough spray to cover the width of Santa Rosa Peninsula.

A combination of storm and high tide results in flooding. Sea water rushes through weak places in the fore dune to flood swales, break second and third dune lines and destroys more sensitive habitats behind the front barrier.

Perhaps the most important marine factor in addition to wind pressure is the constant presence of salt. The combination of wind drying soil and leaf surfaces and salt spray depositing salt upon soil and vegetation makes for an extremely harsh environment. Salt crystals will occasionally collect on vegetation. Dryness and salt accumulation allows for the survival of hardiest of plants.

BIOLOGICAL INTERACTIONS

If there is one outstanding life event occurring in a beach community it is the fierce competition for survival. Plants compete among themselves as they would in an inland locality, but the extreme physical conditions are even more difficult to overcome.

Salt is always present. Wind is constantly blowing salt spray onto everything. Even in winter salt spray can be shipped up from Pensacola Bay and Santa Rosa Sound. How does salt affect vegetation? In high concentration it kills. One can see this in front of the first dune line. When high tides wash over young plants of sea rocket they are killed down to the surface. Where storms have broken through the front dunes salt water kills a number of plant species in the swales.

Salt spray however, is constantly moving inland and collecting on vegetation. Several plant reactions to salt of this type can be observed. "Wind shaped" shrubs and trees in Zone B provide a good example. (See Fig. 2) These plants appear to be growing in a direction away from the ocean front, as if the wind was constantly pushing them in one direction. Well, the wind does not move in only one direction. During winter the wind direction can be toward the beach which is against the observable direction of plant growth. Why do plants maintain the "wind shaped" appearance growing into the north wind? Because wind is only a part of the total influence on growth. Wind transports salt spray from beach to plant in the spring when new stem growth is very tender. Salt becomes more concentrated on new growth closest to the beach. New growth on a plant opposite from the beach is sheltered

to some degree. Stem tips on this side have a better chance to grow and usually do. Stems on the beach side of the plant are damaged, and grow less. This produces a "wind shaped" plant. Salt spray and wind cause this growth response only during the growing periods. Winter conditions cause growth to slow and stop, no bending of stems.

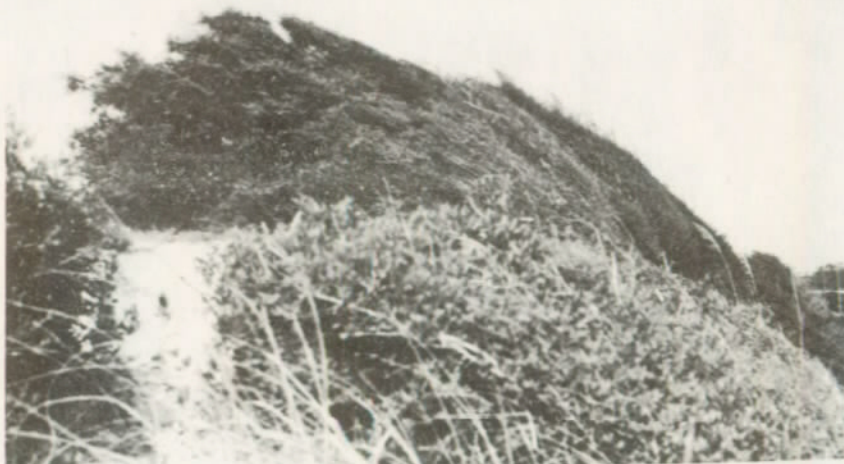


Fig. 2. "Wind shaped" yaupon on dune crest in Zone B.

Vegetation in Zone B receive a great deal of protection from dune lines. The front dune is usually tallest. In addition, most of the shrubs and dwarfed trees grow on the sides of the dunes. When a severe storm occurs tops of shrubs and trees extending too high above dune protection will be killed by the combination of wind caused evaporation and accumulation of salt. This effect extends into Zone C when more severe storms and hurricanes come by.

On a bright windy day one can see the sea oats leaves glistening. Spray is constantly wetting everything. Only a plant that can withstand the salt concentration of sea water and higher could survive. In addition to sea oats seven other plants can survive this condition. Panic grass, cord grass, sand pea and water dollar are just a few. High salt concentrations can reverse the water flow in ordinary plants. Water comes out instead of moving in. This is known as reverse osmosis. Too much fertilizer spilled on lawn grass causes this same event. Any plant that survives in Zones A and B must be able to cope with high salt concentrations.

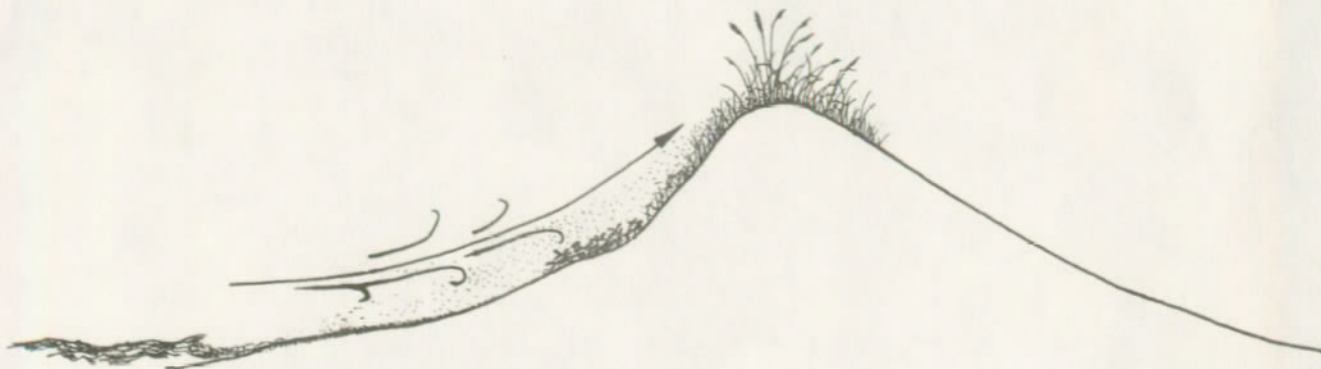


Fig. 3. Dune formation resulting from wind-blown sand accumulating around vegetation.

When wind and sand come together, the landscape changes. Vegetation acts as a stability factor here. What kind of plant can withstand continuous salt spray, drying winds, hot sunshine and moving sand? A very tough one--sea oats. Moving sand come up from the surf. As it dries wind picks up sand grains one by one and moves them toward the first dune. (See Fig. 3) The effect of vegetation upon the movement of sand can be seen in front of the first dune. Sea rocket and a few other plants are found here. Sand seems to pile around these small plants. (See Fig. 4) Piles get taller and wider. The plants grow larger, then the sand piles grow larger. Where there is a uniform supply of sand and a steady wind a long continuous dune is established. With the growth of plants more sand grains are knocked down causing an increase in dune size, which leads to more plants. Sometimes at least a foot of sand will be deposited on top of an existing dune. Here is where a sea oats plant is at its best.



Fig. 4. Vegetation in front of first dune line with sand buildup around it.

Rather than dying or hesitating, sea oats grow straight up through new sand deposits to establish new root and rhizome systems. The criss-cross nature of sea oats underground parts, growing in this way year after year ties the dune into a rather stable piece of earth. A



Fig. 5. Sea Oats covering first dune line.

healthy and somewhat stable beach environment is one with a tall well-vegetated continuous front dune line. (See Fig. 5) It is not the wind alone that forms this vital part of a shoreline community. Sea oats and other plants must be present to prevent sand movement and to enlarge and strengthen the existing dune.

Even dead vegetation acts as a dune builder. Shrubs in Zone B will act as dune builders



Fig. 6. Shrubby yaupon and oak holding and building sand dune in Zone B.

and stabilizers. When some of these plants die their erect stems continue to knock down windblown sand grains making more piles to be stabilized by new plant growth. (See Fig. 6)

Wind and sand continue to move. Dune stability is a direct interaction of the few kinds of plants that can withstand the harsh environment and grow faster than sand can pile on top. Sea oats can do these things in Zones A and B.

Sunlight is as important among the shoreline to green plant survival as it is anywhere. As mentioned above light intensity in white sandy areas is about as great as exists. Plants in Zones A and most of Zone B are usually spaced apart so that little shade exists. Shade requiring plants and growth events requiring shade and cool moisture can rarely occur here. Direct sunlight can also cause high soil and air temperatures when cooling winds can not reach. This is an advantage to sea oats. Their seeds germinate only when temperatures rise above 100°F.

SUCCESSION

One may think that succession of plant habitats, a change in kinds of plants growing in a locality, would not occur along shorelines. Well, succession does occur. It happens in Zone A from dunes with no plants to vegetated ones. An older dune may develop more kinds of plants and as a result become more stable. Some areas along Santa Rosa Island have clear examples of succession activity leading to a modified hardwood plant community. In former years one could locate some of these areas along Ft. Pickens Road. Southern magnolia is a plant that indicates such a habitat. As time passes more kinds of vegetation accumulate in one location: This produces more shade which results in greater soil moisture; which grows more vegetation; which adds organic matter to the soil; which ----. It appears to be a series of developmental changes. Changes which result in more and better plant growth. This is the meaning of plant succession. It actually occurs very slowly over a period of hundreds of years. A sudden shift in environmental conditions can stop succession or even reverse it. Reversals happen often in the shoreline communities.

Another brief example of succession can be found in the swales of Zone B. Here moisture and plant life have accumulated together to produce what amounts to shallow peat bogs. (Fig. 7) Plant and

animal life here reflects environmental conditions found around inland bogs far removed from the sea.



Fig. 7. A wet bog with standing water in Zone B.

As indicated in the beginning of this beach story, vegetation is distributed in a zone pattern. One way of examining vegetational zones is to consider how difficult plant growth is at various distances from the surf. Zone A contains beach and the first two dunes. Only the hardiest plants can survive here. Zone B is an area of severe stress but not quite as severe as A. It is protected to some degree by A. Plants in Zone B are some of the same ones found in A. Other plants in B tend to be grass shrubs and dwarfed trees. Conditions allow for limited and sparse growth. If Zone B plants grow a little too much or too often they will be cut back by wind and salt spray. "Shaping" and "top shearing" of tall plants keep growth below the top of the front dune, at least for most of Zone B. (See Fig. 8 and Fig. 9.) Harshness of the sea influence reduces with dis-

tance away from the surf. In some cases a matter of a few feet makes the difference for the survival of certain plants. Zone C occurs distant enough for vegetation to grow into the normal expected shapes.

What would happen to zone patterns if a new dune was added up front? The expected would be for zone lines to move toward the surf. What could be expected to occur if the large front dune was destroyed and dune number two became the beach front? Again a zone shift but this time shrubs and trees would be severely affected and killed. Zone stability depends upon beach stability which depends upon ocean currents and sand bar stability. It appears that every factor influences every other factor in some way. This is the major lesson to be learned about environmental relationships.

All of the above has been about plants and their physical environment. Perhaps something should be said in favor of animals living within these zones. Plant growth provides food and cover for animal life. Plant eaters live on or near the plants they consume. Animals that eat other animals live near their food source. Shelter and food source determine animal habits and general distribution. In this case animal habitats should be influenced by the plant zone patterns. Since animals do move about they are not always restricted to a small space. For example, many small mammals may use thick vegetation in Zone C for protection and range out into Zone B or even A for food.

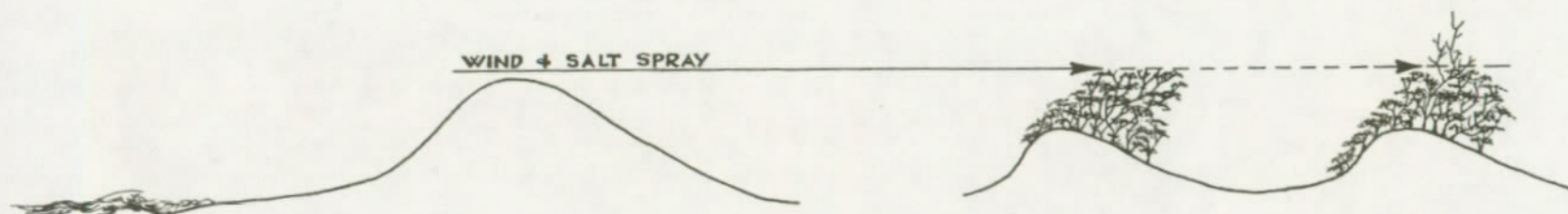


Fig. 8. Wind and salt spray shearing and shaping action during spring growth.



Fig. 9. Slash pine in Zone B showing effects of shrubbing as well as gradual top shearing.

Snakes may find protection at the rear of B, but search out beach mice in other parts of Zone B. In another example of environmental interaction, physical factors and plants establish the plant community which in turn determines which animals can live in a specific location.

Time and change, one complements the other. Is there a way to predict directions of change? Is there a way to predict exact weather conditions? Not at this time. Changes of landscape, ocean currents, plant and animal populations and succession are complex and inter-related. What will Santa Rosa Island be like in 10 or 100 years? There is no way to know, except that it will be different. (*Reference Science News, Vol. 108, No. 15, 237-38.*)

EFFECTS OF MAN

Environmentalists often refer to "natural" conditions as those man has not touched. There are few locations on earth not influenced by man. Man is a product of his environment like other animals and plants. Man has an advanced ability to alter his environment in extensive ways. Some alterations are by accident, others by plan.



Fig. 10. Path made across first dune line resulting in notch.

One unplanned but obvious human influence on a beach front is the path that leads from parking areas, across dunes, to the beach. Most importantly, a path across the front dune starts a long sequence of events--bad events. "Walked on" vegetation is damaged and often dies. Lack of plants to keep sand grains in place, results in sand movement. A path across a dune results in a notch. (Fig. 10) More wind widens and deepens this cut in a dune. Eventually wind will enlarge the gap

and cause much more sand movement behind the first dune. This is called a "blow-out." No great problem one may think, not until the next storm. A few tall waves at high tide during a storm will destroy more dune, vegetation, and almost any man-made structure in its path. A simple path can result in all of this destruction.

Removal or weakening of the front dune for building construction simply paves the way for wind and water damage behind the protective barrier of the first dune. Man can, if he will, restore some degree of stability by repairing the front dune.

Roads, parking lots, paths and building construction tend to disrupt natural formations. He can slow down natural changes but only temporarily.

Another human influence at Santa Rosa Island is garbage. How could this be a factor? Garbage from picnickers adds to the food supply. Several species of animals are supported in part by the almost steady source. Skunks, opossums and raccoons abound on the island.

Where ever man lives there will continue to be changes, usually more rapid changes than he can control.



SEA OATS

ACTIVITIES

PRE-SITE ACTIVITIES

These activities are designed to help prepare the student for the trip to the Gulf NESA. They should be integrated into the normal school curriculum in an effort to minimize the fun day aspects and maximize the relation with everyday activities.

If possible, acquaint your students with the map on page II. Discuss the various safety precautions and practical considerations. (Pages V & VI)

Activities are presented in five generally recognized curriculums: Art, communications, mathematics, science and social studies. When using this approach, be sure to make direct connections back to the overall picture and the interrelated nature of all things.

ART

- Make mosaics and mobiles using objects found around the school yard. A "litter monster" might be a worthwhile project. (Compare with the ones made from natural objects after visiting the NESA.)
- Draw the outdoors at school.

COMMUNICATIONS

- Have students write letters asking for information concerning current local environmental problems, such as development on Santa Rosa Island.
- How have environmental problems affected our language? (New words, phrases, etc.)
- Play pass the rocks game. (Distribute one rock about the size of ping pong balls to each person sitting in a circle. Through touch have each person spend five minutes memorizing his own rock. Collect and mix all the rocks. Everyone closes their eyes and the rocks are passed out one at a time. When a person recognizes his own rock he slips it into his pocket without letting anyone know. After all rocks have been found, check to see if everyone was correct. Settle disputes. Discuss how each know which rock was his.)

MATHEMATICS

- Compute the percentage of paved or surfaced land in your town including buildings. (See yellow pages under photographers, aerial.)
- Compute the population densities for Pensacola, surrounding suburbs and country and compare to state totals for Florida. What factors limit population growth?

- Find out what percentages of foreign materials indicate that air and water are polluted.

SCIENCE

- Study the sewage treatment plants in your town.
- Study how water is made clean in your town.
- Look at the geology of this section of Florida to find reasons for river, creek, bay and island locations.
- Play the protective coloration game. (Take about 250 toothpicks and color 50 each of the following colors: Red, green, blue, yellow, and brown. Scatter the toothpicks in a grassy area approximately 4 ft. x 10 ft. Have each student collect as many of the toothpicks as possible in three to five minutes. Picking out must be done by sight alone--no fair feeling for them. Relate the findings to the protective coloration of animals (rabbits, snakes, butterflies, etc.) and plants (seeds and nuts "hiding" among leaves and branches).

SOCIAL STUDIES

- Investigate why men settled in this area of Florida.
- Study the history of Santa Rosa Island.
- Investigate why man likes Barrier Islands (i.e., Santa Rosa, Miami Beach, Atlantic City, etc.).
- Show an available film on environmental matters. (See the attached resource list.)

These are only suggested activities designed to encourage awareness of the relationships between the natural and man-altered environments.

ON-SITE ACTIVITIES

These activities will give you an idea of some of the kinds of activities that can be done at the NESA. These activities are designed to give more specific direction to those teachers who might not feel quite "at home" in the outdoor classroom. We encourage you to use your own techniques, if you desire.

It would be very difficult for a class to do all of the activities listed here, and it is suggested that only those that fit in with what you are presently teaching in the classroom be used. As in the pre-site activities, the activities are presented in the five generally recognized curriculums with the subject in parenthesis following each title (i.e., Plastercasting of Animal Tracks - Art and Science).

ACTIVITY #1: Plastercasting of Animal Tracks (Art, Science)

Number of Participants: 15-20. Half of the class might be doing another activity, then switch.

Time Required: 15-20 minutes.

Materials: (per group of 20)

5-6 large tin cans or plastic buckets
Construction paper, plastic milk containers, etc., cut
into strips 1 1/2" wide to make collars
Paper cups (1 for each student)
5-10 pounds of plaster of paris or building plaster
(available from park)
5-6 wooden sticks for stirring
Paper clips

Procedure:

1. Select track and position a strip of construction paper around it making sure the collar is tight to the ground so plaster will not seep out.
2. Pour plaster into (#10 size can hold enough plaster for about 10 tracks) mixing can, then add water and stir until it reaches the consistency of pancake batter. Be careful you do not add too much water since you will have a limited amount of plaster in the field with you (the ratio is approximately 2 parts plaster to 1 part water).
3. Quickly pour into tracks (the plaster will begin to set within a few minutes).
4. Before the plaster is completely hard, shape a paper clip to serve as a hanging hook and secure into back of plaster cast.
5. Let the plaster harden until just prior to the class leaving, then remove slowly and clear off collar, disposing of paper in empty can.
6. Gently clean the cast with a paper clip or an old brush (an old toothbrush works great).
7. Mounting the cast to a backing board makes an attractive decoration.

TIPS: Talcum powder sprinkled on the tracks will keep the cast from retaining sand. Salt may be added to the mixture to speed setting time; vinegar to slow down hardening.

Follow-up:

1. Be a detective about your track: How long is it? How many toes on a fore foot or hind foot? Is the track fresh or old? What direction was the animal heading? Who made this track? Why was he out here on the beach?
2. Write a short story about the animal that made your track telling why he was on the beach, what kind of food he was looking for, etc.

ACTIVITY # 2: Food Web Game (Science & General Awareness)

Purpose: To reveal to the class that all plants and animals are inter-dependent and interrelated.

Number of Participants: Seventeen. Select 17 volunteers from the class to be the "plants" and "animals" and let the rest help answer questions.

Time Required: 20 minutes. This could be done prior to your visit to introduce students to some of the animals.

Materials: 17 3x5 cards or pieces of paper
17 straight pins
felt tipped pen with dark colored ink
spool of string

Procedure: Print the names of the following with the felt tipped pen in large letters on the blank cards or pieces of paper (one name per card):

PLANKTON	WHITING
MOLE CRAB	COBIA
SPECKLED CRAB	SEA OATS
COQUINA CLAMS	FLOUNDER
AUGER SNAIL	SEA GULLS
SANDPIPER (Sanderling)	INSECT
STARFISH	OWL
GHOST CRAB	RACCOON
	MAN

Ask each of the volunteers to select a card with a name on it and pin it to his/her shirt or blouse. Cut about 10 feet of string off the spool for each student.

Next have the students form a circle and connect their string to any other plant or animal or human on which they are dependent or to whom they are related. For example: Coquina Clam and Plankton would hold opposite ends of the same string as the Coquina Clam needs the Plankton for food.

NOTE: Let the students figure out the combinations. Refer to the food web on page B-6 of the text to see some possible combinations.

When the students get as many combinations connected as they can think of, let them start disconnecting the strings beginning with the smallest plants and animals first and gradually coming up to the larger ones. For example: PLANKTON MOLE CRAB SPECKLED CRAB COQUINA CLAM FLOUNDER COBIA MAN

This food web game should convince the students that plants, animals and humans are intimately interrelated and that if something happens to one link in the chain the others are affected.

WHAT WOULD HAPPEN IF WE ADDED POLLUTED WATER OR EXTREMELY HIGH TIDES OR HURRICANES TO THIS FOOD WEB?

ACTIVITY # 3: Sand Animal Search (Science)

Purpose: To locate and identify some animal species found buried in the sand.

Number of Participants: Four or five in a group.

Time Required: Varies.

Materials: Screen box
Shovel
One or two pails

Procedure: Dig a shovel full of sand near the water, place it in the screen box, pour sea water on the sand and see what is left in the box.

Be sure to return everything after it has been examined so that it will not be harmed.

NOTE: Two of the more common things you should find will include Coquina Clams and Mole Crabs.

ACTIVITY #4: Shells--Where have all of the animals gone? (Science and for later--art projects)

Purpose: To acquaint students with general types of shells and to stimulate interest in the origin adaptations and fate of shells.

Number of Participants: Varies.

Time Required: 20 to 30 minutes or more.

Procedure: Students search and collect empty shells, discuss special adaptations of each kind, look for signs of how it might have died.

Try to determine how these shells are different from those in the bay.

Look for the holes in the shells. These were naturally caused by such animals as the Moon Snail (makes beveled round holes), the Oyster Drill (makes small, straight round holes), and the different sponges (make a multitude of holes on shells). Why did they drill holes into other animal's shells?

ACTIVITY #5: Collecting Plankton (Science)

Purpose: To learn to collect and examine plankton.

Number of Participants: Small groups.

Time Required: Varies.

Materials: Plankton net with long handle
Microscopes
Medicine dropper
Microscope slides

Procedure: Using the plankton net and handle, make one or two "runs" along the beach as demonstrated by your instructor. (An alternative is to pour about 30 buckets of Gulf water through the plankton net.)

Withdraw a small sample of what is collected, place on the microscope slide and try to determine what you have.

Avoid letting the net touch the sand.

ACTIVITY #6: Birding at a sandy beach (Science)

Purpose: To learn about the behavior of some shorebirds.

Number of Participants: May vary from a few to an entire class.

Time Required: Varies

Materials: Binoculars
Field guides
Notebook
Pencil
Audubon bird checklists (optional)

Procedure: Each student learns to focus a pair of binoculars and how to use a field guide. Look for field markings on birds seen. Try to identify. Discuss with each other. Note what the birds are doing. Remember--some birds of the same species look quite different depending on whether they are male, female, or immature.

ACTIVITY #7: Sand grain study (Science, Mathematics)

Purpose: To determine the different sizes of sand grains on various sections of the beach.

Number of Participants: 5 or 6.

Time Required: About 15 minutes.

Materials: Sand separator
Shovel

Procedure: Using the sand separators provided by the park or Environmental Studies Center, stop as close as possible to the waters edge and fill separator with sand (it is best to use dry sand). Shake the separator and the smaller grains will fall to the bottom. Determine the smallest sand grain on this section of the beach. Move to the middle of the beach and repeat. Now move close to the dunes and repeat once more. Check grains at the top of the dune, then behind the dune. ARE THE SAND GRAINS A DIFFERENT SIZE ON DIFFERENT SECTIONS OF THE BEACH? Why do you think this is so? Make a simple sketch showing where the different sand grains were found.

ACTIVITY #8: Count the plants (Science, Mathematics)

Purpose: To understand plant succession starting at the waters edge and moving inland. Why do certain plants grow where they do?

Number of Participants: Small groups. The class can be divided into small groups of 5 or 6 each.

Time Required: 15 to 20 minutes.

Materials: Paper and pencil for teacher to keep the number of plants each group reports, if desired.

Procedure: Starting from the beach, have each group count the different "types" of plants not the number of plants. Have each group elect a leader to report back to the teacher. At the end of the activity compare the groups' results.

Close to the waters edge there should be only a few kinds of plants. Move inland, behind the Primary Dune, and repeat (there may be 10-15 plant types). Move to the pine tree area last and repeat the count once again (there may be 20-25 plant types). As you move away from the beach, the plants will become more numerous and many more different types will be found. (One reason for this is that salt spray greatly affects the plants close to the beach, while those "protected" from the salt spray and harsh wind behind the dunes survive much better. Other types of less salt tolerant plants appear behind the dunes, providing more variety and build up of the soil.)

As you move from the beach to the pine tree area, you should be looking for the formation of soil, particularly where the Deer Moss lichen grows, in the marshy areas and under the pine trees.

ACTIVITY #9: The Beach--a River of Sand OR Looking at longshore drift (Science)

Purpose: To view and understand how water currents shape Santa Rosa Island.

Number of Participants: No limit.

Time Required: 20 minutes.

Materials: Floats or marker dye.

Procedure: Place floats or marker dye offshore (approximately 10-30 feet) in the surf zone. The marker will most likely move in a westward direction. The waves carry sand particles with them and move the sand in the same direction. Determine in which direction the island should be moving based on the above activity. Would it be the same every day?

Reference Material: Movie: "The Beach, A River of Sand" (20 min.)

ACTIVITY #10: A BEACH ANALYSIS (Art, Science)

Purpose: To recognize the main features of beaches and waves.

Number of Participants: No larger than 15 per group.

Time Required: 15 minutes.

Materials: Pencil and paper to sketch main characteristics.

Procedure:

BEACHES: Sketch an overview of the beach to include the following if observed:

Primary Dune Line (first dune away from the Gulf).
Vegetation Line (line where the plants stop growing).
High Tide Mark (usually a thin line of broken shells,
bits of driftwood or other washed up material).
Berms (see the next page).
Bars (such as the offshore bar).

Is the beach gentle, steep, rolling, or have sharp
scarps?

How wide is the beach in this particular location?
(Estimated.)

Look for other minor beach characteristics such as cusps,
swash marks, backwash patterns and ripple marks.
(See next page.)

WAVES: Carefully observe what the waves are doing.

Are they spilling (small waves that produce lots of white
water but no "tubes"), or are they plunging (large
waves that form the "tubes" of water) waves?

Estimate the wave height. Do this by looking at the ho-
rizon right at the water level.

Some Follow-up Questions:

1. Does the general appearance of a beach change with the seasons?
2. Based on today's wind and wave pattern, which way is the sand being moved?
3. What would a rocky beach be like in comparison to our Gulf beach?
4. How could this wave energy source be tapped?

MAJOR BEACH CHARACTERISTICS TO RECOGNIZE:

Shingle Beach: the slope is steep, similar in slope to the slope of a pile of sand poured from above. A step is usually found at the low tide line.



The steepness of the slope is related to particle size, depth of adjacent water and length of wave. (King 1959)

Larger particles imply a steeper beach. Deeper adjacent water implies a steeper beach. Shorter waves imply a steeper beach.



Sand Beach: tidal with smooth profile.

tidal with ridged profile.

tideless with smooth profile.

tideless with barred profile.
straight bar
crescent bar

SMALLER BEACH CHARACTERISTICS:



Berm: A flat, above-water feature caused by water action.

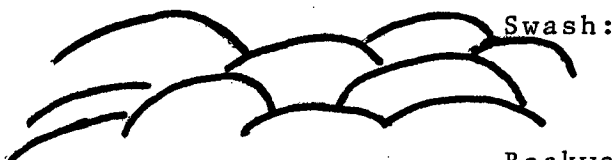
Bar: An underwater ridge of sand usually parallel to the shoreline.

Wave Frequency: The number of waves per minute.

Wave Velocity: Speed of wave.

Wave Length: Distance between crests.

Cusp: A series of evenly spaced crescent shaped depressions below the berm.



Swash: The last rushing water from a wave is a thin sheet. The successive swash marks appear as overlapping crescents.



Backwash Pattern: When retreating water passed over minute projections downward, delta (Δ) shaped marks are left.

Sand domes: As water percolates through sand, entrapped air escapes, causing dome shaped bulges. The domes usually have pinholes in them.

Ripple Marks: Parallel ridges and troughs.

LTL = Low Tide Line
HTL = High Tide Line

ACTIVITY #11: Dune Sketching--Effects of Salt Spray Pruning (Art, Science)

Purpose: To understand, by drawing, how salt spray shapes plant life.

Number of Participants: No limit.

Time Required: 20 to 30 minutes.

Materials: Paper, pencils, and a hard surface such as a clipboard.

Procedure: The effects of salt spray can be seen on many parts of the island. There is a good example at Battery Langdon and a fair example as you enter Loop A of the campground. Battery 234 is the closest example to the Beach Environmental Study Area. Sketch the larger plants such as the pine and oak trees showing how salt spray "prunes" or shapes them.

ACTIVITY #12: Island Weather Factors (Science, Math, Communications)

Purpose: To be able to understand how "weather" is measured, how to predict the weather, and how it effects all of us.

Number of Participants: An entire class divided into five groups--the first four groups using a different instrument, with the fifth group of students recording the "present" weather conditions.

Time Required: 30 to 45 minutes.

Procedure: Determine how the group is to be divided. Each group should be given one instrument: (1) an aneroid barometer, (2) sling psychrometer, (3) thermometers, (4) wind speed and direction indicators, (5) data recording sheets and reference materials if needed. (You might build your own simple weather instruments in the classroom.)

From the data collected, do one or all of the following:

- (1) Compare data you collected with weather conditions reported at an official weather station nearby.
- (2) Try to predict the weather for the following day or week using data you have collected.
- (3) Determine how the weather affects the activity of animals, insects and people.

ACTIVITY #13: An Islander's Poem (Communications)

Purpose: To learn to use poetic form as a means of relating to environments by capturing reactions in the rhythms and patterns of Haiku and Cinquain.

Number of Participants: 15 students.

Time Required: 20 - 30 minutes.

Materials: Paper and writing instruments.

Procedure: Preparation: Poetry for some may have connotations which are not entirely positive. Discuss with the group some purposes of poetry, feelings individuals in the group have about it, reasons they might see valuable for writing poems.

Action: Take the group to a place they find comfortable but that also will have a variety of stimuli. Spread the group out so that each person can have some privacy. Two types of poetic forms are presented below. Either or both can be used.



A. Haiku Poetry--is a Japanese art form whose application in the outdoors is particularly effective and appropriate. Haiku is based on a prescribed number of syllables per line and not necessarily on rhyme. The poet tries to express in words his quick reactions to his observations. The poems are intended to appeal to the senses and use a minimum of words to convey a thought or mood.

The format is: Line One: Five Syllables
Line Two: Seven Syllables
Line Three: Five Syllables

Here are two examples:

- a) Listen! What stillness!
Cicadas buzzing in the sun,
Drilling into rock.
- b) Great waves come breaking!
Forming patterns of white foam,
Pounding into sand.

1. Take the group to a particularly interesting and/or beautiful spot. If they have a favorite spot, let them pick it. Try to stay away from the sight and sound of others.
2. Read a few Haiku poems to them without telling them what they are. See if the students recognize the poetic form.

3. Discuss poetry in general. Try to surface and discuss some of the negative stereotypes about poetry and people who write and enjoy it.
4. Introduce Haiku and explain the format. Read one or two more.
5. Let them try to write some.
6. Ask for volunteers to share their poems.

B. Cinquain Poetry (pronounced "sing cane")--is similar to Haiku in that it has a fixed number of lines and syllables per line. The term Cinquain is derived from the Spanish and French words for five. A slightly simplified version will be presented here for initial use. The true rules for Cinquain will also be presented following the simplified version.

1. Look around you. Write down the name of one thing (noun) you see that catches your interest.
2. Looking at your noun, write two words (adjectives) to describe it. Separate them with a comma.
3. Now jot down three words to tell what your noun does (verbs).
4. Write a short phrase about your noun.

5. Repeat the noun you are looking at or another word related to the noun (synonym).

Here are two examples:

- a) Trees
Tall, green
Shading the forest floor
Standing firm against the strong wind
Trees
- b) Beaches
White, clean
Places to play
Standing firm against the mighty sea
Beaches

True Cinquain requires that there be two syllables in line one, four in line two, six in line three, eight in line four and two in line five.

Follow-up: Ask for volunteers who would like to share any of their work. Don't press too hard for a response. Try writing a group poem. The Cinquain form is particularly adapted to such a procedure. Discussion of the activity should follow.

Discussion: Explain the feelings the group now has toward poetry. Have there been any changes in attitudes? What are similarities between Haiku and Cinquain (if both forms were used)? Who are some poets the members know about? What qualities might make a good poet?

ACTIVITY #14: Man's Impact on Santa Rosa Island (Communication, Social Science, Science)

Purpose: To understand how much and what types of impact people have had on the eco-system of an island.

Number of Participants: 4 groups of 6 to 8 participants each.

Time Required: Approximately 30 to 45 minutes.

Procedure: Break the class down into the following groups: (1) Indians (Send to a natural part of the Island) Pre-1500 AD. (2) Early Europeans--British and Spanish (Send to a high dune area to observe Pensacola Bay and Pass) 1500-1800 time period. (3) United States Army 1800-1945 (Send to Battery Cooper area). (4) Modern U. S. Public (Send to Battery Worth-Picnic Area complex).

After each group has assembled at the proper location, the following chart should be completed, showing man's impact on the island during that particular time period. Each group should think about such factors as food, shelter, water supplies, transportation, clothing and the effects of hurricanes during that special time period. What has been the effect on the plants and animals? After regrouping and comparing notes, what will be the impact in the future?

How did we come to the island?

Why did we come to the island?

What do we do everyday?

What is our impact or what have we done to the island or left on the island?

Food source? How is it stored? How is it prepared?

Shelter: What? How built? Materials?

Water supply source?

Transportation: What?

Clothing: What?

Hurricanes: What effects?

SEE MAN'S IMPACT REFERENCE ON PAGE D-17.

POST-SITE OR FOLLOW-UP ACTIVITIES:

The purpose of having activities after the visit to the NESAs is to follow-up the ideas presented, evaluate what students gained from the experience and to get your students personally involved with environmental issues.

ART

- Make a collage out of the natural objects (shells, etc.) that the group collected. Which is more pleasing, the Litter Monster or the natural collage?
- Does today's art depict what America is like today? Contrast it with the older forms of art.
- Build a class shell collection.

COMMUNICATIONS

- Write to Congressmen, Senators and local officials about your concern over current environmental problems. Ask what he is doing to personally help.
- Write a theme about the beach. Have your views changed since you visited the NESAs?
- What are the most pressing environmental problems in your town? Find out what you can do to help.
- Write a short essay on each animal you saw at the beach.
- See what you can do to help restore the bay beaches near Pensacola.
- Obtain recordings of sea and shore life to play in class.

MATHEMATICS

- Estimate the number of sand grains in (1) a pinch, (2) a teaspoonful, (3) a small dune.
- Find out the volume of a tin can and then multiply it by the number of tin cans used in one day. Now, how much space is taken up by the same tin cans if they are squashed flat?
- On a trip to the beach, make an analysis of the litter found there. How does it affect the life there? How does it affect you?
- How many liters of water is in a wave?

SCIENCE

- Plan a visit to your town's water or sewer treatment plant.

(Post-site Activities Cont.)

- View additional films on pollution and other environmental problems.
- Start or help with a recycling project at your school.
- Make a weather station at your school.
- Construct a food web with drawings and string.
- See "Beach & Sea Animals" film.
- Study how natural selection occurs (remember the beach mouse) and apply to other organisms where one trait helps the organism survive.
- Start a school museum. Include dioramas of beach communities. Use photos, paintings, pictures, or models of animal life.
- Answer this question: What would happen if the ocean were so polluted that photosynthesis could not occur?
- Discuss what you and your friends could do to help shore birds found covered with oil as a result of an oil spill in the Gulf.
- Try to find out about food webs in other communities such as:
 - a. The hardwood hammock
 - b. The sandhill community
 - c. A Florida bog community
 - d. A pine flatwoods community
 - e. A fresh water pond community

MAKE FOOD WEB GAMES OF THESE.

- Study the effect of tides on the life on the beach.
- Try to find out how waves could be used to generate electricity.

SOCIAL SCIENCE

- What can be learned from the NESA experience about man's needs, wants and ways of doing things?
- After explaining to the class that each object, as well as each person, has a history all its own that is dependent upon interaction with environmental factors, use some simple illustration--such as a pencil--to demonstrate how an object is the product of its environment. Have each student choose an item to write the history of, such as a shoe, a sweater, a piece of paper, a glass, etc.

(Post-site Activities Cont.)

--Answer this question. How is man harming the animal life and plant life on Santa Rosa Island and in the adjacent waters?

--Study the economic importance of sea life.

--In all parts of the world, cities and industry dump millions of tons of waste materials in the oceans. How does this affect beach and sea life? Your life?

(USE THIS SPACE FOR NOTES)

MAN'S IMPACT ON SANTA ROSA ISLAND

PRE 1500 A.D.

WHO: Northwest Florida Indians (Swift Creek, Weeden Island Period).
WHY: Food (fish, shellfish and salt) and natural curiosity.
IMPACT: Very little--left a few shell mounds, camp sites, etc.

1500-1800

WHO: Europeans (British, Spanish and French).
WHY: Colonization, exploration, protection of Pensacola Harbor.
IMPACT: Some small wooden and earthen fortifications constructed. Third site of Pensacola established and wiped out by hurricane.

1800-1945

WHO: United States (mostly U.S. military).
WHY: Protection of Pensacola Harbor; coastal defense.
IMPACT: Fort Pickens constructed (1829-1834), Civil War Battle of Santa Rosa Island and bombardments, multitude of coastal artillery defense installed for Spanish American War, World War I and World War II. This included docks, railroad lines, buildings, gun batteries and some roads. (Descriptions of those gun batteries within the Gulf Beach NESA are on the following page.) Most developments located bay side.

1945-PRESENT

WHO: United States public.
WHY: Recreation, businesses and residences.
IMPACT: Bridges to the island and roads along the island constructed. After 1950 tourist interest developed. By 1970, dramatic increase in buildings, particularly motels, hotels, condominiums and private residences along the primary dune line. 1975 - Coastal Setback Line in effect to limit development on Gulf side.

Impacts by man include: Automobiles, roads, unnatural vegetation, litter, loss of natural water table, increased water pollution, sewerage disposal problems, insecticides, dogs, dredging of canals and the Pensacola Pass for larger ships and the dramatic increase of the number of people. Most developments on Gulf side.

PRESENT - FUTURE

WHO: Us
WHY: Recreation??
IMPACTS: ??????????

INFORMATION CONCERNING THE VARIOUS BATTERIES LOCATED WITHIN THE
GULF BEACH NESA:

The purpose of the many concrete batteries and gun emplacements on Santa Rosa Island was to prevent any hostile vessels from entering Pensacola Bay, thus protecting Pensacola and the Naval Base from enemy attack.

- (1) Battery Worth, built during the Spanish-American War, was named after General William J. Worth who had served actively in the War of 1812, the Florida Indian Wars and in the Mexican War. Battery Worth originally mounted eight 12-inch mortars. Later, the number of mortars was decreased to four, two on each side. Just prior to or during World War II this battery was extensively modified. Several of the concrete rooms became very luxurious, sporting acoustic ceilings, tile floors, whitewash and shoe mold. Several rooms with ceramic tile walls were also added. The entire tower complex is also a later addition.
- (2) Battery Cooper, built during the Spanish-American War, was named after Lt. George A. Cooper who was killed in action on Sept. 17, 1900 at Manila in the Philippine Islands. Battery Cooper originally mounted two 6-inch disappearing rifles. In 1938 these guns were removed and replaced by four French 155 mm guns mounted on Panama Mounts in front of the battery facing the Gulf. Two rooms inside the battery were converted to living quarters by lining them in wood, adding fireplaces and supplying electricity to both rooms. The battery underwent other extensive modifications prior to and during World War II.
- (3) Battery 234 was built during World War II. It has many times been referred to as Battery Brown but was officially called Construction 234. The battery mounted two 6-inch en-barbette shield guns which fired a 105 lb. projectile with a maximum range of 15 miles. The magazine complex between and slightly to the rear of the guns contained a tool room and scavenger room for each gun and other rooms for storage and engines. The massive concrete tower next to Battery 234 was used for observation and fire control. There were several other towers similar to this one on the base. One of these was behind Battery Langdon and another was on top of Battery Worth.

While visiting the batteries, please observe the following safety tips:

- obey all signs which designate safety hazards or closed areas.
- use caution when on top of any of the batteries.
- carry flashlights for use in unlit areas.
- protect your feet. Wear shoes.

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OCTOBER 1976

