BOLIVAR HABITAT PRESERVE
FIELD AND CURRICULUM GUIDE
FOR EDUCATORS

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Travis Mader (1970 – 2005): a Dedication

by John Sullivan & Pam Diamond

During his tenure as a manager and educator at the University of Texas Medical Branch at Galveston, Travis Mader played an exceptionally important role in enhancing the overall environmental health literacy of our Island and our region.

Behind the scenes, he coauthored – with Community Outreach & Engagement Director, Pam Diamond - the overarching NIEHS grant proposal that provided all the funding and all other federal support for the P30 Center in Environmental Toxicology at the UTMB. He was also the principal author for the section of that same grant proposal that pertained directly to the Community Outreach & Engagement arm of the NIEHS Toxicology Center. This work included community outreach of many types from different platforms to provide clear answers to community concerns regarding environmental exposures and health impacts, and in developing and marketing multigenerational formats for environmental education.

I connected with Travis most often within this educational context. Using his background as a playwright and former staff member at Houston's Alley Theatre, he helped me personally with launching a regional outreach we called Community Environmental Forum Theatre. He served as an administrative liaison for Camp Rad, the center's annual summer program focused on asthma management. Most significantly, he was a motive force in the Center's **YES** (*Youth Environmental Studies*) project: initially as project manager, and later as **YES** Co-Director with Pam Diamond. This extensive language arts-science-math summer school at Galveston ISD's Central Middle School was a daunting Rubik's Cube of conceptual and management challenges but Travis rose to the occasion with ideas for curriculum, organizational skills, and true quality leadership.

During his YES years, he collaborated with Pam Diamond and YES educational staff in designing a format to frame the relationship of students to their environment as a series of ecosystems based on concentric circles of connection and engagement: starting at home, moving into the neighborhood and environs, the City of Galveston, our Island, situated in the southeast Texas region, the state and, ultimately, the entire planet. This model based on the linkage of local knowledge with scientific expertise led to his active interest in the Artist Boat proposal for a locally grounded, site-specific habitat study and restoration curriculum for Crenshaw Environmental Science Magnet School (Bolivar & Crystal Beach TX). His strong advocacy for this project resulted in seed funding to kick-start the visioning-process that resulted in the Bolivar Habitat Preserve Field & Curriculum Guide for Educators. It is altogether fitting that his name and environmental legacy should be associated with the development of this living curriculum.

Writing this dedication was not an easy task for me, personally. It still fills me up with sadness and a sense of regret when I remember that such a remarkable human being as Travis is no longer with us as an actual, intelligent, multi-faceted, hilariously funny, embodied presence. I'm sad, as are so many whose lives he touched, for the loss; and I regret the fact that we can no longer share moments, stories, and the excitement of future projects. I'm sure the many impacts of climate change and lack of regional diligence in protecting previous environmental protection / restoration victories all over coastal Texas would weigh heavy on his mind and inform his actions as we approach an alarmingly uncertain future for our environment, and all of civilization. That Crenshaw Environmental Magnet School, Galveston ISD and Artist Boat sought to recognize Travis Mader as a major influence on the Bolivar Habitat Preserve Field & Curriculum Guide for Educators gives his memory and his foundational work a sense of persistence over time. His former coworkers and collaborators at UTMB's P30 Center in Environmental Toxicology and the Sealy Center for Environmental Health and Medicine thank you for honoring our much loved and esteemed colleague.

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Preface

The real voyage of discovery consists not in seeking new lands, but in seeing with new eyes.
- Marcel Proust

The purpose and goal of **THE BOLIVAR HABITAT PRESERVE FIELD AND CURRICULUM GUIDE FOR EDUCATORS** is twofold:
First, this guide will be used to inspire enthusiastic teaching and learning by "taking it outside" through the arts and sciences. Unique to Crenshaw Elementary and Middle School is the Bolivar Habitat Preserve as an adjoining extension to the school's science wing. The Bolivar Habitat Preserve is 22 acres of a typical barrier island and Texas coastal margin ecosystem defined as a dune swale complex. This ecosystem can be seen the entire length of the Texas coast. What a better and more convenient way than to extend ideas and concepts from the classroom into our coast's native landscape by taking these ideas and concepts directly outside for realistic and actual interpretation?

This guide will provide an integrative approach for the many diverse teaching and learning styles in order to creatively and effectively pursue field investigation and interpretation of the Bolivar Habitat Preserve. In order that "no learner be left behind," this arts-based environmental education curriculum will serve the needs of our auditory, visual, tactile and intuitive learners through its diverse activities and interpretations of the habitat preserve.

An effective interpretation of the habitat preserve is essential to this guide. To simply "teach" factual information about the preserve's flora and fauna is not the goal here. Rather, the plan of this guide is to enliven learning and teaching strategies through the use of the actual and immediate environments by firsthand experiences and interactions with arts-based activities. This interpretation of the Bolivar Habitat Preserve is not merely instructional, but provocative as well. The curriculum presented stands to inspire creativity as it refines the students' artistic skills. It will encourage a respect and awe for the natural world, and it will evoke a myriad of new questions by the students about their individual interpretations of the preserve's habitats.

The structure of the field and curriculum guide is designed to assist in the interpretation of the dune swale complex ecosystem on the Bolivar Peninsula. The Bolivar Habitat Preserve dune swale complex ecosystem contains or borders five habitats that are easily explored. These five habitats are:

- the coastal prairie environment,
- fresh water wetlands,
- oak motte,
- dune and beach environment, and
- saltwater wetlands

In addition to defining this dune swale complex ecosystem, each habitat will be described graphically in terms of its seasonal changes. This format will support teachers' lesson plans in that all exercises can be used throughout the course of the school year as desired or by

following the format throughout the seasons. This seasonal approach will provide a framework for learners and teachers to see the entire landscape as a place of transitions taking place over time and at the edges where habitats border each other. The campus of teachers will be able to develop the capacity of each student as an artist, scientist, and conservationist. The students will become interpreters of Bolivar habitats and our state's coastal treasure chest of resources and culture.

This environmental and arts education curriculum guide is further broken down into three distinctive developmental stages of learning: kindergarten through second grades, third through fifth grades, and sixth through eighth grades.

It is expected that this field and curriculum guide will be "taken outside" at least twice per season for each grade level. Among our younger learners, the goal is to excite and inspire them into exploring and explaining their immediate environments. The third through fifth graders will begin using sound scientific methodology and investigative procedures while enhancing their skills in the arts. Our middle school students will master scientific and environmental facts as they perfect their classificatory skills and become more active in environmental issues.

Instructor's Thoughts and Notes:

What Is Interpretation?
How the role of the "teacher" changes

An educational activity, which aims to reveal meanings and relationships through the use of original objects, by firsthand experience, and by illustrative media, rather than simply to communicate factual information.
Freeman Tilden

A communication process that forges emotional and intellectual connections between the interests of the audience and the meanings inherent in the resource.
National Association for Interpretation

Environmental education in the outdoors changes the role of the teacher. The teacher becomes an interpreter. An interpreter is the voice and illuminator of nature and its changing processes throughout the day, seasons, and year. The natural resource, the audience, and the interpreter engage and become a dynamic equation. The interpreter is a key component of this equation containing knowledge of the audience and knowledge of the natural resource.

There are five guiding principles an interpreter must integrate into their style of interpretation to engage their audience and illuminate the natural resource.

1. The interpreter must engage the personality and experiences of the their students in order for the students to form a relationship with the concepts being delivered.
2. Interpretation involves the transmission of information to the audience. However, interpretation is also revelation. This revelation is based upon concepts that contain information.
3. Interpretation itself is an art. The disciplines teachable through the art of interpretation are many and multidisciplinary.
4. A teacher's aim may be instruction, yet interpretation results in provocation.
5. Interpretation is about presenting whole systems, concepts, or ideas. The parts of the whole will reveal themselves as the interpreter, student, and the environment interact with each other.

The interpreter's role is central to the goal of tying the audience to the natural environment. True interpretation is the ability to transfer ideas and relationships onto others rather than transferring facts and figures. The interpreter facilitates the ability of the students to answer the question "so what?" by presenting a whole message from which the parts reveal themselves as students begin to inquire, observe, and develop a sense of place. The interpreter is willing to use hands-on methods, multidisciplinary lessons, and the environment to facilitate revelation. The facts should be used to support the message, not be the message.

As teachers step out of the classroom and into the environment, they should be prepared to become facilitators of the acquisition of knowledge through an experience with nature. It is a powerful way to increase environmental literacy. The interpreter teaches less and shares more. This allows the students to experience more and learn in a memorable way.

If you love it enough, anything will talk with you.
George Washington Carver

A joy shared is a joy doubled.
Goethe

Instructor's Notes and Thoughts:

What is Environmental and Arts Literacy?

To engage your eye in the act of observation and tie that act to your hand is to create an image revealing not only a place but also your moment in that place. It is powerful to share these moments and places with others who could not be there with you.
Karla Klay

Environmental education involves a multidisciplinary approach that utilizes interpretive skills. The Environmental Literacy Council defines environmental literacy as a fundamental understanding of the systems of the world, both living and non-living, along with the analytical skills needed to weigh scientific evidence and policy choices. The living outdoor classroom used through methods of environmental interpretation is the cornerstone of developing an environmentally literate campus and student body. The more connections the faculty and students make with this dune swale ecosystem, the more questions they will have about the impacts of humans on the environment, natural processes in the environment, and actions they can take to preserve the environment.

Developing arts literacy on the campus provides an outlet for communication about the environment to students' families, neighbors, and communities. Arts literacy and environmental literacy are developed through experience. The natural world reveals many combinations and permutations of its elements, just as art does. The natural environment is the perfect place to spur ideas, especially over the seasons. As students continue to explore the arts outdoors, they see natural complexities revealed, and their work becomes more complex, as does their understanding of the environment.

Arts literacy is an essential tool for children to have. It allows children to start the learning process at the highest cognitive level of thinking. Children (artists) decide how to create artworks; they start at the level of evaluation. From this cognitive level of thinking, all other levels of thinking and learning follow (knowledge, comprehension, application, analysis, and synthesis) and become important to the learner. Creating art allows children to decide which level of thinking process they need and when they need to use which level of thinking.

We are immersed visually in a world of form, color, texture, light, composition, pattern, and beauty as soon as we are born and open our eyes. To understand our world visually, to translate this into media others can see, to develop a sense of our visually changing world over the course of a day, a season, a year, or a lifetime is to engage ourselves fully in the transformation of life on earth. Arts and environmental literacy leads students on a quest for knowledge, comprehension, application, analysis, and synthesis. This is vital to the teacher's goal of providing students with the skills to evaluate questions and answers, to develop their own questions and answers and to evaluate their results. What a better way and place to start the learning process than armed with the tools and the eyes of an artist or scientist, especially when accompanied by an interpretive guide ready to facilitate the process.

An Introduction to Bolivar Peninsula's Human and Natural History

Imagine that 14,000 years ago the climate was colder and wetter in the area that was to become the Galveston Bay ecosystem. Paleo-Indians hunted large bison, woolly mammoths, mastodons, and other ancient animals that grazed the coastal prairie grasslands. These early inhabitants also collected seasonal fruits, berries, and nuts as they traveled in family groups, or bands, following the herds of wild game. There is further archeological evidence that prehistoric camels, horses, armadillos, tigers, sloths, wolves, bears, rabbits, turtles, and manatees inhabited what would become the Galveston Bay area.

The coastal shores along the Texas coast are always changing. It is believed the shoreline was more than seventy miles out into the Gulf along the Continental Shelf between 14,000 and 8,000 B.P. (before present). Sometime between 5,000 and 4,500 B.P., the shoreline and the Galveston Bay estuarine system, Galveston Island, and Bolivar Peninsula assumed their present shapes due to glacial melting, sediment deposition from rivers, and a steadily rising sea level. The Galveston Bay estuarine system became a rich environment fueling life within the bay, on the shores, and out into the Gulf of Mexico.

The changes in sea level, reshaping of islands and land, and movements of sediments from rivers created the dune swale complex ecosystem along our coast of barrier islands and peninsulas. Barrier island formation, like that of Galveston Island and Bolivar Peninsula, occurs because of the interactions of complex coastal processes. Longshore currents deposit sand from offshore where they become spits, bars, and eventually, small sandy islands. This process takes countless seasons of rain, wind, and waves. Once sandy mounds are established, beach plants begin to emerge from drifting seeds and fragments of sea oats, creating natural shields against the coastal winds. These beach grasses force sand-laden winds to a halt and shoot runners to further arrest the sands from covering the land past the dunes. Swales, or dips in tracts of land, begin to emerge. Here, moisture from rainwater and tidal flow is held, and vegetation becomes more lush and diverse. Farther from the beach when standing on higher elevations you are standing atop ancient dunes.

Between 100 A.D. and 1528 A.D., lifestyles of the Galveston Bay hunters and gatherers continued to improve as is evidenced in their production of pottery from local clay. Pots were used to cook and store food, and some potters decorated the rims of their pots with geometric designs before firing. When the first Europeans arrived in the Galveston Bay area in 1528, they were met by seasonal residents with a nomadic lifestyle who had no planting and harvesting practices in place. These native people, the Karankawas, made their tools out of stone, bone and shells, and they relied upon the bounties of the bay area—clams oysters, shrimp, crab, finfish, seagrasses, pecans (which they pulverized to create a form of flour meal), blackberries, prickly pears, small coastal mammals, deer, and bison. Their canoes were made from dugout cypress and cedar trees and were used primarily to navigate the bayside waters. Native coastal dwellers did little traveling and harvesting in the Gulf.

As the Spanish and French continued to claim native lands for their own between 1685 and 1690, sending ships and establishing outposts in the Galveston Bay area and throughout

much of the New World, the demise of the Karankawas became imminent. Although French traders and explorers established posts on Galveston Bay and traded pelts and hides for metal items, interests in the area had more to do with transportation and access to new frontiers than with trading natural resources among the native peoples.

Spanish posts were no longer necessary in the Galveston Bay area after 1763, when the French lost the French and Indian War, thereby conceding all territory west of the Mississippi River to Spain. The Spanish, moreover, had little interest in Texas coastal people and the natural resources of the region. They were keen on gold, silver, and precious stones, none of which could be found in the Galveston Bay area. As a result, many Karankawas were exiled to Mexico as slaves for labor to build Spanish colonial structures. If they were unable to work because of age or gender, they were killed. What is known of these native people can be surmised from a scant archeological record or through the journals of early explorers and settlers such as De Vaca and his crew.

Instructor's Notes and Thoughts:

What's in a Name?

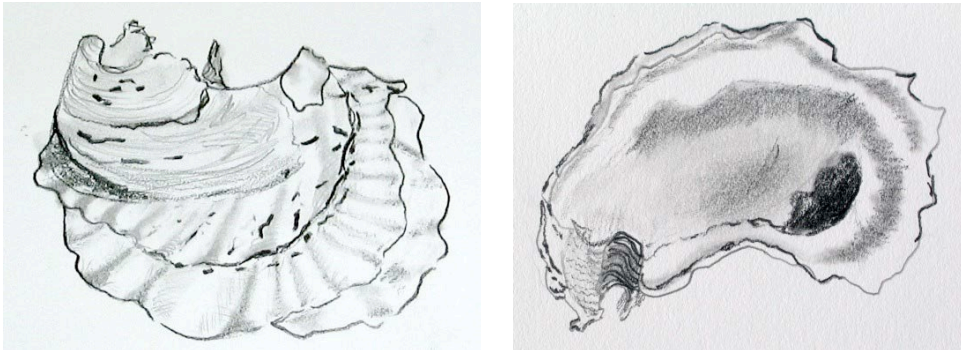
Galveston Bay was given its name by the Spanish naval officer and cartographer, Jose Antonio Evia. Evia was commissioned by the Spanish governor of Louisiana, and soon after, Viceroy of Mexico, Bernardo de Galvez, to complete a survey of the entire Gulf Coast. Evia astutely named the relatively deep bay on the Texas coast Galveston Bay in honor of his patron, Galvez.

Bolivar Peninsula, on the other hand, was named in honor of the great Venezuelan soldier and leader of many South and Central American battles for independence against Spain. Simon Bolivar, who lived between 1783 and 1836, was a popular figure with Mexican and Texas citizens because of his numerous successes in the struggle against Spanish rule in the New World.

Photo credit: NASA

Resources of the Bolivar Peninsula

Archeological records indicate that humans have been using Galveston Bay's resources for over five thousand years. We learned earlier in the text that early natives harvested shellfish and other indigenous wildlife. Their "trash" produced very large shell middens, which altered the bay environment. These middens, or trash heaps of shells, were so large they became islands, altered shorelines, and ultimately, altered currents of Galveston Bay. Anytime you see a raised place in the marsh or large heaps of oyster shells on the bay side, you are very likely to be witness to a former favorite eating place of Karankawa. After 1800, when settlers began arriving into the bay area, the coastal prairies, salt marshes, cypress forests, and surrounding waters were exploited for cattle ranching, lumber, fin fishing, and shell fishing. In addition to this, construction materials in the form of clay, sand, and oyster shells were extracted from the bay and its tributaries. The removal of large quantities of oyster shell changed the upper part of the bay from a hard-bottomed clear bay to a muddy and turbid bay. These released sediments affected the water quality of the lower reaches of Galveston Bay, too. The oyster shells were primarily used to pave roads for use by covered wagon, and later, the automobile. Just as Karankawan trash heaps turned into islands and altered currents, people living today participate in the alteration of land and water by the cumulative effects of their actions.



OYSTER SHELL

The use of coastal prairies in the late 1800s and into the early 1900s was that of cattle ranching and agriculture. This agricultural and ranching boom was made possible by the advent of the railroad. This boom, along with the railroad, resulted in habitat fragmentation of the vast coastal prairie on the Texas coast. The coastal prairie was a continuous habitat running from Neches, Louisiana to Corpus Christi, Texas. Once, the coastal prairie was vast, providing 6.5 million acres of habitat, which was able to sustain biodiversity levels rivaling the savannah of Africa. Today less than 65,000 acres remain. The prairie on the Texas coast was home to bison, pronghorn antelope, and red wolves. At one time, there were over one million Attwater's prairie chickens on the coast. Today, they are one of the most endangered birds in North America and no longer found on coastal prairies of Texas. The railroad also brought new groups of people to the coast and Bolivar. A group of Japanese farmers began cultivating rice in and around Bolivar after 1900, and used methods of budding and grafting citrus plants. These crops remain successful today, particularly on the western side of the bay in Chambers County. Likewise, cattle ranching continues along the peninsula and along both sides of the bay.

A major change in the vista of Bolivar Peninsula was the 1901 construction of the deep water **Houston Ship Channel.** This massive dredging project was completed in 1937, creating planned and unplanned islands and altering bay currents. This new deep channel altered the salinity balance of the shallow watered bay by allowing for a greater amount of saltwater to enter the bay. The average depth of the bay changed forever, increasing wave energy along shores and islands in the bay. Since the ship channel's creation, islands have disappeared and land has slowly eroded from shorelines. Today, people living on shorelines create bulkheads to protect their homes. These cement structures decrease the amount of marshes along shorelines and further decrease the amount of habitat on our shores.

Oil production came to the bay area around 1900. Lumber barons invested their fortunes to drill for oil while successful cattlemen leased their property to oil companies. Construction of refineries along the Houston Ship Channel and the southwestern shore of the bay at Texas City after 1930 began the trend toward the highest concentration of petrochemical plants and refineries in the world. The drilling for oil, along with groundwater removal for drinking water, has caused subsidence (the sinking of our bay bottom). This subsidence altered the average depth of Galveston Bay, and over 30,000 acres of saltwater marshes have disappeared.

Today, the Galveston Bay area continues to be a natural resource mecca. There are a total of over 1,571 gas wells and 5,354 oil wells in the five counties surrounding Galveston Bay. Nearly one half of the total petrochemical production in the U.S. takes place in the Galveston Bay area, and the majority of these plants are within Galveston and Harris counties. With this exponential growth, however, comes urban growth in the forms of residential, commercial, and industrial sprawl. Such sprawl threatens to reduce the quality and quantity of our wildlife habitats. Natural areas able to soak up water during floods have decreased, and these effects are witnessed frequently, as people's homes, and sometmes whole cities, are flooded.

Historically, Galveston Bay has been the leading fishery resource base in Texas. About one third of Texas' commercial fishing income comes from Galveston Bay. Four species of finfish account for the majority of total finfish harvest: black drum, southern flounder, mullet, and sheepshead. In addition, white and brown shrimp are the primary shellfish, as shrimp account for nearly half the total seafood harvest. People from Dallas to Galveston use freshwater on its way to Galveston Bay along the Trinity River for many household, yard, and agricultural uses, which are needed to maintain their lifestyles. The freshwater inflow into Galveston Bay is critical to the salinity balance required by oysters, finfish, shrimp, and blue crabs.

Blue crab represents another dominant shellfish, as more blue crabs are commercially harvested in Galveston Bay than in any other Texas estuary. Probably the most important natural marine resource for Bolivar residents, in addition to shrimp, is the oyster fishery. This has been a vitally important commercial species for over one hundred years. Harvested from both private oyster leases and public reefs, the annual commercial harvest of oysters from Galveston Bay averages close to four million pounds. Translated into dollars, this represents about eight million dollars in ex-vessel value from Galveston Bay.

Other resources from Bolivar's bounty

Sport fishing within the bay and estuary account for about fifty percent of all sport fishing expenditures in Texas. Other recreational activities include saltwater fishing, duck hunting, pleasure boating, swimming, camping, picnicking, and ecotourism. Galveston Bay possesses many valuable sites that serve as ecotourism attractions. Bolivar Flats, High Island, Anahuac National Wild Refuge, the North Jette, and the Smith Oaks Bird Sanctuary and Rookery are some of the more outstanding stops around Galveston Bay that attract bird watchers and naturalists from around the world. The ecotourists and anglers plan their visits to our region to match the annual migrations of species of interest. Anglers seek the bay during flounder runs, when red drums enter into the bay, and during peak summer salinities in order to catch large game fish. Birdwatchers flock to our coast during the winter to see large flotillas of ducks and winter shorebird migrations. Bolivar Peninsula and High Island are considered world-class destinations for spring migrations of shorebirds to Bolivar Flats and descending flocks of neotropic migrants looking for rest in oak mottes.

In summary, Bolivar Peninsula is a most unique place, with natural resources and breath-taking beauty. It is a place to examine more closely, and it is our great fortune to have this opportunity to explore the Bolivar Habitat Preserve. All that is required is that we step outside.

Instructor's Notes and Thoughts:

An Introduction to the Dune Swale Complex and its Five Representative Habitats

In the end, we will conserve only what we love,
We will love only what we understand,
We will understand only what we are taught.
Baba Dioum, Senegalese Poet

An ecosystem is a community of living organisms and their physical and chemical environment; an ecosystem is the interrelationships between abiotic and biotic factors. Every ecosystem has specific characteristics. The characteristics of the dune swale complex ecosystem were created by the long-term geological transformations of the Texas coast. A habitat is a place where an animal can find what it needs to live. These needs include space, shelter, access to mates, food, and water. An animal's needs may change throughout the seasons or throughout the animal's life. Animals may move between habitats within ecosystems or may move over greater areas and utilize different ecosystems at different times of the year. An animal's preferred habitat is where the animal spends most of its time. All animals are driven to eat, to avoid being eaten, and to reproduce offspring. They must live within habitats that offer the best conditions for their survival and their young's survival. The place the animal most often occupies and/or its role in

the ecosystem is called a niche. For example, the fiddler crabs of the marsh live in holes they dig. These holes actually aerate the soil and move nutrients around. Fiddler crabs are the earthworms in the garden of the marsh.

The five habitats represented within and around Bolivar Habitat Preserve are:

1. the beach and dune swale,
2. a coastal prairie scape,
3. fresh water marshes,
4. saltwater marshes, and
5. an oak motte.

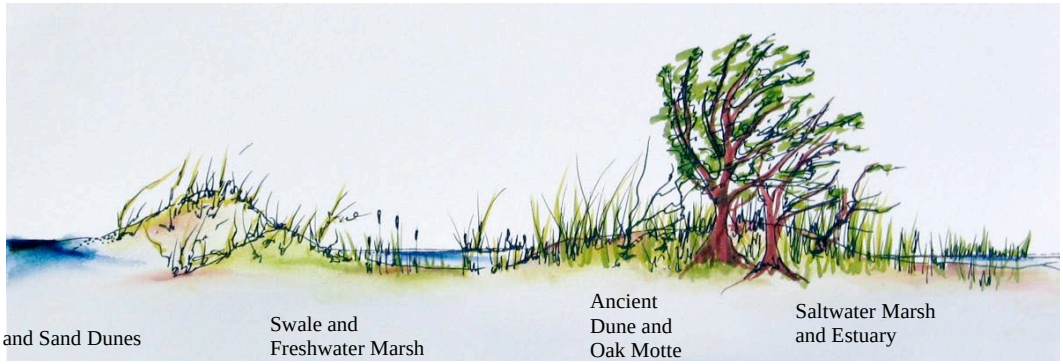
The ancient dune swale complex creates all of these habitats. The forces that created the barrier island and the Bolivar Peninsula are still working today. Each of these habitats provides the student a realistic encounter with indigenous plants and animals as they cohabit and interact within their environments. These five habitats will be further described in terms of their general characteristics and their seasonal trends in an effort to fully study the life ways and cycles of the native flora and fauna of Bolivar Habitat Preserve.

Instructor's Notes and Thoughts:

THE DUNE SWALE COMPLEX

There are two ways to live; one is as though nothing is a miracle.
The other is as if everything is.
Albert Einstein

SAND DUNES OF THE GULF OF MEXICO



CROSS SECTION OF DUNE / SWALE COMPLEX OF GULF COAST

Before describing the five major habitats within and around the Bolivar Habitat Preserve, it is helpful to look at the evolution of dune swales and their contributions to inland ecology.

Barrier island formation, like that of Galveston Island and Bolivar Peninsula, occurs because of the interactions of complex coastal processes. Longshore currents deposit sand from offshore where they become spits, bars, and eventually small sandy islands. This process takes countless seasons of rain, wind, and waves. Once sandy mounds are established, beach plants begin to emerge from drifting seeds and fragments of sea oats, creating natural shields against the coastal winds. These beach grasses force sand-laden winds to a halt and shoot runners to further arrest the sands from covering the land past the dunes. Swales, or dips in tracts of land, begin to emerge. Here, moisture from rainwater and tidal flow is held, and vegetation becomes more lush and diverse.

These foredune environments are well-protected from coastal winds and give rise to more woody plants like the beach plum and southern bayberry. The older dunes further inland of the foredune systems sustain even more diversified flora, such as beach heather, varieties of lichen, and woody shrubs.

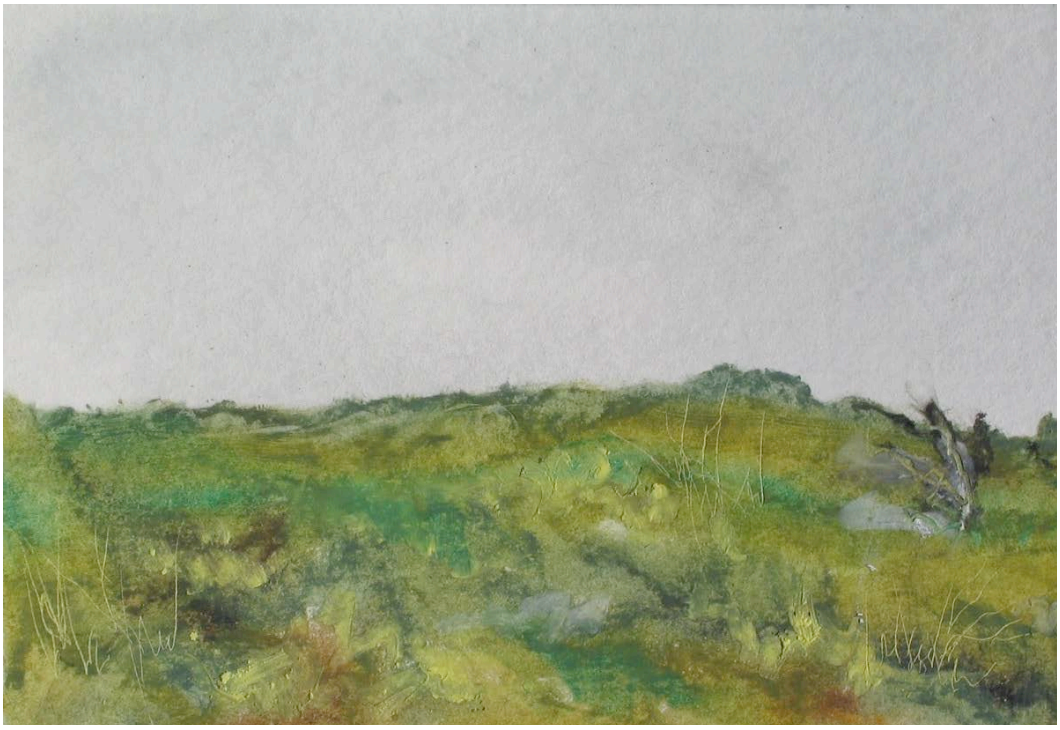
Further inland of the foredune swale, fresh groundwater lies above the heavier layer of saltwater to create freshwater wetlands and the appearance of hollies, pitch pines, and oaks. These plants are naturally pruned by salt-spray aerosols and remain short and sheared. It is in these settings that freshwater marshes and the beginnings of the coastal prairie environments take root.

On the backside of the barrier islands and the Bolivar Peninsula, saltwater marshes form at low elevations where tides change the water levels daily. Sediments carried into the bay settle along shorelines that boarder the bay. As these sediments are trapped by the roots of marsh plants, the marshes grow and over many years may eventually become land.

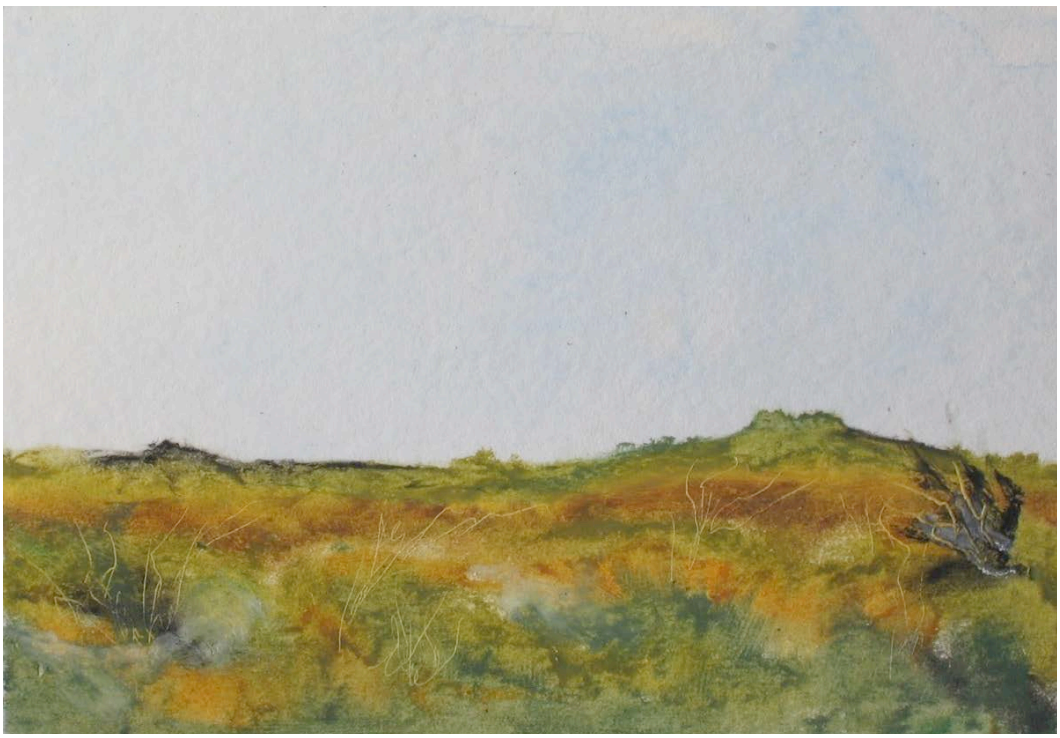
On the beach side, the ecosystem endures high energy forces from wind and waves, creating dunes with plants that can tolerate salt, drought, and wind. On the bay side, the ecosystem is much lower in energy, so emergent grasses can grow and create marshes. In between these places, life thrives on top of ancient dunes in the prairies and oak mottes. Life also thrives in the swales of the system because freshwater wetlands occur, providing water, an essential ingredient to sustaining all life.

On barrier islands and the Bolivar Peninsula, the dune swale complex offers a great look at habitats that establish themselves in narrow bands running along the island or peninsula as they place themselves appropriately across the width of these places. It is a unique opportunity to witness the shifting edges of the habitats that make up the community of the dune swale complex ecosystem.

THE COASTAL PRAIRIE HABITAT



Coastal Prairie during the summer



Coastal Prairie during the fall

Coastal Prairie during the winter

Coastal Prairie during the spring

The first habitat to be described is the coastal prairie environment, which borders the southern portion of the Bolivar Habitat Preserve and runs across the top ridges of ancient dunes. It is distinguished from the freshwater marsh by its elevation and inundation. At any time, a heavy rain or flood can turn a coastal prairie into a marsh. Conversely, a sustained drought can transform a marsh into prairie grasslands.

There are three types of grassland prairies in the Galveston Bay area: the grassland prairies which are cousins to the bluestem prairies found further inland; the wet coastal prairies that surround fresh water marshes; and the salt prairies that have high groundwater levels but usually encircle salt marshes. All of these are on the Bolivar Peninsula.

The Bolivar Habitat Preserve prairie that borders the southeastern portion of the preserve is a combination of the bluestem prairie and wet coastal prairie types. This coastal prairie is an upland tallgrass prairie just inland of a coastal freshwater marsh. Prairie plants such as green milkweed, little bluestem, goldenrod, Indiangrass, huisache, and Texas and prairie coneflowers dominate this grassy landscape. Because these grasses have dense, fibrous root systems thriving underneath a tightly woven sod layer, each tuft sends out underground runners, or rhizomes, that pop up far and wide distances from the source. This growth pattern prevents woody plants like trees and shrubs from taking root. Additionally, the prairie plants host many species of butterflies.

The amphibians, reptiles, and insects that inhabit the grasslands would not exist without their natural breeding and nesting habitat just east on the Bolivar Habitat Preserve, the freshwater wetlands. It is in these nearby pools throughout the spring, summer, and fall that the green tree frogs, red-eared turtles, ribbon snakes, spadefoot toads, dragonflies, and mosquitoes lay their eggs. When they mature, they prefer the transitional zones overlapping and extending into the coastal prairie. Both the venomous snakes (diamondback rattlers) and the nonvenomous snakes (grass and ribbon snakes) feed primarily upon juvenile rodents and adult frogs, lizards and toads that inhabit the grasslands. Snakes are cold in the winter, and the temperature must be 75 degrees for them to be able to move around. They are most likely to be seen in the summer, fall, and spring, sunning in order to digest their food.

The birds commonly found in and around the Bolivar Habitat Preserve grasslands are kestrels, loggerhead shrikes, mockingbirds, orioles, hummingbirds, meadowlarks, scissor-tail flycatchers, and harriers. Harriers and kestrels feed on the dragonflies that migrate to the freshwater marshes and grasslands in the fall. These birds will stay on the coast over the winter. When the dragonflies die with the cold of winter, the harriers relocate to warmer climates. Orioles and hummingbirds are seen in the spring flashing bright colors as they search for nectar. Orioles love oranges and will frequent a backyard that has a citrus tree. Scissor-tail flycatchers are seen frequently during the summer. You cannot miss them because of the long forked tail displayed during flight.

Harriers will be found throughout the Bolivar Habitat Preserve primarily between September and May. In addition to the green darner dragonfly, harriers will eat small prairie rodents, amphibians, reptiles, and birds. They mate between March and June, and their nests of

sticks, grass, and leaves are built on the ground or on a mound of dirt or vegetation. However, since they nest on the ground, their nests are in danger of being trampled by cattle and deer and are unprotected from prairie fires. The number of harriers on our coastal prairies has declined because of human uses of the land.

Harriers hunt by flying low to the ground in open prairie areas. They circle an area several times listening and looking for prey. When they spot something appetizing, they swoop down and grab it with their sharp talons. Many farmers in the vicinity like harriers because they eat the mice that damage crops. They are sometimes referred to as "good hawks" because they pose no threat to poultry as many other hawks do. They are also known as marsh hawks. You can confirm a sighting by spotting the white flash of their rump (this is located just above the tail).

Permanent residents of the coastal prairie include the loggerhead shrikes, mockingbirds, and meadowlarks. These birds breed in the grasslands in early spring, and their juvenile phases range between May and December. Loggerhead shrikes are small and have a fancy black mask over their eyes. The are known as butcherbirds because they impale things like lizards onto thorns and barbed wire to eat later. They can be found all year perching on tops of trees, telephone wires, and posts. The meadowlark has the most beautiful song and is heard throughout the year. Its song is *seeeoaaa seeeadoo* with many variations. They are often seen on a tall shrub singing. You cannot miss their bright yellow chest and belly or their fancy black necklace when they are in breeding plumage.

The tall grasses of the prairie provide camouflage for nesting and raising young for ground-dwelling birds like the horned larks, burrowing owls, mourning doves, sparrows, and killdeers. In addition to this grassy cover, parent birds are close to good supplies of grasshoppers, ground worms, and crickets for their nesting young. This good supply of food makes this place the winter home of the savannah sandhill crane.

Grassy fields are often visited by animals that don't necessarily live there all year. Hibernators like the hispid cotton rat, pocket gopher, ground squirrel, prairie dog, speckled king snake, and ribbon snake are found on the prairie after the winter months.

The swamp rabbit can also be found on Bolivar Habitat Preserve's coastal grassland, although it enjoys the wetland habitat as well. It is unique in that it is large, weighing as much as six pounds and measuring over twenty-one inches as an adult. Swamp rabbits have rough gray-brown fur with white undersides and extra skin between their toes to help them swim and walk through the mud. They travel by water most of the time and can duck beneath the surface with only their noses showing when dodging predators. Swamp rabbits eat cane, sedge plants, and other tall grasses found on the prairie and in wetland habitats.

White-tailed deer enjoy the new crop of prairie grasses and flowering plants that begin blooming in early spring. Moreover, grass seeds, which are abundant in summer and throughout the fall, are the preferred diet of most rodents
found on the prairie.

A prairie mammal that appears year-round is the coyote. Coyotes eat rodents and other small mammals within and around the coastal prairie environment. They venture into the freshwater wetlands and dunes to prey upon wildlife found there as well. A former resident of the coastal prairie is the red wolf that is now extinct in the wild.

The coastal prairie is characterized by tall grasses, small mammals and their predators, the low nesting birds. The insects that inhabit the coastal prairie depend entirely upon the vegetation that abounds there. From an artist's perspective, however, the coastal prairie provides a fertile palette of greens, golds and browns, all of which are situated in a very horizontal format. The relationship between the earth and sky is never more apparent than when one stands on the prairie and looks upward.

Instructor's Notes and Thoughts:

OAK MOTTE HABITAT

Oak Motte during summer

Oak Motte during fall

Oak Motte during winter

Oak Motte during spring

Oak mottes, or woodlots, are clumps of live oak habitats that can be found near freshwater marshes, coastal grasslands, and ancient dunes. These woodlots emerge when shrubs form a stable carpet of soil and roots. Sturdy live oaks sprout along the fringes in time and begin to dominate the woodlots. Oak mottes are a favored habitat for many species of resident and migratory birds that flock to these patches of relative height and vegetation en route north and south.

Likewise, avid bird watchers flock to these same mottes during peak seasons—from late March through May, and from September through November—to observe an amazing variety of migratory birds. These mottes are havens for birds about to start or finish an 18 to 24 hour flight over the Gulf of Mexico. Every fall, the neotropic migrants head south, and the oak mottes and barrier islands are their last place to refuel and rest before their departure to South, Central, or Latin America. The oaks and other trees are teeming with insects and fruit for migratory birds to eat and offer protection from predators. In the spring, the neotropic migrants return in breeding plumage, dressing oak trees like Christmas trees in shapes, colors, and excitement. These high oaks offer a place for exhausted birds to head for when coming off the Gulf. These prime resting places are seen from very far away by the birds coming in off the Gulf and are a welcome sight.

Bordering the northwest quadrant of the Bolivar Habitat Preserve and embellishing the deck of the Crenshaw School's Science Wing is an oak motte. Several live oak trees dominate this oak motte and are surrounded by hackberry, mulberry, and huisache trees. Woolly bucket and bumelia also thrive beneath the shade of the live oaks here. Hackberries and the acorns of the live oaks ripen in late summer and become a major food source for small mammals like the hispid rat within this habitat. It is in the winter that migrating monarchs roost in the trees, and smaller insects rely upon the green nutrients contained in the live oak leaves.

Woodlots are year-round homes to green tree frogs, tree toads, fire ants, speckled king and ribbon snakes, hispid cotton and kangaroo rats, armadillos, opossums, and coyotes. Coyotes enjoy roaming the woodlots for an ample supply of kangaroo and hispid cotton rats.

It is common to find loggerhead shrikes, mockingbirds, and yellow-rumped warblers year-round in the woodlots of Bolivar Peninsula. April through June is when the scissor-tailed flycatchers nest in isolated trees and orchard orioles breed in the woodlots. Ruby-throated hummingbirds traveling north can be spotted in early August in the woodlots as they feast on varieties of insects living in and around the live oaks. Other migratory birds to be sited on Bolivar Habitat Preserve's woodlot habitat are ibises, great egrets, and green herons, all of which breed in early April around the fresh and saltwater wetlands nearby. These wading birds are seen year-round; however, they are not always the same birds, and in other areas, are migratory and only seen during certain seasons.

It is important to note the presence of the invasive Chinese tallow tree on the grasslands and woodlots of the Bolivar Habitat Preserve. The Chinese tallow has degraded indigenous flora and fauna along the prairie and oak motte habitats since Benjamin Franklin introduced it in the late eighteenth century. The tallow tree now covers many thousands of acres of former coastal prairie and woodlot environments, preventing the growth of native plant species and

discouraging the appearance of native fauna. The tallow tree has noxious roots, which most other trees that might have grown there cannot tolerate. Consequently, an active effort is being made to eliminate the Chinese tallow tree from the Bolivar Habitat Preserve.

Instructor's Notes and Thoughts:

BOLIVAR BEACH AND DUNE HABITAT

Beach and Dune Scape during the summer

Beach and Dune Scape during the fall

Beach and Dune Scape during the winter

Beach and Dune Scape during the spring

The beaches and dunes directly east of the Bolivar Habitat Preserve are classified as soft shores. These sandy beaches face the open Gulf and experience considerable wave exposure. They also respond dramatically to any changes in the intensity and direction of the winds and waves offshore. As swash, or sand over which water washes, pushes landward by incoming waves, particles from the Gulf are moved toward the foreshore and backshore. Included in these "castaways" are the strand biota, the organisms deposited on the upper beach by high tides and storm waves. These organisms are shells, sand dollars, worm tubes, sea whips, and sea pens. Other strand biota are the Portuguese-Man-of-War and cabbage heads, or the up-side-down jellyfish. They are most common in the early spring following strong southeasterly winds.

Wood-boring crustaceans like the piddocks, gribbles, and true shipworms are found along Bolivar beaches. Like living sculptures, they are always attached to driftwood and beached planks, as wood is their major source of nutrition.

What barrier island beach would be accurately described without mentioning the presence of sargassum? This floating brown algae has its source in the Sargasso Sea in the mid-Atlantic Ocean and becomes dislodged and spread throughout the Gulf primarily during hurricane season from June through October. Imbedded within sargassum are sargassum fish, pipefish, snails, sargassum shrimp and crabs, and anemone.

PIPE FISH

Shorebirds such as gulls and willets feast on these heaps of beached living masses. Tourists and beachcombers don't seem as excited about the appearance of sargassum, however. The interruption of a soft, sandy beach is a nuisance to most seasonal beach bathers. Sargassum, however disagreeable some may find it, is a vital part of beach ecology, and it serves as a defense against erosive processes. The weight and tangled masses of this seaweed trap and hold down sand, provide nutrients for dune plants, and assist in the natural dune-building process. If the sargassum is not raked from the beach, the mats will eventually build dunes, assisting the beaches in growth forward into the Gulf, preventing erosion, and maintaining a healthy shoreline. Without it, the beaches on Galveston Island and Bolivar Peninsula would steadily diminish.

Shells commonly found along the foreshore and backshore of Bolivar beaches are rock shells, pecten, angel wings, whelks, scallops, cockle shells, oysters, and razor clams.

The Gulf currents between late December and early March beach some of the more spectacular shells. The cockles, which are bivalves with heart-shaped shells, clutter Galveston and Bolivar beaches primarily during the winter months. They measure from one to seven inches across, and on the outside, they are yellowish-brown spotted with rust red. Their insides are salmon pink.

The knobbed whelk is another prize find along the beaches during colder months. Whelks are univalves that come in sizes up to nine inches long. Whelks have a row of knobs, and they are yellowish-gray outside, smooth and bright orange inside. Whelk eggs are laid in a ribbon-like strand made of dozen of yellowish capsules. Each capsule contains from twenty to one hundred eggs.
Studying the larger, more robust shells along Bolivar beaches will provide further insight into the shell technology developed by the early native inhabitants of the Peninsula and Bay area. This concept will be expanded upon in the curriculum chapters to follow.

The backshore and dunes of the beach habitat are laced with glasswort and beach pea.

BEACH PEA AND GLASSWORT

The beach pea is a trailing vine with lavender pea-like flowers that bloom through the summer. Long, curly tendrils cling to other dune plants as the beach pea spreads along the ground, anchoring itself against the coastal winds and blowing sands.

BEACH GRASSES

Beach grass acts to stabilize sand dunes. Without it, the dunes would constantly move. Long, many-branched roots of beach grass bind the sands together and spread quickly for many feet. Every swelling, or node, on the rhizome (branched root system like that of the coastal prairie grasses) produces new shoots. Beach grass seeds, produced in small, spike-like flowers, spread with the wind. The tough, thin green blades grow up to two feet tall and roll up to conserve moisture on hot days, but unroll to catch moisture when temperatures are in the seventies.

Jointed glasswort, or salicornia, grows along Bolivar beaches as well as the Peninsula's salt marshes. This striking annual grows from six to eighteen inches tall. Its smooth, fleshy branching stems can store large quantities of water for use when the weather is dry. Glasswort has the amazing ability to grow in soils and wet areas with high salt content, places that would kill many other plants. Its tiny flowers grow in threes in the upper joints, and in the fall, the stems turn red to expel salt. Early settlers used to pickle glasswort stems or add them raw to fresh greens.

Many invertebrates inhabit the beach and dune habitats. The beach tiger beetle is found along the backshore and preys upon smaller insects like the digger wasp, dune grasshopper, mosquito, red ant, deer fly, and horse fly. The ghost crab is another common invertebrate of this

habitat. These crabs do not like cold weather, or temperatures below forty degrees. They are likely to be spotted from late spring through early fall on Bolivar. Ghost crabs burrow in sand close to the water's edge and feast on most dune vegetation.

The birds most commonly seen along Bolivar beachfronts are terns, gulls, plover, curlews, black skimmers, sandpipers, and willets. Common terns feed by diving for mullet and whiting that swim near the surface of the Gulf waters. Terns nest in sandy islets and along the beach and line their nests with seaweed and shells. Baby terns are hatched after about twenty-five days of incubation and are fed by their parents for only two to four days. After this short period, tern chicks begin to roam the beach for food on their own.

The black skimmer feeds on small fish and crustaceans in the Gulf waters close to the beach. It flies low over the water, slicing its long, lower bill through the surf as it scoops up its prey. Skimmers are the only bird whose lower jaw is longer than it's upper jaw. Skimmers nest in large colonies of up to several hundred pairs along side seagulls and terns, and dig shallow discs of sand for their nests. When terns and skimmers nest, they are actually keeping their eggs from overheating on the beaches.

The brown pelican is likely to be seen feeding in Gulf waters as it soars and dives from the air for its food. It nests in trees and branches, building its nest mainly of sticks and branches. Sometimes, brown pelican will construct shallow scoops or mounds of soil on the ground for their nests. For the first two weeks, their chicks are fed regurgitated food placed in their nests. After two or three weeks, the nestlings are strong enough to feed from their parents' pouches. In the winter, the white pelican is seen on Bolivar flats and around the bay. During the summer, it prefers large inland lakes.

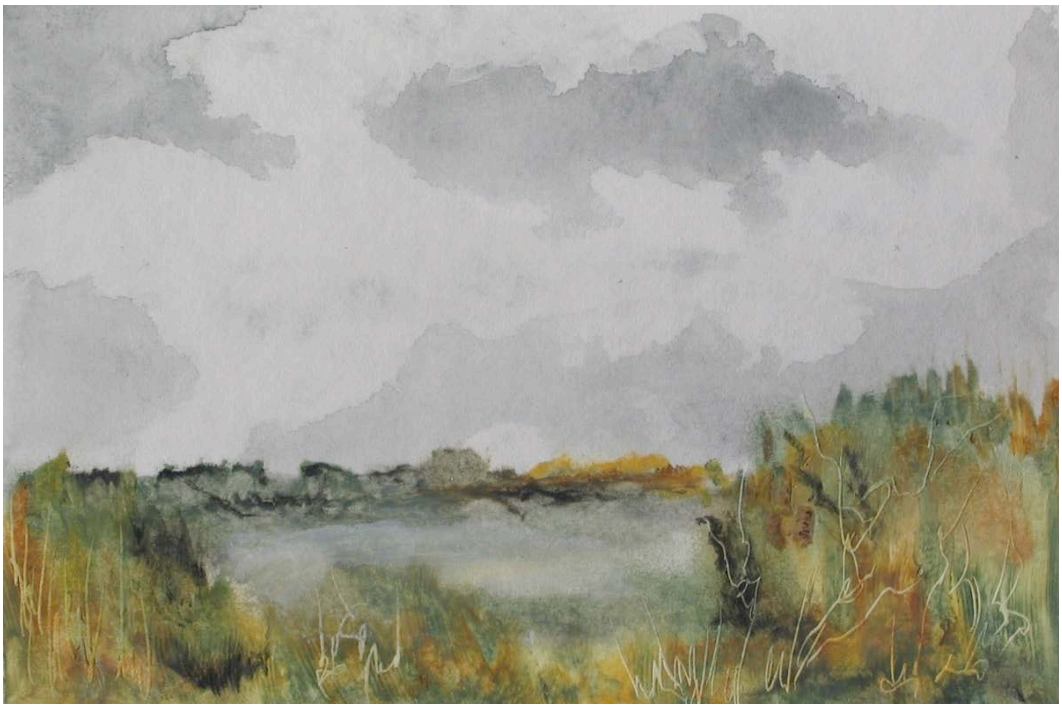
The long-billed curlew forages gracefully for its food along the water's edge during winter months. It breeds from April through September in the fields and grasslands further inland. Distinctive to the curlew is its long, thin, down-curled bill that it uses inland to forage for insects and worms. On the Gulf shore, the curlew probes in the mud and sand with its long bill in search of shellfish, crabs, and fish. It builds its nest on the ground in flat, open areas with clumps of grass, and it is prey to hawks, badgers, coyotes, and snakes.

Another bird that enjoys the beaches and tidal mud flats of Bolivar's coastline is the piping plover, one of the smallest shorebirds. It is considered a "winter Texan," as it migrates north to Canada in the spring and arrives along the Gulf Coast in late July and early August. The plover eats primarily marine worms, beetles, spiders, crustaceans, mollusks, and some small mammals. Its predators include raccoons, skunks, falcons, foxes, crows, and gulls. When intruders come close, the young squat motionless in the sand while the parents attempt to distract the unwelcome predator by feigning a broken wing like the killdeer. The beach and dune habitats are home to a wide variety of flora and fauna. But as we'll see, the salt and freshwater wetlands are considered the most productive of all habitats worldwide.

Instructor's Notes and Thoughts:

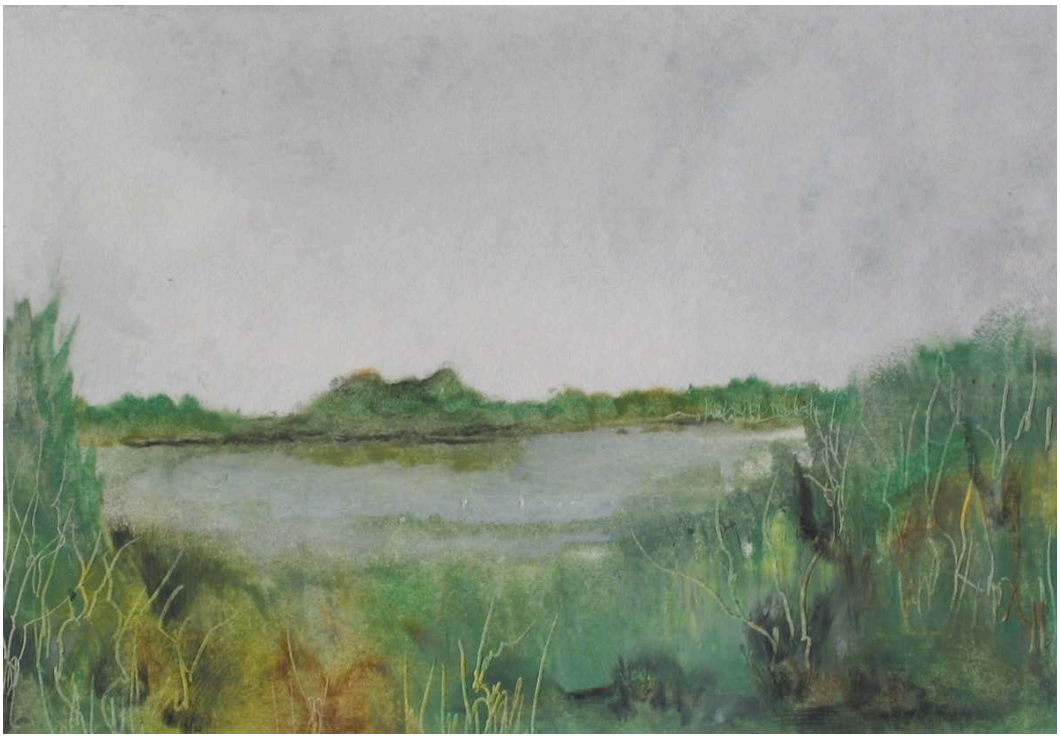
FRESH WATER WETLANDS

Freshwater Marsh during the summer



Freshwater Marsh During the fall

Freshwater Marsh during the winter



Freshwater Marsh during the spring

An aerial view of the Bolivar Habitat Preserve indicates a barrier island, non-tidal, fresh water wetland that cuts across the eastern third of the preserve.

As is typical of fresh water wetlands, this habitat rests in an inter-dune swale and on the larger, interior wind-eroded flat along Bolivar Peninsula's eastern length. The water in this non-tidal trough is derived from a combination of runoff from the neighboring dunes and from groundwater. This water percolates through the dunes and comes to the surface in the swales between the dunes. As a result, only wetland vegetation survives.

Fresh wetland plants like southern cattail, bulrushes, burdock, cordgrass, phragmites, coastal plain pennywort, and sedges abound here and provide nourishment and shelter for many species of animals. Summer and autumn months are peak seasons for wetland plant flowering. In the winter, between December and March, these plants are dormant. Late March through early June marks an explosive growing season for wetland plants, which bud and proliferate at this very fertile time.

Reptiles and amphibians include several species of frogs and toads, mud and red-eared slider turtles, ribbon snakes and alligators. Southern leopard frogs breed year round at the preserve. Several hundred eggs are laid in clusters below the water's surface. After seven to ten days, newly hatched tadpoles begin growing to three times their original size. Between sixty and ninety days, they metamorphose into frogs. They eat mosquitoes and other small invertebrates, and although their mottled coloration helps camouflage them, their predators include fish, raccoons, skunks, and aquatic snakes. In addition to these, the American alligator feeds on snakes, turtles, frogs, fish, muskrats, nutria, swamp rabbits, rice rats, and any other species it can catch.

Among the many fish found in freshwater wetlands are sheepshead minnows. These fish are an important link in the coastal food chain in the estuary, as many freshwater wetlands can be tidally influenced and connected seasonally to the estuarine system. These fish eat plant materials like algae and are then eaten by red drum, spotted sea trout, turtles, and wading birds. Sheepshead minnow spawn between February and October when the males construct nest pits in wetland bottoms. Hatching typically occurs during spring and summer. Some anglers use sheepshead minnow as bait, but environmentalists study these fish to determine pollution levels in the wetlands.

The mammals you are likely to see in fresh wetlands are rice rats, raccoons, skunks, nutria, and muskrats. Raccoons are almost exclusively nocturnal and nest in dens. Their dexterous hands and nimble fingers are used to feel the bottoms of streams and ponds for food. They are agile climbers and strong swimmers. Raccoons eat nuts, insects, small rodents, frogs, bird eggs, carrion, and human garbage. Their predators are owls, coyotes, bobcats, and humans. Baby raccoons are born in the fall and are weaned by three months. They remain with their mothers for a year and can live up to fifteen years.

Many birds populate the wetlands throughout the year. Those most likely to be found on the preserve's wetlands are mottled ducks, teals, coots, rails, gallinules, and grebes. Wading

birds include black-necked stilts, herons, egrets, and ibises. Shorebirds are represented by sandpipers, long-billed curlews, whimbrels, willets, yellowlegs, snipes, black-bellied plover, killdeer, and dowitchers. Perching birds include the red-winged blackbird and the sedge wren. Watch the tops of reeds and rushes for a bright red flash and announcement by song, and you will see a red-winged blackbird.

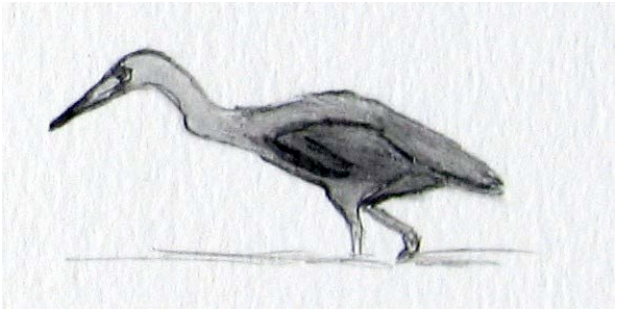
The black-necked stilt mates between April and August and builds its nest of mud, sticks and shells on the ground near water. Look for a bird with very long pink legs and tuxedo plumage. The stilt eats worms, mollusks, shrimp, insects, small fish, and floating seeds. Its predators are gulls, skunks, coyotes, and other larger birds. Because it summers on the Gulf Coast, stilts are seen in the wetlands only during mating season.

The white ibis has narrow, slender toes that help it walk on the mud and silt without sinking down. Its bill is long and down-curved and can readily probe in holes and crevices in the mud for crabs and crayfish. These birds are valuable to the wetland environment in that they consume crayfish, which, in turn, are known to consume large numbers of fish if not checked.

Ibises begin their fall migration south to Texas in mid-September and their spring migration in May. These beautiful birds fly in formation to their roosts and generally nest in huge colonies around freshwater marshes in the company of herons, egrets, anhingas, and other large wetland fowl. Ibises build low-lying, bulky nests of twigs, branches and moss, and lay their eggs. In only three weeks, the chicks hatch with full, grayish down. It takes about two years before their feathers become brilliantly white like their parents'.

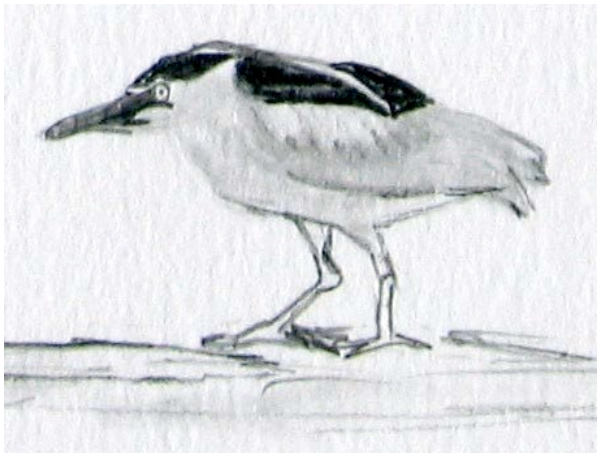
White Ibis

There is no doubt the fresh and saltwater wetlands along Bolivar Peninsula and neighboring High Island are temporary and permanent homes to some of the world's most exquisite birds. Bolivar Habitat Preserve is among the several sites in which these birds can be viewed and studied.

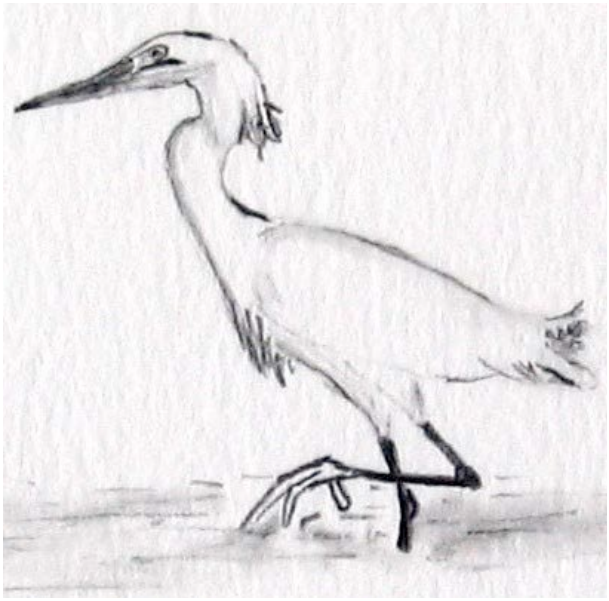


Little Blue Heron

Wood Stork

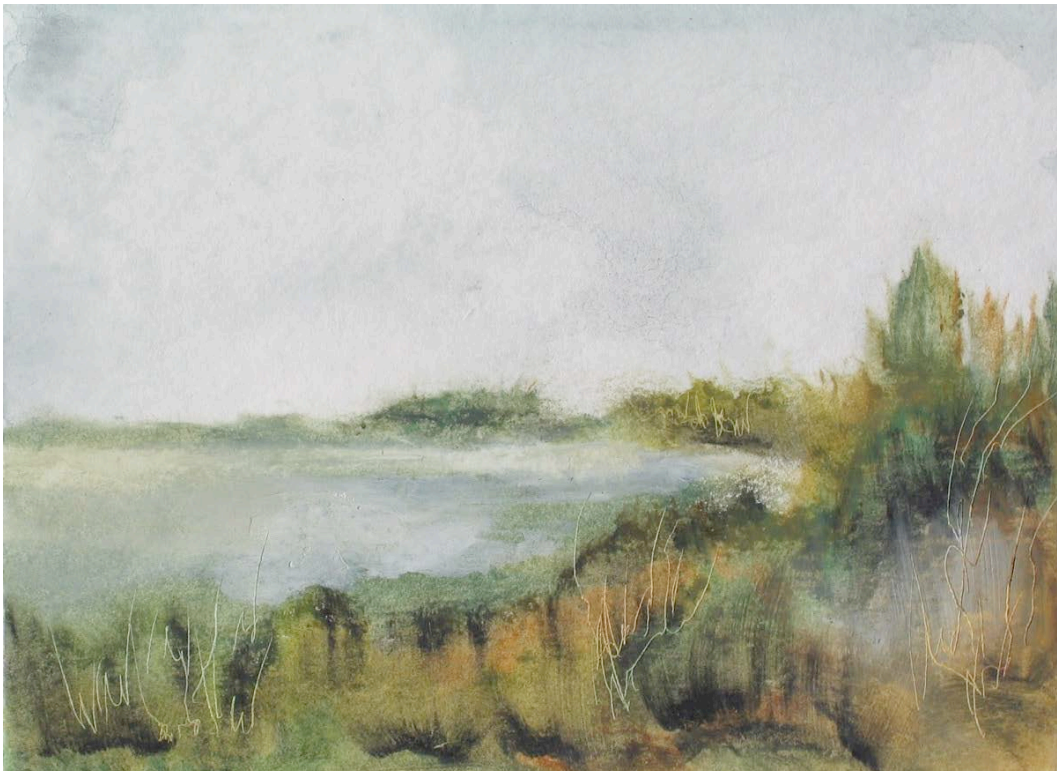


Black-crowned Night Heron



Snowy Egret

THE SALT WATER WETLANDS



Saltwater Marsh during the Summer

Saltwater Marsh during the fall

Saltwater Marsh during the winter

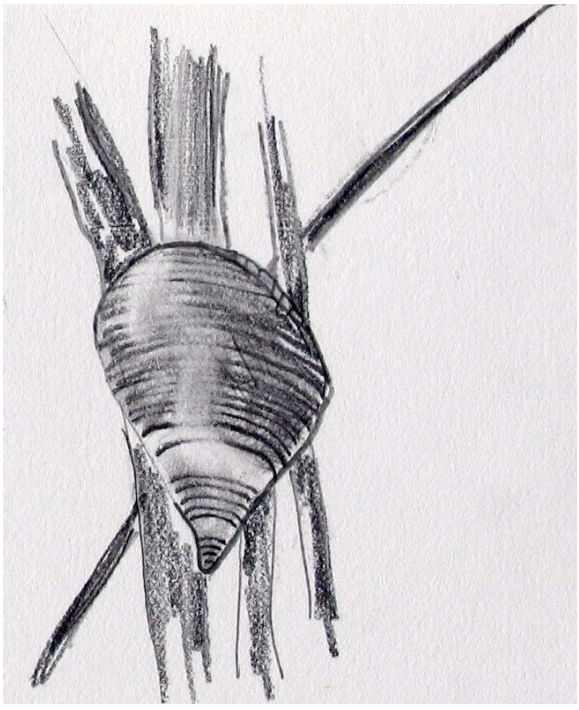
Saltwater Marsh during the spring

The last habitat to be described in this field and curriculum guide is the saltwater wetlands, or tidal fringe wetlands. These wetlands can be vegetated as in the case of tidal marshes, or unvegetated as are found in the mud and sand flats around the open saltwater of Galveston Bay. Although this estuarine environment is not one found within the Bolivar Habitat Preserve, it is nevertheless a significant habitat to describe in completing the Peninsula's ecological complex.

Most Texas estuarine wetlands are in river valleys that flooded when sea levels rose over ten thousand years ago. Most of the salt marshes that exist today are the result of the flooding and filling of these ancient river valleys with the salt water from the Gulf.

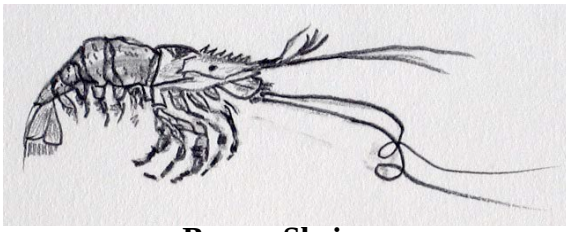
Salt marsh soils, which range from clayey to sandy, have the most organic matter of all Texas wetland soils. Spartina, or salt marsh grasses, dominate the flora of this habitat. In the high marsh, which is irregularly flooded by tides, salt meadow cordgrass is the most common grass. The low marsh, where regular flooding occurs during the day, produces saltmarsh cordgrass, salt grass, and saltmarsh bulrush.

Smooth cordgrass



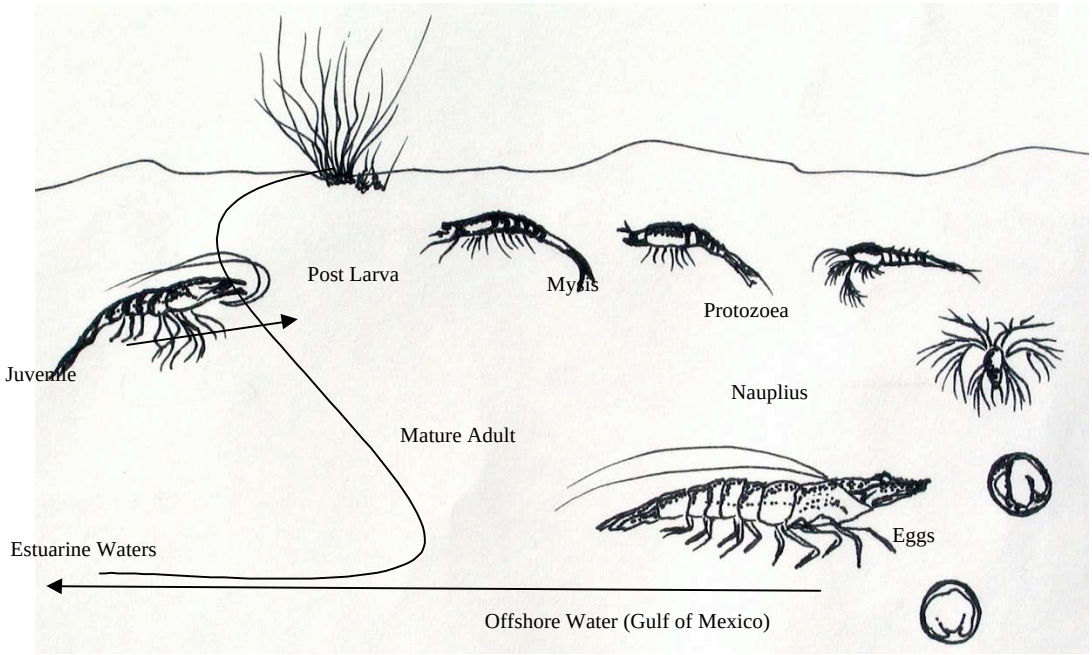
Marsh Periwinkle

Coastal dwellers depend tremendously upon the functions of salt marshes. Salt marshes are wave buffers, fish nurseries, water purifiers, oxygen pumps, and a major food source to much wildlife. In fact, salt marshes produce ten tons of organic matter per acre per year. This is more than twice the productivity of farms. More than three-fourths of all the shellfish and seafood that is harvested in the Bay area spends its early life in our salt marshes. 90% of commercial fisheries in the Gulf of Mexico are estuarine dependent species.



Brown Shrimp

The life cycle of brown shrimp involves both the Gulf and the Bay. In the shelf waters (waters that lie over the continental shelf) of the Gulf, each adult female shrimp sheds between 500,000 and a million eggs a year. The fertilized eggs hatch in a day or so, releasing tiny larvae. Between two and four weeks of development, the shrimp become post larvae. Post larvae migrate from the Gulf into the Bay and bordering marshes. Growth here is fast with the protection and abundance of food, and after two to three months, the juvenile shrimp reach three inches in length and begin migrating back into the Gulf where they mature, mate, and spawn.



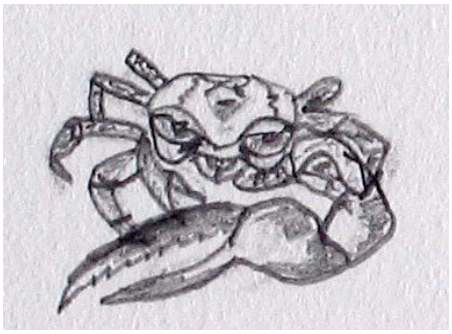
SHRIMP LIFE CYCLE

Oyster reefs of the Galveston Bay are not only commercially important, but they help to filter and clean the water and provide habitat for all sorts of other animals such as small crabs, sponges and fishes. Oysters are bivalves, or two shells attached together at one end by a natural hinge and by a single large muscle. Oysters eat plankton and algae and are prey to oystercatchers, sea anemone, sea stars, sea nettles, and humans. They spawn in late spring to early fall, but only about one percent of the fertilized eggs successfully reach maturity. Oyster larvae use tiny probing feet to find a suitable place to attach. Once settled, the feet excrete a cement-like glue that adheres the oyster in place for the rest of its life. Although oysters attach

themselves to such things as boats, tires, cans, bottles, crabs, and turtles, they prefer to attach to other oysters, creating oyster reefs.

The Texas diamondback terrapin is an important reptile found in the brackish and saltwater wetlands around the Peninsula. These turtles mate in the water during spring months. The females come ashore and dig tear-shaped nests in the sand and mud where they lay between four and eighteen eggs. If temperatures are warm, these eggs will hatch in about eighty days. The hatchlings will emerge if temperatures remain warm.

Terrapins eat crabs, shrimp, bivalves, fish and insects, and are hunted by raccoons, skunks, crows, and humans. During the day, they spend most of their time in the water or basking in the sun. At night, terrapins bury themselves in the mud. These turtles are rare to find and endangered on our coast.



Another animal likely to be found in the muddy areas of salt marshes is the fiddler crab. By burrowing deep in the mud of the marshes, these crabs create a maze of tunnels that aerate (add oxygen to) the marsh grasses and underwater seagrass meadows. It is their mating behavior that gives them their name of fiddlers. Between June and August, male fiddlers, which have one large claw, or cheliped, and one small claw, line up beside the tiny burrows they have dug. They begin moving their cheliped back and forth in a fiddling motion to attract females. If a female is receptive to the male's advances, she will enter his burrow. In two weeks, if things go as planned, the female will emerge and release her fertilized eggs or "sponge" into the water.

Shorebirds and waterfowl are abundant in these estuarine habitats. Herons, egrets, ibises, and other wading birds feast on the fish, shrimp, crabs and other invertebrates found in the wetlands. Other predators of the salt marshes are bobcats, coyotes, raccoons, skunks, mink, and river otters.

It would take volumes to describe the multitude of waterfowl attracted to the marshes and estuaries along the Gulf Coast, and specifically Bolivar Peninsula. For the sake of brevity, the following two species of salt marsh wading birds are highlighted. The reddish egret is an example of a permanent resident of the Bay area habitat, and the roseate spoonbill represents the migratory species of waterfowl. Both species can be sighted in and around the Bolivar Habitat Preserve.

The reddish egret is a permanent resident of the Texas coast, and although it is recognized as one species, the reddish egret may be either white (white phase) or gray with a rusty colored head and neck (dark phase). Its mating season is early March through late July, and it tends to nest close to the ground near bushes on islands surrounded by water. The reddish egret feeds on small fish, frogs, tadpoles, and crustaceans. Reddish egrets and can live up to twelve years. Its predators include raccoons, coyotes, and great-tailed grackles, which destroy

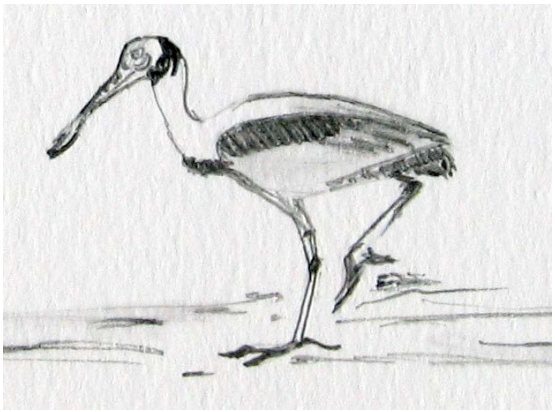
the eggs and eat young egrets. When feeding, reddish egrets spread their wings to create shade and reduce glare in order to see their prey more easily in the water. Much like owls do, the reddish egret regurgitates all the edible parts of its prey to feed their young by regurgitating into the chicks' mouths.

Reddish Egret Feeding

Reddish Egret

The roseate spoonbill is a remarkably beautiful bird with pink plumage that intensifies as it matures. The pink coloration is a result of their diet of carotenoid-rich shrimp. The more shrimp they eat, the pinker they become. Another distinctive characteristic of the roseate spoonbill is its spoon-shaped bill designed to swish back and forth in the water in search of fish and crustaceans.

Roseates can be viewed in the Bay area from March through October. In winter, most roseates migrate to Central and South America. Their nests are built in thick vegetation above water and are well-cupped. During breeding season, the male uses "gifts" of nesting materials to attract the female. Once mated, the pair remains monogamous, and both take turns sitting on the eggs and feeding their young. Young roseates are ready to fly in about eight weeks after hatching. They become sexually mature in about sixteen weeks.

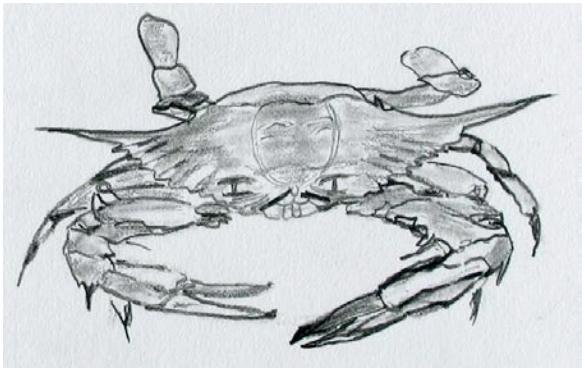


Roseate Spoonbill

Tying the Saltwater Marshes to the Gulf of Mexico

One cannot discuss saltwater marshes without tying this estuarine system of Galveston Bay to the Gulf of Mexico and its nearshore habitat that borders the beaches of the Bolivar Peninsula. As discussed earlier, brown shrimp move in and out of the bay to the Gulf of Mexico to spawn, provide food for finfish, and fuel an economically valuable commercial fishery to many communities on the Texas coast. Other species of significance are tied to the estuary and provide food for us and other species. These species define our culture on the coast by timing commercial and recreational fishing seasons. As they move, we move to take advantage of their place in the Bay or Gulf depending on the season, what growth stage they are in, if they are mating or spawning, or if they are moving between the Gulf and the Bay. Three species of significance to the fishing community of Bolivar other than brown shrimp and oysters are blue crab, red drum, and flounder.

The blue crab's scientific name is *Calinectes sapidus* and means beautiful swimmer. This comes from its ability to swim sideways and efficiently maneuver great distances through the water. It is also the most important crab to the economy of Galveston Bay. Blue crabs can tolerate huge changes in salinities, dissolved oxygen, and temperature. This means you can find them far into the upper reaches of the bay where the salinity is low and out in the waters fronting the beach where salinities are high. The females prefer higher salinities near the gulf passes, and the males prefer fresher water and frequent the upper reaches of the bay.



Blue crab

The blue crab is amazing in that it mates and spawns at different times of the year. When a female molts, she has a soft shell. This is the only time she can mate. The males travel to the lower reaches of the bay and tidal passes to take advantage of this in April through June and again in September through October. The females are inseminated, and when the oocytes are freed from the ovaries, they become fertilized. This spawning takes place in the winter and summer in tidal passes and the nearshore Gulf of Mexico. The females have a large orange spongy mass underneath them and may release up to one million fertilized eggs from their egg mass. Sponge females are commonly found along the beaches. These eggs are released in the Gulf of Mexico. The larvae are planktonic and go through several larval stages until they become megalops. If you have ever been swimming in the gulf and had tiny creatures nipping at you trapped inside your swimsuit with bright green eyes, you have seen a megalops stage of a

blue crab. During the fall, the megalops enter the bay, molt, become benthic organisms (bottom dwellers), and grow up. It takes a year for blue crabs to reach a harvestable size. Blue crabs are fished commercially and for fun along many edges of the bay.

The Texas coast is famous for red drum, and Galveston Bay is the number one destination for the recreational angler. Many hotels and bait camps fill up during red drum "runs." These fish, along with other drums, are able to fill their swim bladders with air and produce sounds. The male drum uses this musical instrument to seduce females and stimulate spawning. This occurs in September through October and can be witnessed via hydraphone in passes leading to bays and the Gulf of Mexico. The "bull reds" are the ones mating and spawning. They are over 12 pounds in weight. After spawning, the surface currents of the gulf bring eggs and larvae into the estuary. The larval red drum will hatch in 18 to 24 hours. For two or three days after hatching, the larval red drum will use up the resources in their yolk sac and develop mouthparts. These juveniles will remain in the estuary until reaching maturity in 3 to 6 years. Then, like their predecessors, they will emigrate to the Gulf of Mexico, returning annually to tidal passes to court or be courted, mate, and spawn. Anglers become experts at following these migrations and movements in order to catch this highly-prized fish. At one time, the commercial fishery decimated population levels of red drum for seafood restaurants serving blackened red fish. Now the red fish are only fished for recreationally, and it is a highly-regulated fishery.

East bay along the Bolivar Peninsula is a famous place to catch Gulf and Southern Flounder. Also, it is one of the best fish to eat on the Gulf coast. In the spring, these fish migrate from the Gulf to the bay. During this time, flounder run fishermen are poised at Rollover Pass, Bolivar Flats, and Bolivar Roads on the jetties ready to catch a good meal and brag to their friends. The warm tides of spring prompt this major migration of flounder from the gulf to the bay. They will stay until October or November, and then another flounder "run" will happen as they migrate back into the gulf to mate and spawn. Just like many species that mate and spawn in the gulf, the surface currents will bring the larva and eggs into the estuary. This cycle repeats itself again and again.

Even large species of fish in the gulf that never enter the bay like swordfish, tuna, and red snapper are considered estuarine dependent because they feed on species that rely on the estuary to complete their life cycle. The saltwater marshes that border the bay are the cradle of life for the Gulf of Mexico. Even though the Bolivar Habitat Preserve does not border the ocean, every habitat is connected to the seasonal changes of the land and its adjacent waters. The dune swale complex ecosystem is formed, changed, and dependent on the whims of the waters that surround it.

Having reviewed the five major habitats defining Bolivar Habitat Preserve—a coastal prairie, an oak motte, the beach and dune complex, and fresh and saltwater wetlands—the opportunity to provide an effective and exciting environmental curriculum rests just outside.

HABITAT INTERACTIONS

Wisdom begins with wonder.
Socrates

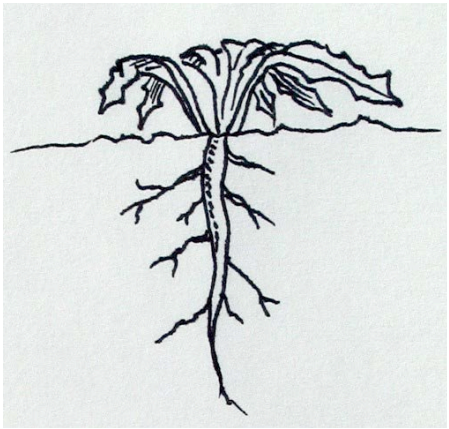
The following is a curriculum design that incorporates the five habitats represented within and surrounding Bolivar Habitat Preserve in relation to four distinct seasons. We begin with our youngest learners, the kindergarten through second grade students. The educators' focus will be to get younger students excited about environmental education. Teachers will inspire enthusiastic learning by "taking it outside" with an integrative approach in field investigations through the arts and sciences.

WEED WATCH

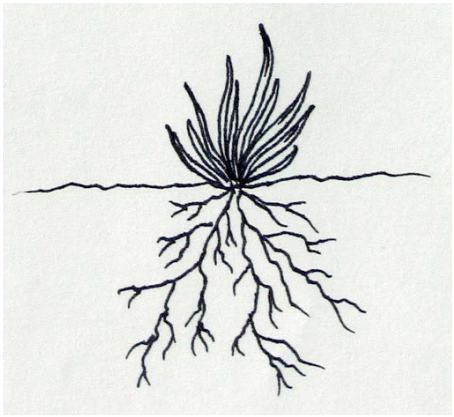
K through 2
Oak Motte and Coastal Prairie/Summer

Pierre-Joseph Redoute was a French botanical artist of the late eighteenth and early nineteenth centuries. Redoute mastered the unusual technique of stipple engraving – the use of tiny dots, rather than lines, to create subtle variations in coloring. His colored sketches were well-known for their beauty as well as their extraordinary detail, right down to their root systems! Moreover, there was not a plant Redoute did not find and render exquisite, even lowly weeds.

A "weed" is a plant that grows where we do not want it. Some weeds are actually fine in the wild; however, they may not be wanted in our yards. Weeds are everywhere on Bolivar's coastal prairies and woodlots, and they can be used to show different types of root systems. Tap roots, like carrots, are big and fleshy and can grow straight down. Diffused root systems, like most grasses have, consist of small roots and rootlets that spread over a large area.



TAP ROOT



DIFFUSED ROOT SYSTEM

With your interpreter, take a field trip to the prairie and woodlot areas of Bolivar Habitat Preserve. Together identify a few species of weeds and gently pull them so as not to separate the plant from the root. Shake off the loose dirt and determine which types of root systems the weeds are classified.

Place each weed—plant and root—on a backdrop of white paper to better observe its composition. How are these plants alike, and how are they different? Have they developed seeds? Begin a botanical sketch of the whole plant (roots, stems, leaves and flowers) on white sketch paper using a fine point Sharpie permanent marker. Draw what you see, not what you think you see. Shade and add depth to your sketch by dotting, or stippling. This can be done by using the tip of your Sharpie and tapping it where you want more shade. The more you tap, the darker the image you produce.

Now fill in the colors of your weeds and roots with colored pencils. Complete only the plant, leaving the background of your sketch paper blank. You have just completed a botanical scientific illustration in the likeness of Pierre-Joseph Redoute!

LIVE OAK STIPPLE WITH COLORED MARKERS

What you'll need:

- sheets of sketch paper pre-taped to particle board or other hard surface
- a set of 12 colored pencils per student
- a fine point Sharpie permanent marker for each student
- a square yard of white butcher paper for placing the weed and root specimens

What you'll know:

Pierre-Joseph Redoute
Weed
Diffused root system
Taproot
Stippling
Botanical sketching
Scientific illustration

Instructor's Notes and Thoughts:

Prairie Bird Walk – No Binoculars Required

K through 2nd

Coastal Prairie / Summer

In the summer, it is a perfect time of year to look for resident birds. Take your students on a walk to the prairie habitat. You will be looking for mockingbirds, shrikes, scissor-tailed flycatchers, harriers, sparrows, and meadowlarks. Walk quietly; keep your eyes wide open, and your ears tuned in for sounds. At first, the landscape will all look very similar. Search for movement in the tall grasses and silhouettes on lines and taller shrubs. Ask students to point to any sounds or movements.

Mockingbirds will sing proudly mimicking other bird songs. You will not be able to miss their bright white wing bars flashing as they move from tall places to the ground in search of food. The northern mockingbird will be busy and easy to find around the prairie on fence posts.

Loggerhead shrikes like to perch on taller sticks, wires, and shrubs. They are boldly marked across their face with a black mask. They are efficient predators looking for lizards and other prey such as insects. You may hear them singing but most likely you will see them sitting and waiting on a wire.

Scissor-tailed flycatchers cannot be missed in flight. They have a very long forked tail and bright pink/peach underneath their wings and lower on their bellies. If you see them on the wires, their tail is longer than any bird you can see on the peninsula.

The northern harrier is a bird of prey and can be seen flying low over grasslands in search of rodents. Harriers have a white rump patch easily seen as they fly low over the ground.

Many sparrows live in grasslands. You may not be able to identify individual species, but you will see the small sparrow on tops of grasses, appearing to sing, and then disappearing again.

The eastern meadowlark is always heard before it is seen. Listen for the most beautiful song. Look in that direction. You will find them perched on a taller shrub or fence post singing. They have bright yellow chests with a prominent black spot on their chest. If you see one take off from the ground, you will see white feathers on either side of its tail.

Once you have found and taken a good look at these birds, talk about the differences in flight, bill shape, and where you found them in the landscape. You can make a list of the birds seen or look at the birds in field guides when you return to your room. It is most important for children to develop their powers of observation as early as possible. They will be able to find these birds all over the peninsula and can even find them when driving in their car with their parents.

Encourage students to spend time looking, listening, and remembering what they see. This one tool called observation will sharpen cognitive level of thinking more than any other tool scientists and artists use.

What you'll need:

- sunscreen
- bugspray

What you'll know:

Resident birds
Observation

Instructor's Notes and Thoughts:

CAPTURING THE WIND

K through 2

Beach and Dune/Fall

Take a stroll to the beach, find a comfortable space on the sand, and lie belly up. As the sun's blanket covers you, the sand gets warmer and warmer. You become warmer as the air increases in temperature. Meanwhile, over the Gulf, the air is cooler. Because warm air weighs less than cool air, the cool air pushes down more and the pressure is higher. Air rushing from a high-pressure area in the Gulf to a low-pressure area, like the beach, creates a steady breeze. All over the world, wherever there is enough of a difference in temperature to create a difference in air pressure between two places, the wind blows from high to low trying to keep things equal. The bigger the difference in pressure, the harder the wind blows. Hurricanes, for example, represent extreme differences in barometric pressure.

After being blown away by the interactions of warm and cool breezes, focus your attention on the direction and the movement of the beach grasses. Look for ripples in the sand to determine the direction of the wind. Does your hair blow away from your face, or does the beach breeze blow your strands into your eyes and mouth? Are you facing the Gulf, or the dunes? Are clouds traveling in a particular direction, and what is their character?

Now, paint a beach or dunescape, which emphasizes the motion of a constant breeze. Use the waters from the Gulf to wet your brush and blend your paints. Then, notice how the beach grasses bend and dance in the direction of the wind. Sand may catch onto your wet paper. This is no accident. Let it remain as part of the art. Catch the motion of the clouds as they move with the vegetation below. Notice, too, how the waves will also create a directional flow that is in harmony with everything else affected by the wind's movement. Think direction and let your brush blow.

What you'll need:

- watercolor palettes for each student
- two watercolor brushes, one broad and one fine
- sheets of watercolor paper that have been pre-taped to individual particle boards or clip boards
- small cups for each student to scoop the Gulf water into - You may notice that the salt of Gulf waters affects your watercolor. Talk with your interpreter or teacher about these observations.

What you'll know:

landscape
temperature
barometric pressure
watercolor
dunescape
wind

Instructor's Notes and Thoughts:

Beach Walk – Abiotic and Biotic Factors

K through 2
Beach / Fall

Abiotic (a = non and bio = life) factors are the non-living components in a habitat that affect the environment. Biotic factors are the living organisms in a habitat that affect the environment.

Take your students on a walk to the beach. Have your students identify all the living organisms they can see from one place. If you do not know the name of the species, use names that are more general. Make a list of the organisms. Ask the students how the organism is affecting or using the beach, dune, and ocean. Now make a list of all the non-living components they can see or hear. Make a list of the abiotic factors. Ask the students how the non-living components affect the environment. How do these things affect the way an organism makes its living? What to different organisms need to do in order to deal with the effects of wind, waves, sand, heat, currents, waves, sunlight, and constant movements of the beach or water? There are many interactions at the beach. Your list will be long and exciting! Take time to notice how plants grow. Do they have leaves, runners, deep roots, or salt on their leaves? Take time to see how animals feed and travel. What do these adaptations allow different species to take advantage of or handle in the environment?

When you return to your room, give each group of four students a large sheet of butcher paper and colored markers. Ask them to draw as a group all of the abiotic factors witnessed at the beach. They can use symbols or show how the abiotic factors affect living organisms. Remember there is no right or wrong way to draw. By using pattern, symbol, and contour line designs that they have developed, the students will create something wonderful. Trust your students' current abilities and their ability to grow as artists, scientists, and naturalists. They can use different marks and colors for different abiotic factors. Display this drawing on your wall or in the hall to share with others.

What you'll need:

- butcher paper
- colored markers
- pencil
- paper

What you'll know:

Abiotic
Biotic

Instructor's Notes and Thoughts:

Y-STICKS
THE YING OF TWIG WEAVINGS

K through 2

Oak Motte/ Fall and Winter

As you wander around and under large oak trees, you will inevitably find forked tree branches lying on the ground. These fallen branches have separated from the trees by way of natural causes—heavy rains, new growth, death of parts of the tree, lightning, or drought, to name but a few. Because they are branches, they usually form a "Y," hence the term "Y-sticks." These Y-sticks make perfect natural looms on which twine and yarn can be woven to create frames. The frames become the vessels into which natural objects are inserted.

What you will need to create the base of a twig or Y-stick weaving is a forked tree branch, yarn, or twine, raffia and long grasses. The found objects to complete your woven sculpture may include feathers, seedpods, long strips of fallen bark, small twigs, moss, seashells, grasses, and leaves.

Y – STICK WEAVING

What to Do

1. Tie one end of the yarn to the top of one of the forks of the branch.
2. Stretch the yarn across to the other fork, and wrap it around once.
3. Stretch the yarn back across the first fork, about 1/4th inch below the first wrap (where the knot is). Wrap the yarn around.
4. Continue taking the yarn back and forth between the forks, wrapping it each time, until you reach the bottom of the fork.
5. Now weave the other materials up and down through the yarn. Go over one strand of yarn, then under the next, then over, and so on.
6. Between the strands of yarn place seashells, mosses, and other natural objects that may be too short to weave.

Suggestions: Allow your students to collect natural items from the habitat during summer and fall in preparation for creating a Y stick. Keep large zip lock bags with their names written on them in sharpie marker to keep track of their collection of natural objects found in the habitat preserve.

Also: Try using a branch with more than one fork - they are out there! - for a three-dimensional effect.

What you'll need:

- Y sticks and other natural objects
- yarn

What you'll know:

Habitat
Weaving

Instructor's Notes and Thoughts:

GYOTAKU

K through 2

Fresh and Salt Water Wetlands/Winter

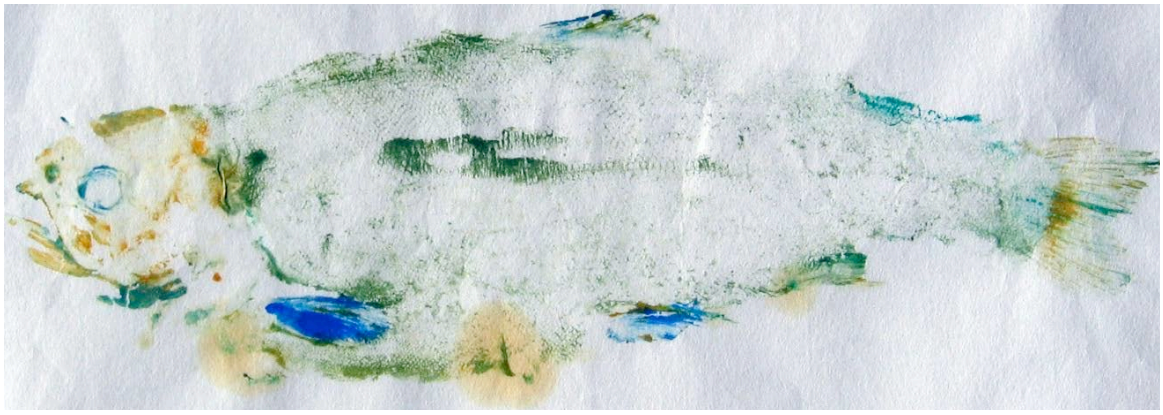
According to legend, the ancient samurai, skilled warriors in the service of their Japanese emperors, were given many tasks to prove their abilities as capable defenders of the empire. Among these tasks was a journey into the wilderness with nothing more than rice paper, ink, and the will to survive for one month entirely alone amid the natural world. The samurai hunted and fished for their meals with their bare hands. No knives, spears, fishing poles, or any other tools were permitted. How great and honorable were they upon returning to court after thirty days, well nourished, unscathed, and alive.

To prove their skill in fishing, samurai caught their fish by hand and painted them with *sumi*, or black ink. Rice paper was placed over the inked specimens to print and record their true size. This printing technique is known as *gyotaku.* It became very popular among Japanese artists and remains today a revered art form. After printing the fish, many artists have come to detail the fins, scales, gills and eyes with contrasting colors for a more interesting composition.

You are wandering the wetlands of Bolivar Habitat Preserve with nothing more than rice paper, colorful inks, brushes and some freshly caught fish and prawns. How will you record your catch?

First, notice the rice paper has two distinctive sides. One side is shiny and slick. This is the “dry” side, or the side upon which the paint or ink will not spread. The other side of the rice paper is fuzzy and textured. This is the “wet” side upon which the paint and ink will spread beyond the shape being printed. You have choices. Will you choose to have your print bleed out and appear wet, or will you choose a dry print that is crisp and well-defined? Try two sheets of rice paper and alternate sides to determine which print you prefer.

Paint or ink your specimen, place the rice paper over it, and gently rub. Carefully lift the paper away and study your print. Look for the features you want to emphasize on your fish. Will it have a large golden eye, orange dorsal fins or scarlet scales? Again, you have choices.



What you'll need:

- Local catch of fish and/or prawns from a nearby fish market—fresh, or freshly thawed, including the whole fish, head and tail.
- two sheets of rice paper per student
- tempera paints or colored ink
- paint brushes to coat your specimens
- newspaper for placing specimens before painting and printing
- small bucket with handle to put brushes in water after their use

Suggestion: Place a small cooler with the fresh catch at the end of the wetland dock with fish from the local market in it awaiting the student Samurai warriors.

What you'll know:

Gyotaku
Samurai
Sumi
Fins
Scales
Gills

Instructor's Notes and Thoughts:

Wetland Walk – Looking for Tracks

K through 2

Winter

In the early part of the winter the wetland area of the habitat may have a lower level of water, and the mud will be exposed. Take your students to the water's edge. Look for footprints along the shore. Ask the students to identify the tracks as bird, reptile, mammal, or amphibian. Did the footprints appear suddenly, do they come out of the water, do they walk off into the vegetation, do they disappear suddenly, or do they continue to meander between water, vegetation, and the mud? Why would the tracks do this? Bird tracks would appear and disappear suddenly, mammal tracks would come out of the vegetation and may or may not enter the water, and reptiles and amphibians may come out of the water onto the shores. If you are quiet on your approach, you may witness the animal making the tracks. If you find good tracks, take a photograph!

What you'll need:

- camera
- mud shoes

What you'll know:

Tracks
Wetland

Instructor's Notes and Thoughts:

THE FLOWER HUNTER – PUC PUGGY
A STUDY IN PRESSING FLOWERS AND LEAVES

K through 2

The Coastal Prairie/ Spring

William Bartram (1739 - 1823) was America's first botanical artist. His renderings of flowers, plants, birds and other wildlife are notable for their beauty as well as their scientific accuracy. William Bartram explored the wilderness of Colonial America in search of plant specimens, but he also documented and lived among Gulf natives such as the Seminoles during his travels. Here is what he wrote in September of 1776 when our country had just won its independence from British rule:

> *My search for plants has taken me into wilderness that few Americans know exists. I have lived with the people of the Choctaw, Creek and Cherokee nations. They taught me their customs and language, and guided me on their forest trails. The Seminole people invited me to feast on watermelon and oranges at their harvest celebration. They call me Puc Puggy, which means "flower hunter."*

You, too, are flower hunters, exploring Bolivar's coastal prairie. As with any habitat and its bounties, always be respectful when harvesting flowering plants. Pick only single stems with representative leaves and flowers and be careful not to pull whole plants, root and all, from the soil. Keep a field notebook and jot down the names of the plants that you gathered and the dates upon which you gathered them.

When you've harvested four to six varieties of flowering plants, place them on a paper towel and cover them with another paper towel. Try to keep your plants from overlapping or touching one another. Insert your flower "sandwich" inside your notebook. When you return to the science lab or art studio, place your "sandwich" on a counter top and stack one or two heavy books on top of it. Tape a piece of masking tape with your initials on it by your work to easily identify it later. In about a week, your flowers will be pressed and ready to be glued onto art paper in a composition of your choosing.

Drying leaves and flowers requires time and patience. When you dry a flower or herb, you are actually removing the natural moisture that all plants contain in their petals, leaves and stems. So try to pick the flowers you want to dry on a sunny morning after the dew has dried. This lessens the flowers' drying time.

What you'll need:

- single stems of flowering plants harvested in the coastal prairie habitat
- a spiral notebook for recording the names and locations of specimens
- a pencil
- a paper bag to contain the specimens

(in the art studio or science lab):

- paper towels
- two to three heavy books per student
- masking tape and a marker to label individual work
- Elmer's glue
- Card stock quality paper

What you'll know:

William Bartram
Botanical species
Specimen
Choctaw, Creek, Cherokee, Seminole Nations
Plant press
Collection
Specimen

Instructor's Notes and Thoughts:

Sound Walk

K through 2

Spring

In the spring, plants are blooming, birds are singing, insects and butterflies are migrating, reptiles are moving again, mammals are looking for mates, and people are happy to be outside again. Take your students on a long sound walk. Everyone must be very quite to hear the subtle sounds animals make.

Have students walk very quietly in pairs of two for several minutes through a section of the habitat. Ask the students what they have heard during this time and make a list. Do they hear the rustling of wind or the swish of a plant as an animal moves around? Insects may buzz, or if you are very silent, you can hear them move. Mammals will make bigger sounds and rustle more vegetation when they move. Birds will call or sing out to let their presence be known. Reptiles will make slow and very subtle sounds that are continuous as they move. Many amphibians have songs. Can the students hear manmade sounds? Can the students hear the sounds of nature made by wind, wave, and weather?

Continue to walk through sections of the Bolivar Habitat Preserve. And every several minutes note where you are and what sounds your hear. This should change when you move from oak motte to prairie, from prairie to wetland, and from the wetland to the beach.

It is not important to identify sounds to the level of species but more important to identify each different sound and look for its source. This walk will further the students' skills of observation and wonder at how many sounds are heard and yet unseen. In addition, students benefit greatly from learning how to listen and be silent outside. This is one of the most important skills to a naturalist looking for animals.

Post this list outside on the door of your classroom so other classes will know what to listen for during the spring. Organize your list of sounds in categories (abiotic & biotic, natural & manmade, land or sea or sky, etc.). Be creative with the classifications of sounds.

What you'll need:

- paper
- pencil

What you'll know:

Naturalist
Observation

Instructor's Notes and Thoughts:

Come forth into the light of things.
Let nature be your teacher.
William Wordsworth

Third through fifth graders will study the five habitats of Bolivar Habitat Preserve with an emphasis on refining their investigative methods. The art disciplines of journaling, scientific illustrating, and watercolor and oil pastel studies will be the primary focus toward enhancing the quality of the students' and teachers' experiences in the field.

LANDSCAPES IN OIL AND WATER

3rd through 5th grades
Coastal Prairie/ Summer

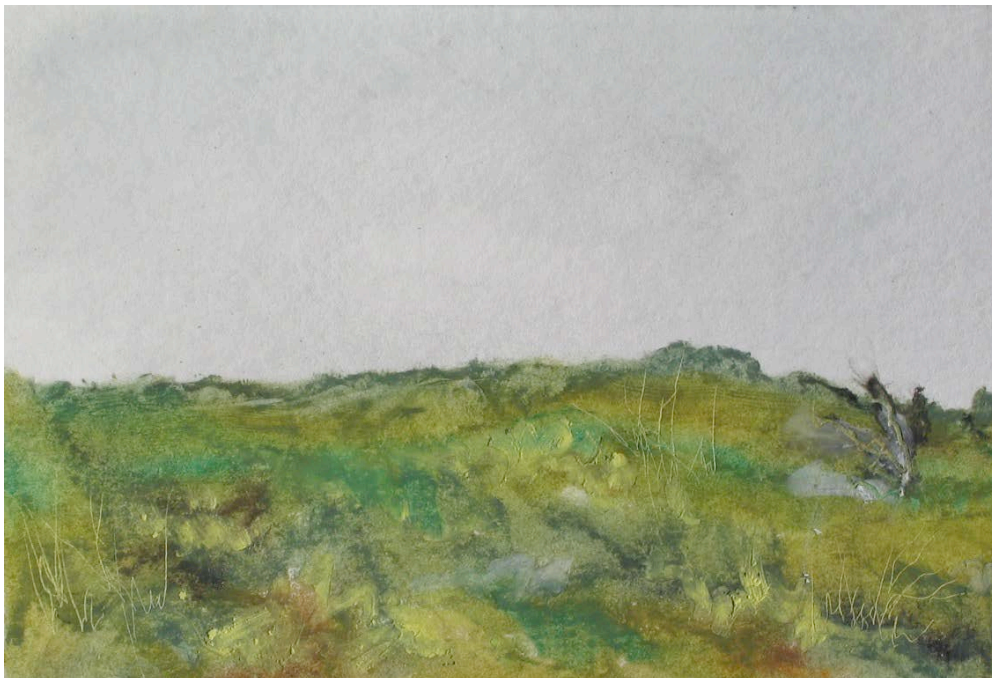
A prairie by definition is a broad tract of level grassland. The coastal prairie of Bolivar Habitat Preserve is characteristic of the bluestem prairie and wet coastal prairie types. It is entirely horizontal, and for this reason, it is a great study for the relationship between earth and sky from the artist's perspective.

The sky will set the mood or atmosphere of any picture. Observe, first, the types of clouds present before beginning your landscape. If the clouds are cirrus, or wispy white due to tiny ice crystals collecting at high altitudes, get ready for some "blow art." Wet the top half of watercolor paper that has been taped to particleboard with clean water and a full #4 brush. Now match the colors you see in the sky. Are they a clear sky blue, or are there gray tones appearing? Wash your wet paper's surface with blended watercolor paint and let it "bleed" a bit. Before your paint begins to dry, position the board flat toward your face and blow sideways. The air you blow upon the paper will create perfect cirrus clouds.

If it is cumulus clouds you want to achieve, or ones that have flat bases and rounded, cotton ball outlines, wet your paper and match the sky's tones from your palette. Again, let the watercolor bleed, but this time take a tissue or paper towel and blot out the color here and there to create puffy clouds in the white spaces that result.

Once your sky is painted, you can begin to work on the landscape. With oil pastels, you have many possibilities. You can bend and smooth low bushes and grasses into the full scapes because oil pastels are a combination of soft pastels (chalk) and oil and wax based crayons. In other words, you can blend and smear images with your fingertips to create a variety of textures and tones. Keep in mind that oil pastels are chalky oil paint, so do not treat them like crayons or pencils. They were created for blending and rubbing, so have at it.

Your prairie composition will no doubt have a horizontal format, but keep in mind that it is the relationship and activity between earth and sky that sets the tone and peaks the viewer's interest. The sky's condition determines how bright or how gray the foliage below is perceived.



Example of Prairie Scape in watercolor and oil pastel

What you'll need:

- a watercolor palette and brush per student
- watercolor paper that has been pre-taped to particle board
- set of 12 or 24 count oil pastels
- small cup for water

What you'll know:

Prairie scapes
Bluestem prairies
Oil pastels
Cirrus clouds
Cumulus clouds
Stratus clouds
Horizontal or landscape format
Land and sky relationship

Instructor's Notes and Thoughts:

Beach Walk – What is in the Sargassum

3rd through 5th

Summer

In the summer, a lot of Sargassum floats up on to the beaches of the Texas Coast. Take your students to the beach. Wade into the water with a five-gallon bucket. Find floating clumps of Sargassum. Shake the seaweed over the bucket and animals will fall out of the seaweed into your bucket. Keep several inches of seawater in the bucket. Repeat this several times. If students are allowed to wade into the water, break them up into teams of four, each armed with a bucket. You will increase your chances of catching a wider variety of organisms if more of you are searching for them.

Look into the bucket and see what has been caught. Notice how every animal is camouflaged to be the same coloration as the sargassum. In the bucket, you will find crabs, shrimp, nudebranchs, fish, seahorses, and pipefish. These animals are all specifically adapted to living their entire life in sargassum. Most of the animals will be very small and can easily be passed around and shared with each other. Additionally, you really cannot kill them because eventually the organisms wash ashore with the seaweed and become food for gulls, terns, and shorebirds. Discuss the different animals by phylum. You will find invertebrates from the phyla arthropoda and mollusca and vertebrates in the phylum chordata. Have fun and see how many different critters your class can catch.

Suggestion: 3rd – 5th grade is a good time to begin keeping a nature journal. Prepare journals with students that are at least 20 pages in length. Have them keep a journal throughout the year to document their experiences in the habitat preserve. Show them how to keep track in their journal of date, time, season, weather, temperature, type of cloud cover, and any thing else noticeable. This initial entry should include notes, thoughts, drawings, and a species list.

What you'll need:

- nature journals
- pencils
- 5-gallon buckets

What you'll know:

Sargassum
Phylum

Instructor's Notes and Thoughts:

THE MAN WHO DREW BIRDS
John James Audubon (1785-1851)
3rd through 5th
Fresh or Salt Water Wetlands / Fall

John James Audubon, who in 1827 published the first volume of his extraordinary work, **THE BIRDS OF AMERICA,** actually visited Galveston Bay. The date of his visit here was in the spring of 1837. The following are a few excerpts from his notes and journal that document the experiences he had on Bolivar Peninsula, Galveston Island, and the Bay area.

April 27. We were off at an early hour for the island, two miles distant; we waded nearly all the distance, so very shallow and filled with sandbanks is this famous Bay. The men set large fires to keep off the mosquitoes, which were annoying enough even for me. Besides many interesting birds, we found a new species of rattlesnake, with a double row of fangs on each side of its jaws.

April 29. Hundreds of Least Tern are breeding on the island of Galveston Bay. Also, on one of these islands I found eight or ten nests of the Roseate Spoonbill, placed in low cactuses, amid some hundreds of nests belonging to Herons of different species. Snakes are abundant on the island, and live on eggs of nesting birds, whence the old name for Galveston Island of "Snake Island."

May 1. The muskrat is the only small quadruped found here, and the common house rat has not reached this part of the world.

May 5. Hunted birds over the interior of Galveston Island today. While I was watching some Marsh Hawks that were breeding . . . I was much surprised to find a large flock of Skimmers alighted, and apparently asleep, on a dry grassy part of the interior . . . I found broods of the Spotted Sandpiper, or Tattler, already well grown.

When Audubon was a boy, he believed that studying birds and other wildlife in their natural habitats was more interesting and informative than just reading about them in scientific publications. He pioneered a technique essential to the understanding of birds by describing their behaviors and "languages" in natural settings. He became America's greatest painter of birds by portraying them as they went about their natural activities—building nests, brooding, roosting, feeding their young, fleeing predators, catching prey, or simply striking a beautiful pose.

The following activity revisits a time when early American naturalists combined biology and art to capture the beauty and complexity found in the natural world. You'll need to bring along a blank book, a set of colored pencils or watercolors, and a fine point ink pen or mechanical pencil into the field.

Begin by isolating a particular bird you spot and wish to illustrate. Pay attention to its behavior, the shape of its beak, the structure of its legs and feet. Is it multicolored? Does it have large eyes? Is it feeding? For example, the shape of a bird's wings reveals a lot of information

about its life ways. Short, rounded wings tell you that the bird is an escape artist. It probably lives in woods, bushes, or on the ground where it must be able to take off quickly to avoid enemies (cardinals, sparrows). Wide wings with feathers that spread out like fingers at the ends are clues that the bird is a hunter and a sky rider (eagles, hawks, vultures). Long, skinny wings with sharp looking tips indicate that the bird is a wind-surfing sailor. They glide over the water without flapping their wings (gulls, pelicans).

Some of the fastest flying birds, however, are those with narrow, pointed wings that angle back, like the wings of a jet. These birds sweep through the sky by flapping their wings quickly, then diving to snatch a meal (sandpipers, swifts, swallows).

As you observe your bird, with your pen or pencil, sketch only what you see. Don't create a shape that isn't there. Trust your eye. After you've completed your bird sketch, fill in the immediate background—a simple branch, bulrushes, or a post, for example. You don't have to complete an entire landscape or waterscape . . . keep your eye on the birdie, so to speak.

With your interpreter's help, identify your bird and journal some of your observations directly below your sketch. You are becoming a naturalist.

What you will need:

- a blank book or sketch book per student
- a set of colored pencils (24 or 36 count) per student, or a watercolor palette, brushes, small cup and water for each student. Sets of watercolor pencils are also recommended.
- a fine point Sharpie permanent marker per student

What you will know:

John James Audubon
Roseate spoonbill
Animal behavior
Naturalist
Nesting
Brooding
Roosting
Predator
Prey

Suggestion: Do not worry about how realisticly your students draw. Let them practice, and they will get better at recording observations through the media of drawing. It takes time to see and learn how to draw. They can make sketches of birds in flight from memory or quickly draw parts of the birds. Later the class can look in field guides to see how other naturalists in the past have drawn.

Instructor's Notes and Thoughts:

Hawk Walk - Prairie

3rd through 5th Grade

Fall

During the fall, many species of hawks migrate across the bay. Many of them can be witnessed resting on poles along roadsides, feeding in open fields, flying in large groups high up in the air, and flying over prairies. Demonstrate how to use and care for binoculars. Take your students armed with binoculars and field guides out into an open space of your habitat. Have your students stand in a circle with their backs facing into the circle. Pair the students so one can be a recorder and one can be the spotter. Everyone should have a clipboard with paper and pencil to take notes with while out in the field. Scan each level of the landscape in bands horizontally from right to left moving slowly up into the sky until they are focusing on the upper reaches of the clouds. Every time a large bird is seen, have students spend some time looking closely at the bird trying to note unique characteristics of the bird.

Are the wing tips a certain color? Does the hawk's tail have any banding, and what is the pattern of the banding? If you can see the top of the tail, is there a patch of any color on the tail or the rump? Does the bird have any markings on its face? These can be called whiskers, mustaches, eyebrows, masks, and crowns. Can you see the color of the bird's feet?

Now after they have taken a very close look at the bird and noted as many characteristics as they can, have the students open their field guides and try to identify the bird. Once you class returns to the classroom, make a species list for that day. Keep it for next year. Over time, the 3rd through 5th graders will be able to compile a species checklist of birds of prey seen from the habitat in the fall.

Using binoculars can be tricky, but your students are capable of mastering this skill. Students should always adjust the binoculars for their face. First, pull the binoculars together until they have one big circle in their view. Then spin or push the knob in the middle of the two barrels until the binoculars are in focus. Next, use the ocular knob that moves to put the binoculars into fine focus. Use an object that does not move to focus and adjust the binoculars.

Finding what you are looking for in the binoculars is also a tricky task. But, once you realize that it is easy to keep your eyes and head still, focus on the point your want to see and then bring the binoculars up to your face and eyes with out moving them. Your students will experience many wonders with binoculars. Once the bird is in view, then you can focus to that distance and move your head to keep the bird in the field of view of your binoculars.

Tens of thousands of hawks migrate across Galveston Bay via Smith Point. Many hawks rest along the Bolivar Peninsula waiting for the sun to warm the air and thermals to rise. The hawks need the thermals to carry them up into the air and over Galveston Bay. Many birds of prey should be seen in the fall. For more information, contact HawkWatch International at www.hawkwatch.org.

What you'll need:

- binoculars
- paper
- pencil
- clipboard

What you'll know:

Binoculars
Hawk

Instructor's Notes and Thoughts:

CLAY TILE CASTING

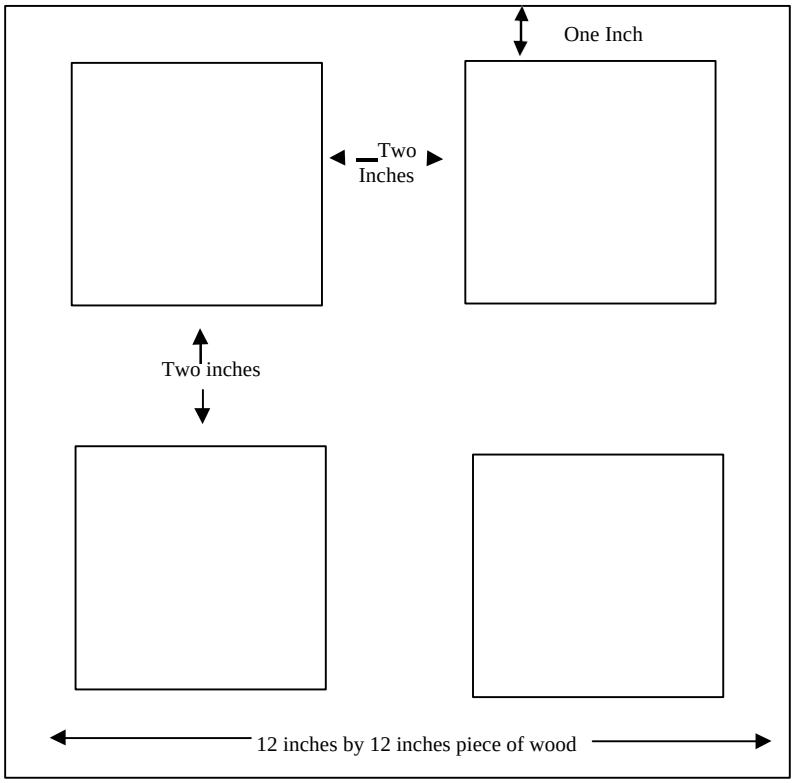
3rd through 5th grades

Fresh Water Wetlands/ Beach and Dune/ Fall or Winter

Fossils are impressions or the remains of plants or animals from a past geologic age. They are preserved mostly in sedimentary rock found in the earth's crust. It takes millions of years for fossils to form, but it only takes a trip to the beach or wetlands with a bucket of clay to recreate the process of fossil formation.

Students will be given enough kneaded clay to create foursquare tiles of 4 inches by 4 inches. In addition to the clay, rolling pins, oil cloth, and clipboards with wax paper adhered to them are needed to complete this field activity. After rolling out the clay to about 1/4th inch thick, cut four 4-inch squares with a palette knife. Collect "fossil" subjects such as scallop or cockleshells, grasses and other interesting leaves and ferns, feathers, dragonfly carcasses (they're all over the beach and wetland habitats particularly in the fall), and twelve-inch long driftwood. The found natural objects will be used to create an imprint in the prepared clay squares.

When you return to the classroom, the imprinted squares may be glazed in organic colors and fired, or simply bisque fired and rubbed with a metallic bronze lacquer. After the square tiles have been fired and/or treated, mount them onto a twelve-inch by twelve-inch particle or wooden board with a silicone adhesive. With carpenter's glue, adhere the driftwood to the four sides of your piece to create a frame. Refer to the illustration below for suggested dimensions.



What you'll need: (in the field)

- 25 pound slab of kneaded clay for whole class
- rolling pins
- clip boards for each student
- wax paper
- palette knives
- driftwood, shells, plant matter, varieties of organic textures
- clay cutting tool – tie a piece of string between two small sticks and it will easily cut the clay pieces from the slab or pieces in half

What you'll know:

Past geologic age
Fossils
Sedimentary rock
Bisque firing
Imprints
Glaze

Instructor's Notes and Thoughts:

PRINTING IN THE ROUND

3rd through 5th grades

Oak Motte/ Winter

Nature is full of patterns. Look closely at a leaf, flower, or feather, and you'll pick up a rhythm or a repetition of a simple theme. With brayer printing, repetition occurs within three or four inches of a brayer rotation.

For this exercise, you will need large pieces of butcher paper and a variety of tempera paints as well as brayer rollers for each student. Collect small, pliable natural objects like grasses, leaves and tiny seeds. Twigs and pebbles will not work in this activity as they are stiff and hard and cannot be easily picked up by a wet brayer roller. Add to your selection a bit of yarn no longer than five or so inches.

Set up shallow pans of paint and add to them your found objects. Roll your brayer roller through them and the objects will stick to the brayer in a random manner. The paint serves as glue for the objects. Now roll your textured brayer roller over the butcher paper and observe the patterns and compositions. You may want to roll several columns and rows of print, or intersect the rows and columns of print. Use contrasting colors and alternate rows. Be experimental.

When you've completed your brayer printing, step back and observe your work. Can you imagine seeing any trees, animals, mountains or landscapes? Give your work a title and compose a piece of prose or haiku (first line, five syllables; second line, seven syllables; third line, five syllables) based upon what you imagine seeing.

Dragonflies hover
Seeking mosquito offspring
Insect repellents

Brayer Print (Abstraction of Marsh and Dragonflies)

What you'll need:

- several yards of butcher paper in varying colors
- a variety of tempera paints
- a brayer roller per student
- small pieces of yarn, and pliable, natural, found objects
- a field note book and pencil per student
- take a walk with students to find natural objects

What you'll know:

Pattern
Repetition
Brayer roller
Haiku
1-inch by 14-inch long strip of poster board

Instructor's Notes and Thoughts:

Wetland Walk – Casting Tracks

3rd through 5th

Wetland / Winter

Early in the winter when tides can be very low, the wetlands have lower levels of water. This is the prefect time to search for animal tracks. Take your students to the muddy water's edge of the wetland. Look for animal tracks. Once a track is found, have pairs of students work together. Take a 1-inch by 14-inch long strip of poster board and circle the track and secure the circle with a paperclip or stapler. Push the poster board down into the mud a bit. Mix a ratio of one part plaster to one parts water in a 16-ounce cup with a Popsicle stick. Do not mix the plaster until a track has been found. The plaster should have the consistency of pancake batter. Students will pour their plaster into the ring. Plaster sets within an hour. It will be warm to the touch during this process. If the mud is wet, it will take a bit longer to set. You can leave the wetland, let it set, and come back later in few hours.

Take your molds inside and identify the tracks. Many track identification books exist, and some websites have examples, too. Did you find tracks that overlapped on one another? Could this have been a predator and prey interaction? Can you tell if it was a wading bird or a smaller bird taking a drink? Was a group gathered as a family? Were some tracks fresh, indicating the animals had been there recently? Were some tracks old, indicating the animals had been there in the last week? What type of animal was most commonly found? Were more bird tracks found than mammal tracks? Make a species list of tracks for the wetland with your class. Create a display in the hall of the identified tracks so other classes know what different tracks look like in the wetland.

What you'll need:

- 1-inch by 14-inch long strips of poster board
- stapler
- plaster of paris
- water

What you'll know:

Tracks
Plaster Casting
Wetland

Instructor's Notes and Thoughts:

IMPRESSIONISM
A STUDY OF SUNLIGHT ON WATER

3rd through 5th grades

Beach and Dunes/ Fresh Water Wetlands/ Spring

During the last half of the 1800s, a remarkable movement in art was taking root and spreading throughout Europe and into the United States. It was described as *Impressionism* and represented the study of how light falls on an object, body of water, or figure by touches of broken color to model form and outline. Landscapes, waterscapes, and all objects in and around them were painted with the idea that sunlight visually chops things up. Water has ripples and patterned textures, for example, and the sun points this out with dots and lines of yellow-white that seem to flow with the current.

In this exercise, you'll use watercolors or tempera paints and watercolor paper to capture the light and shadows created by the sun as it interacts with a body of water. Before you fill your brush and begin painting, however, there are a few general rules about water to consider. First, when painting a body of water, all light is marked horizontally because water is flat. In a beach scene, the curved appearance of the waves is created by placing horizontal marks in a curved pattern. Also, whatever their size or shape, ripples always have pointed ends.

Reflections occur in water because the water acts like a mirror. In most cases, reflections are painted by making ripple-shaped brushstrokes with darker tonal value, as there is a certain amount of distortion because of the movement of the water. If the water is still, however, the reflection is an exact mirror image. What you see is what you get, only upside-down.

Notice, too, how sunlight brightens one side of an object and is blocked on the other side, creating long and short shadows. If you can paint the differences between bright and dark, textured and smooth, with white paint at the tip of you brush, you are indeed painting impressionistically.

What you'll need:

- a watercolor palette per student or tempera paints
- four natural brushes of varying tips
- watercolor paper that is pre-taped to particle board

What you'll know:

Impressionism
Waterscape
Reflections
Mirror images
Horizontal versus Vertical

Instructor's Notes and Thoughts:

Prairie Butterfly Watch

3rd through 5th grade

Spring

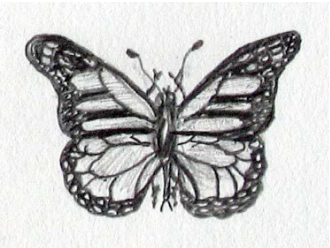
Spring is famous for smelling wildflowers and watching butterflies on the prairie. Get out your binoculars again. Pair up your students so that one can be a recorder while the other student can watch. Get out a few good butterfly field guides and head to the prairie. Remember all of your tools used during the hawk watch and remind the students. The ability to see butterflies in binoculars is a skill that requires refinement and practice.

Once on the prairie, have the students scan with their eyes looking for butterflies flying or resting. Once one is found, have the students look through their binoculars at the butterflies. Students will need to be farther than 10 feet away from the butterflies to get a good look at the butterfly. Have the student looking at the butterfly take some time to notice characteristics about the butterfly and tell the recorder:

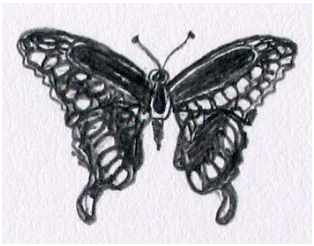
- What color is the wing pattern of the butterfly?
- Does the butterfly have any large distinctive shapes of colors on its wings?
- Is it all one color? What color is it?
- Do the butterflies wing beat in any particular pattern?

Once you return to your class, have each group tell which species they saw. As a class, make a checklist of all species seen that day and save the list to refer to next year. Eventually, the 3rd through 5th grade classes will be able to compile a spring species checklist of butterflies seen on the Bolivar Habitat Preserve's prairie.

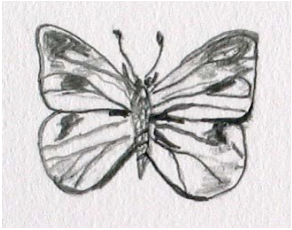
Have students look at the range map in the butterfly field guides of each species. Have them use the color codes to figure out if the butterfly is a resident or migrant, where it is headed to or from, and if it is a male or female. Add this information to your species list.



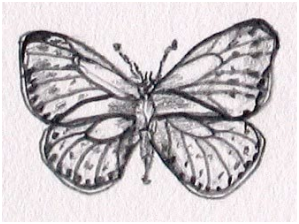
Monarch Butterfly



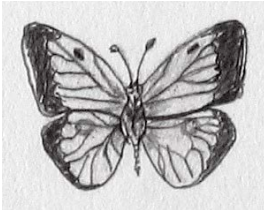
Giant Swallowtail butterfly



Cabbage Butterfly



Spring Azure Butterfly



Clouded sulphur Butterfly

What you'll need:

- binoculars
- paper
- pencil
- field guides

What you'll know:

Observation
Butterfly

Instructor's Notes and Thoughts:

Nature uses only the longest threads to weave her patterns,
so that each small piece of her fabric
reveals the organization of the entire tapestry.
Richard Feynman

The following activities are designed for middle school students in an effort toward mastery of environmental knowledge and awareness. These students, through photography, journaling, and art history, will develop the skills necessary for appreciating and protecting their indigenous environment.

SUMI-E
CONTEMPLATING AND RECORDING NATURE

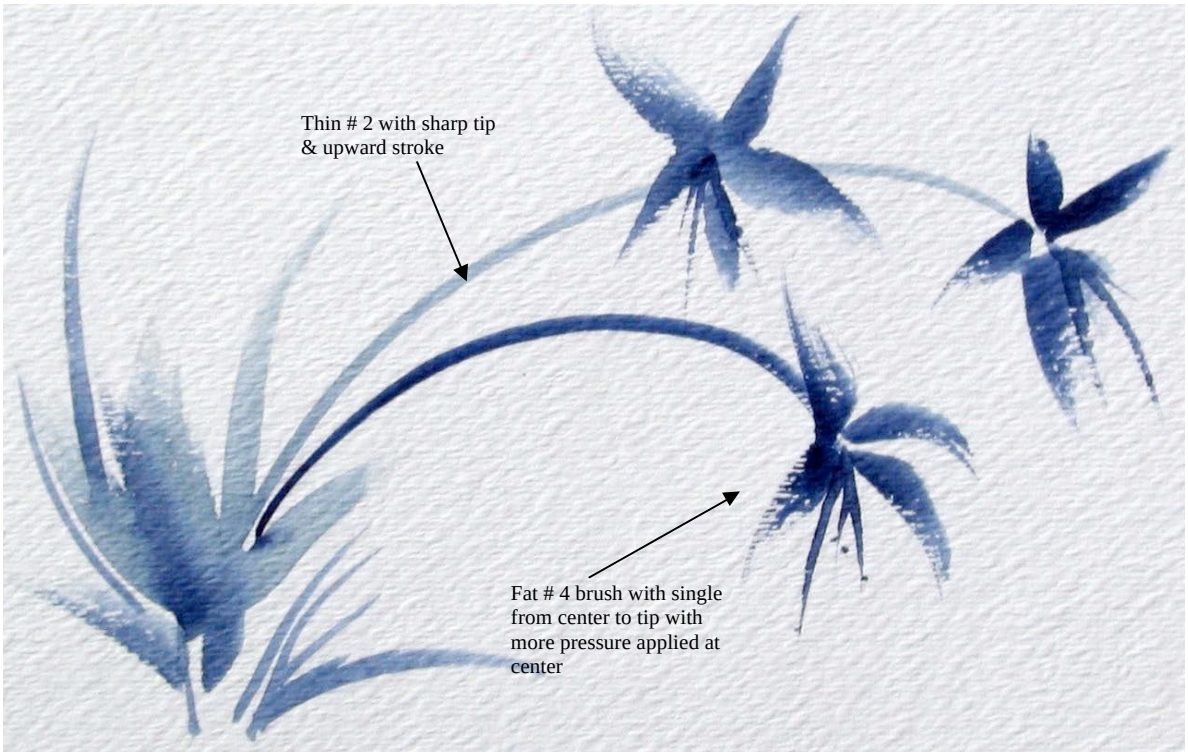
6th through 8th grades
Dunes/Fresh Water Wetlands/ Summer

Sumi-e, or ink and brush painting, originated in China over a thousand years ago as the art of Zen Buddhism. Its simplicity and beauty soon spread to all regions of the Far East, and today it is studied and practiced all over the world.

There are two important elements of sumi-e that make it a great art form to take to the dunes and wetlands of the Bolivar Habitat Preserve. The first element is that studying sumi-e places humans within the environment as a part of nature with no boundaries between kingdoms of plants and animals, the animate and inanimate, the living and the dead. In our Western culture, for example, we are inclined to classify, rank and distinguish ourselves as separate from our natural surroundings.

The second element of sumi-e is the economy of brush strokes made to render a painting. The fewer brush strokes used to render a bird in flight or a clump of beach grass bending with the wind, the better one is as an artist according to sumi-e masters. In other words, ***less is more.*** In fact, sumi-e masters actually count the number of brush strokes made in a completed composition to determine its excellence, or its need for improvement.

You will need watercolor palettes, two brushes per student—one full, (# 4) and one thin, (# 2)—some clean water, and rice paper. The paper can be taped or clipped onto particle board or a clipboard. Now, isolate something in the environment—a clump of beach grass, a bird standing by the water, a cluster of rocks, or a dragonfly, for example. Study your subject and decide what parts of your composition will require a thick brush for broader strokes and what will be necessary for fine lines and a thinner brush. Work quickly and count the number of strokes you use. Try to keep the number of brush strokes under twenty-five. This is what is meant by *less is more.* Try completing several different subjects while you're in the field. The more you practice this technique, the better you become. You may even find this process soothing or calming the further you pursue it.



SUMI – E Demonstrating the economy of Japanese brush strokes

What you'll need:

- 1 watercolor palette per student, or 1 sumi-e set per student
- 2 brushes per student, a #2 and a #4 natural brush
- clean water
- rice paper, which has been clipped to a clipboard

What you'll know:

Sumi-e
Zen Buddhism
Economy

Instructor's Notes and Thoughts:

SARGASSUM BEACH WALK

6th through 8th

Beach / Summer

Background Information:

In the summer, a lot of Sargassum floats up on to the beaches of the Texas Coast. Two species of sargassum are of interest to Galveston visitors: Sargassum natans and Sargassum fluitans. These sargassum species are pelagic brown algae, more commonly referred to as seaweed or gulfweed. While many sargassum species are benthic, the species we find in the Gulf of Mexico are free-floating and never attach to the ocean floor. The sargassum species reproduce asexually by fragmentation from the parent organism rather than by seed or spore, making them almost like one big super organism. Sargassum also has air bladders that allow them to float on or near the surface of the water to gather sunlight for photosynthesis.

Free-floating sargassum is only found in the Atlantic Ocean where the algae grows in the calm waters of tropical and subtropical areas like the Sargasso Sea. The Sargasso Sea is almost two-thirds of the size of the United States and is a free-floating meadow of sargassum, lying between the United States and Africa. The sargassum consolidates in large floating mats that can span over a hundred meters. Ocean currents and winds carry these mats to coastlines along the Caribbean and Gulf of Mexico where they are deposited on beaches at the high tide line.

Sargassum travels to the Texas coast through what researchers at Texas A&M University at Galveston describe as the Sargassum Loop System. The loop originates in the Sargasso Sea and currents carry the floating mats through the Caribbean Sea, north past the Yucatan Peninsula, around the Gulf of Mexico and eventually through the Florida Straits back to the Sargasso Sea. Other than the Sargasso Sea, more sargassum is found in the Gulf of Mexico than anywhere else in the world, and during the time in the warm waters of the Gulf, the Sargassum tends to grow rapidly.

The exact reason the influx of sargassum to Texas beaches varies each year is still being researched. Different factors that affect the amount of sargassum include weather patterns impacting ocean currents and the amount of time sargassum spends in nutrient-rich waters. For example, due to the unusually cold winter in 2014 and the numerous cold fronts that moved into the gulf that year, the sargassum was pushed into the Bay of Campeche. The Bay of Campeche is a very nutrient-rich part of the Gulf of Mexico, and the prolonged stay allowed the sargassum to grow longer and increase in size.

The floating mats of sargassum provide important functions for pelagic species. The floating mats are essential habitat for many species of fish, shrimp, crabs, other invertebrates, and microorganisms. Ten species are actually endemic to the floating mats and found nowhere else in the world. The mats serve as a resource for migratory species such as humpback whales out in the vast openness of the ocean, and are even a food resource for larger commercial species such as tuna and other predators that lurk around the edges of the sargassum community. Four species of sea turtles even use the sargassum: the endangered loggerhead and green sea turtle,

and the critically endangered hawksbill and Kemp's Ridley (the Texas state turtle). After hatching and the frenzy of making it to the water, young sea turtles use the floating mats as rafts and means of shelter and sustenance for survival in the ocean.

Organisms that reside in the sargassum or use it for transport often possess physical adaptations that allow them to blend into the floating mats and camouflage from potential predators. The Sargassum Shrimp is perfectly colored to blend into the algae's leaf-like blades, and Sargassum Sea Slug is so well camouflaged it looks like an extension of the algae. The Sargassum frogfish also blends in well to the floating mats, and the shape of its fins enable the predator to easily creep up on unsuspecting prey.

Although historically the answer to sargassum landings has been to rake it for removal or return to the ocean, sargassum also provides many benefits on our beaches. Sargassum traps sand within its strands, and as it accumulates it can facilitate dune build up, which is an important defense against beach erosion and damage from topical storms.

As it decomposes, the sargassum also serves as fertilizer for dune plants, which help stabilize dune systems. Even the decomposing organisms washed ashore with the sargassum serve as an important food source for sea and shore birds.

The accompanying smell is one of the main reasons visitors find seasonal sargassum landings unsightly. The sargassum itself does not smell, but rather the process of decomposition occurring on the beach gives off an odor. Not only is the sargassum decomposing, but also the multitude of marine life that is found in the floating mats and washed ashore in the sargassum. Despite the smell, this decomposition actually hints at several important benefits provided by the floating algae.

Activity:

Take your students to the beach. Wade into the water with a five-gallon bucket. Find floating clumps of Sargassum. Shake the seaweed over the bucket, and animals will fall out of the seaweed and into your bucket. Keep several inches of seawater in the bucket. Repeat this several times. If students are allowed to wade into the water, break them up into teams of four, each armed with a bucket. You will increase your chances of catching a wider variety of organisms if more of you are searching for them.

Look into the bucket and see what has been caught. Notice how every animal is camouflaged to be the same coloration of the sargassum. In the bucket, you will find crabs, shrimp, nudebranchs, fish, seahorses, and pipefish. These animals are all specifically adapted to living their entire life in sargassum. Most of the animals will be very small and can easily be passed around and shared with each other. Additionally, you really cannot kill them because eventually the organisms wash ashore with the seaweed and become food for gulls, terns, and shorebirds. See how many different species you can catch in one location and record your findings below in the column labeled "Habitat 1." Use the Sargassum Seek and Find Guide in your supply kit from Artist Boat to identify the species you catch. After you have practiced as a

class, divide your students into groups and allow them to spread out to different locations along the beach to collect data for “Habitat 2.” Feel free to encourage a little friendly competition, as well as collaborative effort.

Species	**Habitat 1:** **Number (n) of each species**	**Habitat 2:** **Number (n) of each species**
Sargassum frogfish		
Plane-head filefish		
Sargassum crab		
Brown grass shrimp		
Sargassum shrimp		
Nudibranch		
Sargassum pipefish		
Gulf pipefish		
Needlefish		
	Total number (N):	**Total number (N):**

Simpson's Index of Diversity
Guided Practice

Directions: Complete the following guided practice exercises with your class. Demonstrate how to calculate species diversity using the first sample data set. Complete the second set of calculations together or in student groups.

Background Information: In ecology, Simpson's Index is used to quantify the biodiversity of a habitat. A habitat is the natural environment of a plant, animal, or other organism. Biodiversity is the variety of life in a particular habitat. Biodiversity takes into account the number of species and the relative abundance of each species. Species richness is the number of different species represented in a particular habitat. Species evenness is the abundance of each species represented in a habitat. When calculating biodiversity, Simpson's Index accounts for both species richness and species evenness in order to determine the overall biodiversity of a given habitat.

Formula for Simpson's Index of Diversity:

$$D = 1 - \left(\frac{\Sigma\, n(n-1)}{N(N-1)} \right)$$

Interpreting Results: D represents the probability of randomly sampling two different species in a given habitat. For example, if D = 0.75, then there is a 75% chance of selecting two different species (and a 25% chance of selecting two of the same species).

For Example:

Species	Habitat 1: n (number of individuals)	Habitat 2: n (number of individuals)
Ibis	7	10
Great white egret	5	10
Snowy egret	3	10
Brown pelican	31	10
Great blue heron	9	10
Reddish egret	5	0
Total: N	60	50

Calculations for Habitat 1:

D= 1 – (7(7-1) + 5(5-1) + 3(3-1) + 31(31-1) + 9(9-1) + 5(5-1) / 60(60-1))

D= 1 – (42 + 20 + 6 + 930 + 72 + 20 / 3540)

D= 1 – 0.31

D= .69

Calculations for Habitat 2:

D= 1 – (10(10-1) + 10(10-1) + 10(10-1) + 10(10-1) + 10(10-1) / 50(50-1))

D= 1 – (90 + 90 + 90 + 90 + 90 / 2450)

D= 1 - .18

D= .82

Interpretation Questions:

1. Which habitat has more species richness? Habitat 1
2. Which habitat has more species evenness? Habitat 2
3. Which habitat is more biodiverse? Habitat 2

Simpson's Index of Diversity:
Independent Practice

Directions: Catch and identify species in sargassum on the beach in two different locations. Record your data in the chart below. Add species to the list as needed. Then, calculate the Simpson's Index of Diversity (D) for each habitat. Compare results.

Species	**Habitat 1:** **Number (n) of each species**	**Habitat 2:** **Number (n) of each species**
Sargassum frogfish		
Plane-head filefish		
Sargassum crab		
Brown grass shrimp		
Sargassum shrimp		
Nudibranch		
Sargassum pipefish		
Gulf pipefish		
Needlefish		
	Total number (N):	**Total number (N):**

Formula for Simpson's Index of Diversity:

$$D = 1 - \left(\frac{\Sigma\, n(n-1)}{N(N-1)} \right)$$

D =

What you'll need:

- Sargassum Seek and Find Guide
- 5-gallon buckets
- Guided and Independent Practice Worksheets

What you'll know:

Sargassum
Biodiversity
Species Evenness
Species Richness
Simpson's Index of Diversity

Instructor's Notes and Thoughts:

AN ABSTRACT LOOK AT THE ENVIRONMENT
POSTER ART

6th through 8th grades

Fresh and Salt Water Wetlands/Beach/Fall

Posters are art forms intended for public display. They suggest a point of view and provoke public response.

This exercise invites several levels of activity and thought. First, middle school students will scan the **GALVESTON COUNTY DAILY NEWS** and/or the **HOUSTON CHRONICLE** for a full month to find articles involving the Galveston Bay area (Galveston Island, Bolivar Peninsula, Galveston and Harris Counties) for political, economic, and environmental news and issues. Students will then clip out pertinent articles and organize their findings on the classroom bulletin board.

Given these retrieved facts and issues, the students will then visit their immediate wetland habitat on Bolivar's Preserve to create the visuals necessary to present a powerful public art piece. What would you like to express about where you live and attend school? Do you want others to know how important the welfare and legacy of your environment is to you, your families, and friends? Keep in mind that although the words are concise and to the point in poster art, the graphics, or the deliberately communicated art work, can go in many interesting directions. Some of the most effective graphic work, in fact, is done in abstract terms.

Cubism, an art movement inspired by **Pablo Picasso**, is an analytical way of looking at and developing a composition. In 1909, Picasso, one of the world's greatest artists and innovative scholars, returned to his homeland of Spain where he began taking a closer look at the landscape surrounding Horte de Ebro, a small village in southern Spain. It was here that Picasso created the first landscape with a true cubist structure. Picasso's hills and skies were constructed in blocks and geometric shapes in an effort to show segments of nature as an organized whole. Picasso believed the natural world has sharply defined patterns and demonstrated this through his cubist studies.

In creating the art for an effective poster, *cubism* could well be a bold visual possibility. First, study the wetland landscape and issue you intend to develop. Imagine natural subjects like trees, grasses, bodies of water and animals as rectangles, circles, squares, triangles, and overlapping figures and shapes. Create a composition of abstract shapes that simplify what was viewed outdoors in the habitat. You can sketch outdoors and simplify the drawing on poster board in the style of cubism. Use tools to create very straight lines or different ovals that represent your abstraction of the habitat landscape. Design a slogan or message to overlay on your painting on the poster board. Use the newspaper clippings as inspiration or to copy certain messages. Choose, as well, colors that imply attitudes and symbolism – pure blacks, grays and whites, yellows, reds and greens, for example. Say something honest and bold with shapes and colors about how you regard your own habitat. Then, add a concise and complete sentence for punctuation.

What you will need:

- poster board
- tempera or acrylic paints
- multi-width natural brushes
- design sketch paper and pencils
- compasses, T-squares, protractors, rulers, yard sticks
- a month to collect newspaper articles

What you will know:

Pablo Picasso
Cubism
Graphics
Current environmental issues and topics

Instructor's Notes and Thoughts:

HUMAN IMPACTS ON THE ENVIRONMENT: BEACH CLEAN-UP AND MARINE DEBRIS ART

6th through 8th

Beach

Background Information:

Human actions are responsible for changing every ecosystem on the planet in profound ways. Some impacts to the environment are created indirectly by human activities. For example, the human activity of burning fossil fuels results in increased global temperatures, which results in rising sea levels and an increase in extreme weather events like hurricanes and droughts. Other human actions, like oil spills and deforestation, impact the environment directly.

Marine debris is an example of a human action that impacts the environment directly and causes serious issues for wildlife in our coastal and marine ecosystems. Marine debris is trash found in the ocean or along shorelines, and consists of not only litter, but also objects like abandoned crab traps or derelict boats. Some of the major forms of marine debris found in the ocean include aluminum cans, cigarettes, food packaging, and various plastic items like bottles, caps or lids, utensils, bags, and straws.

Plastic objects such as fishing line or six-pack rings are especially damaging, as they can entangle marine mammals, sea turtles, birds, and fish and make them sick or weak. These animals can also ingest plastic waste, such as when sea turtles mistake plastic bags for jellyfish or birds mistake plastic particles for fish eggs. Scientists estimate that up to one million sea birds and 100,000 sea mammals and sea turtles die each year from ingesting plastic, because they starve from a false sense of fullness. Issues with plastic waste are especially troubling as scientists now estimate that forty percent of plastic waste not recycled ends up in the oceans. In 2010 alone, scientists figure 4 to 12 million metric tons of plastic was washed offshore, enough to cover every foot of coastline on the planet.

Plastic waste breaks down into smaller particles (micropalstics), which are carried throughout our oceans by currents and can be deposited onto beaches. Other types of plastic waste start out small, such as microbeads. When not deposited on beaches, this plastic waste can be found in all levels of the water column and is potentially on the menu for a majority of marine life and even sea birds.

These microplastics do not degrade, and cannot only be ingested by marine life, but also act like sediment particles and potentially bond with other harmful pollutants in the oceans. Plastic waste can even become trapped in the floating sargassum mats, harming the diverse communities in the mats and washing ashore with the sargassum. Since the plastic waste is carried by currents and does not decompose, it remains in the marine ecosystem for a long time, from decades or centuries depending on the original item. Depending on current flow, this can lead to congregation of plastic debris in certain areas, such as the Great Pacific Garbage Patch, also known as the Pacific Trash Vortex, a patch of ocean the size of Texas where bits of plastic

have accumulated. A similar, if not quite as large, plastic patch has been discovered in the Atlantic Ocean as well.

Fortunately, there are several actions we can take in our every day activities that will reduce the amount of marine debris in our oceans. Most of these activities require minimal or no extra effort to complete. Just as nonpoint source pollution can add up through a watershed, these seemingly small actions can add up and have a large, positive, impact on our environment.

Choose Reusable Options	Replace single-use plastics with reusable options. Most single-use items have an alternative. For example, you can choose reusable shopping bags, reusable containers for food, and reusable bottles instead of single-use plastic bottles. This reduces the amount of waste that ends up in our waterways.
Recycle	In instances where you do use single-use items, be sure to recycle when possible so items do not end up in a landfill or floating in our waterways. Be sure that you remove extra food particles, and check the number on the items you are recycling to be sure your recycling center accepts the items. Most places accept #'s 1, 2, and 5, but the others depend on the market available for them. Otherwise, the items could contaminate the entire batch of recycling.
Pack In and Pack Out	Pack In and Pack Out: make sure when you go out that whatever trash you take with you is brought back and properly disposed of so that it does not end up in our waterways as storm water runoff.
Secure Receptacles	Secure your trash receptacles so that trash and recyclables do not accidentally blow away and end up in our waterways. Also, if a trashcan is full or overflowing, adding your trash might create overflow that could end up in our waterways.
Check for Microplastics	Check products you purchase for microplastic particles known as microbeads. Microbeads are found in many personal hygiene products and will have polyethylene, PVC, polystyrene, or polypropylene listed in their ingredients. You can check your personal product ingredients online at Walgreens.com
Collect fishing line	Collect your monofilament fishing line. Do not leave fishing line behind, and retrieve any other line you may find while fishing, but be careful not to tug on snagged lines that could be caught on habitat below the surface.

Activities:

1) Host a Beach Clean-Up

Divide your team into groups of 5 and assign each group to a designated area of the beach. Set the length of your clean-up to meet the needs of your participants. Encourage hydration and suncreen breaks. Give awards! Let your students help you decide on the categories. Be safe and have fun!

2) Host a Marine Debris Art Contest

At the start of the beach clean-up, tell students about the marine debris art contest that will follow your beach clean-up event. Instruct your students to save some marine debris for the art contest in a special collection bin. For safety reasons, no glass may be saved, and no items bigger than the collection bin. Set a deadline for your marine debris art contest. Select judges and give awards!

What you'll need:

- trash bags
- gloves
- art piece collection bins
- various art supplies
- a truck to haul bags of marine debris
- extra water and sunscreen

What you'll know:

Marine debris
Microplastics
Direct impact
Indirect impact

Instructor's Notes and Thoughts:

LAND ART

6th through 8th grades

Oak Motte Habitat/ Winter

Land art involves creating sculpture within a landscape using the natural materials immediately at hand, and the chance conditions of placement, time, weather and season.

Andy Goldsworthy, the contemporary British land artist, creates arches, circles, columns, domes, holes, lines, spheres, spirals and spires, all fashioned from found natural objects lying about. His natural sculptures are powerful expressions of the patterns and rhythms found in nature. They are attempts to understand the purpose of sculpture, and through it, the purposes of nature itself.

The following activity involves whole class participation. Some classmates will scavenge for rocks and stones while others collect dead branches found lying on the ground. Still others will gather leaves, twigs, feathers, and any other natural object that has fallen or is rested. Do not harvest anything still living.

After gathering interesting natural objects, place them in categories of mineral, vegetation, or animal. Decide as a whole group upon a sculptural composition using these found objects. Will you create a twig shelter for groupings of stacked and balanced stones? Is it possible to suspend or connect your found objects together with twine? How will your composition change given a heavy rain or a tropical storm? How will the passing seasons affect a change?

Document the process of change to your sculpture by photographing the original composition, then photograph it a month or two later. Compare photographs and write an essay based upon your observations of the elements, time and compositional change.

What you'll need:

- found objects from the environment, classified in categories of mineral, vegetation, or animal
- twine, if needed
- team effort and coordinators

What you'll know:

Land Art
Andy Goldsworthy
Found objects art
Patterns
Rhythms
Arches, circles, columns, domes
Respectful manipulation of the environment
Site Specific Art
Installation Art

Instructor's Notes and Thoughts:

SOUND MAPS

6th through 8th

Beach / Dune / Spring

Take your students on a sound walk. Everyone must be very quiet to hear the subtle sounds animals make. Have students walk very quietly through a section of the habitat. Do they hear the rustling of wind or the swish of a plant as an animal moves around? Insects may buzz, or if you are very silent, you can hear them move. Mammals will make bigger sounds and rustle more vegetation when they move. Birds will call or sing out to let their presence be known. Reptiles will make slow and very subtle sounds that are continuous as they move. Many amphibians have songs. Can the students hear manmade sounds? Can the students hear the sounds of nature made by wind, wave, and weather?

As you and your students walk through the habitat, point out the sounds you hear. At first, you will give students your interpretation of the sounds. As you continue, especially when you hear the same sound repeated in a different location, try to get students to interpret the sounds for themselves. When you encounter new sounds, ask questions that assist your students in making inferences about the sounds they hear. Make sure that you walk through several sections of the Preserve, from oak motte to prairie, from prairie to wetland, and from the wetland to the beach.

First, focus on the process of distinguishing and locating different sounds. Then, add a level of complexity by using evidence from the habitat and background information from field guides to draw inferences about species identification. This demonstration and collaboration time should prepare students to complete a sound map on their own.

Students will need to find their own “sound spot” within the designated boundaries that is within sight of the teacher but away from other students. While mapping, they need to be as quiet as possible and not interact with other students. They can choose to sit or stand on their sound spot, whatever is comfortable for them.

Students will begin to create their sound maps by drawing a dot in the center of the paper to represent themselves. The space at the top of their paper represents space in front of them. Space at the bottom of the paper represents space behind them. The right side of the dot represents space to their right and so on.

When you give the signal to start, students should begin recording everything they hear using a series of symbols that they create. In this way, students will use shapes to represent sounds. Each time they hear a repeated sound, they record it again using the same symbol. Some students might do better if they close their eyes and wait for a sound, then open their eyes and record the sound on their paper. Encourage students keep listening and recording until time is up. Five minutes is a good starting place. If your students can stay focused for longer, go longer!

When you return to the classroom, students will finish their sound maps by creating a legend. If your students enjoy this activity, consider repeating it. They can return to the same

spot in a different season to compare results or visit a different site during the same season. Students can also use their sound map data to make predictions about the habitat quality of different locations. Students looking for extra credit could create a story based on their sound map.

What you will need:

- paper
- colored pencils
- clipboard (or something else to write on in the field)

What you will know:

Species identification

Instructor's Notes and Thoughts:

KARANKAWAN SHELL TECHNOLOGY
THE ANTHROPOLOGY OF FOUND OBJECTS

6th through 8th grades

Beach and Dunes/ Spring

In November of 1528, when a violent storm cast Alvar de Vaca and his crew ashore on the Texas coast close to Bolivar Peninsula, little was known of the native coastal inhabitants. De Vaca, one of only a handful of survivors, spent eight years among the Karankawas learning their customs and assuming their life ways. He later published a detailed account of his life among these coastal people when he returned to Spain in 1542. Here are a few of his entries:

> *"The natives are naked, large and well-formed. They use only bows and arrows for weapons. They stay on the island from October through the end of February when a favorite underwater root is in its first stage of growth. When the roots begin to grow they are unpalatable and the nomads leave the island."*
>
> *"When the band is ready to leave the island, the women load their belongings into the canoes and paddle to the mainland. They camp on the Bay for three months eating oysters until about May when they go to the coast for blackberries. They seem to understand the rhythm of seasonal harvests"*
>
> *1534- "There is an annual gathering of all the bands [of Karankawas] at the pecan groves in the river bottoms. The natives grind the pecans into a meal-like consistency to be stored. Some groups travel to areas rich in prickly pears to eat the purple tunas (fruit) that line each pad."*

De Vaca eventually became a trusted faith healer and trader among the Karankawas. He traded seashells that were used to make tools, sea-beans used for medicine, hard cane for arrows and sinew for bowstrings, and other bindings. From this first European record, it is apparent that the native people were resourceful in the Galveston Bay area and used whatever food was available. Their shelters were made of grasses and reed matting and poles, and they could load their belongings into canoes for easy transport to new camps.

Your task is to visit the beach and dune areas of Bolivar Habitat Preserve when larger shells are available. The winter months are the best time for successful beachcombing of larger specimens. Harvest whelks, cockles, and other large shells indigenous to Bolivar's beaches. Take a close look at these shells and imagine how they might make tools and vessels. The Karankawas did much the same activity as they gathered shells for eating utensils, awls, arrows, drills, needles, decorative items, and possibly even buttons.

With sandpaper, driftwood, string (some sort of binding materials), smaller shells, and other natural or manmade found objects, fashion simple tools of the larger shells you have harvested. You can break, grind, scrape, bind, and manipulate the shells any way you like to create the tool you envision. Place them in the context of their functions. Are they vessels for eating and drinking? Are they implements for hunting? Could they be musical instruments?

Use your imagination with this activity, just as the Karankawas did in "setting up their household." Set up a display of tools, create cards that tell the tool's history and function, and share the display with the rest of the campus. Finally, research and find pictures of Native American tools. Were the tools created by the class as creative as the ones created by the original inhibitors of North America or the Gulf Coast?

What you will need:

- a variety of shells collected from Bolivar's beach and dune areas
- sandpaper
- awl and hand drills
- driftwood
- a vivid imagination

What you will know:

Native tool technology
Karankawa
De Vaca
Contemporary tool technology

Instructor's Notes and Thoughts:

A PHOTO JOURNALISTIC STUDY

6th through 8th grades

Live Oak Woodlots/ four season study

Photo journalism marries two intensely communicative art forms into one body of work. Photography, no matter how you manipulate a print, is about as real and honest as it gets. Photographic prints depict reality in the moment the photo is taken. Journalism can be a bit more subjective, but its aim is to define and describe moments and circumstances as they really are according to the author. Put the two endeavors together, and you can begin to define a world as it really is.

Consider the magnificent oak trees that grace the northwest border of Bolivar Habitat Preserve. These trees are habitats to countless species of plants and animals, some staying throughout the seasons, and others migrating back and forth with the seasons. Because they maintain their green foliage year round, live oaks are vitally important to many species of insects as well.

The following activity involves visiting and revisiting the woodlots of Bolivar Habitat Preserve, beginning at the start of the school year in August, then again in mid-November. The third and fourth visits should occur in late January and finally in late April or early May. With cameras loaded with black and white film, students will locate an appealing frame of an oak tree. These angles may be shot straight on, straight up, straight down – you get the picture. Therefore, you can **remember and recall** your specific subject and its angle, create a table or diagram to relocate your position throughout the seasons. This is important because you will stand in the same location and take the same shot through four seasons of the school year.

As you photograph your subject, write about the wildlife inhabiting the space, the sounds they are creating, the smell of the soil, the leaves. Has it rained recently, and how does moisture smell when it rests on the leaves and bark? Record any sensory experiences or observations you've made or have had during your seasonal photo shoots. Now accent your photographs with these seasonal descriptions. Create a photo journal in May that combines your written seasonal depictions and musings with the photographs taken throughout the year. Each year from 6th grade through 8th grade, these journals should become more complex in writing, and the photography will become much better. As students gain confidence with photography and writing, the work will become more intuitive and exciting.

What you'll need:

- a disposable camera with black and white film
- a blank book or spiral notebook
- pencil or pen

What you'll know:

Photo journalism

Oak motte
Relevant plant and animal species associated with the live oak
Seasonal trends

Instructor's Notes and Thoughts:

NEOTROPIC BIRD MIGRATION

6th through 8th

Oak Motte / Spring

Late spring is a perfect time of year to look for neotropic migrant birds in the oak motte of the Bolivar Habitat Preserve. Take your students on a walk in April or early May to identify species. Walk quietly; keep your eyes wide open, and your ears tuned in for sounds. At first, the landscape will all look very similar. Search for movement in the tall grasses, silhouettes on lines, and taller shrubs. Ask students to point to any sounds or movements.

It is never too soon to become a birder. As a young child, Jim Stevenson worked on bird identification in the field with his father, Florida's most prominent ornithologist, Henry M. Stevenson, the author of *Birdlife of Florida*. Years later, as an adult, Jim moved to Galveston and became the author of his own bird book, *Birdlife of Galveston*. Jim writes:

April on the Upper Texas Coast is our Contintent's most amazing birding. It begins with a trickle, but by about the tenth, around the time of FeatherFest, there are usually multiple migrants in the woods on any walk into the forest. Some beautiful warblers like Hooded may be seen, but early-to-mid April is an even better time for the famed Great Eight: the two orioles, buntings, grosbeaks and tanagers. Mid-April is, in fact, the best time for Painted Buntings, our Nation's most beautiful bird. The other seven are seen well into early May.

Decades ago, when we had far more birds in North America, early April was very good. Unfortunately, with many of our songbirds having been reduced in a crippling way by pesticides, cars, cats, windows, deforestation and other plagues, it's just a nice time to bird. Pleasant temperatures, a scattering of songbird migrants, some good waterbirds that drop in and Island specialties like Mottled Ducks very much in evidence. All of us "old-timers" remember with sadness the month-long invasion of Neotropical migrants blessing Galveston with Color and activity. Now, sadly, early and mid-April is nothing more than mediocre, but is also an annual reminder of what is coming.

Beginning on around April 20, [look out!] Not every day and nothing like decades past, but for about two weeks, birders shouldn't think of planning anything on their schedules except birds, birds and more birds. Even today, despire being a shadow of the past, many days offer trees full of warblers—often over 20 species—and many other great birds to boot. Theses are largely the species which nest in the northern United States and Canada, with some not seen in fall.

Spring songbirds which are almost exclusively seen from the 20th of April to the 10th of May include: Olive-sided, Yellow-bellied, Willow, Alder and Leave Flycatchers, Western Kingbird, Warbling and Philadelphia Vireos, Band and Cliff Swallows, Veery, Swainson's and Grey-checked Thrushes and Bobolink.

There are many key waterbirds that also fit this window of later April/early May, including Hudsonian Godwit, Semipalmated, Baird's, Stilt, Buff-breasted and White-rumped

Sandpipers, Wilson's Phalarope, Franklin's Gull, Common and Black Terns. Birds of prey seen in this window include: Swainson's and Broad-winged Hawks and Mississippi Kite. But nowhere is the late April/early May status more prevalent than with warblers. Those fitting that parameter include: Yellow. Chestnut-sided, Magnolia, Wilson's, Blackburnian, Bay-breasted, Blackpoll, Cerulean, Mourning, and Canada Warblers, plus American Redstart. Another half-dozen or so warblers are not included because they may be seen occasionally as early as around the tenth of April.

The last week or so of April, as well as the very beginning of May, represents the last vestiges of the mass bird migrations of yesteryear, when trees practically sagged with the reds of tanagers, the blues of buntings, the oranges of orioles and the greens and yellows of warblers. If the rate of loss continues, our future generations will only be able to read books on this miracle, and I may count it, at the end of my life, as the one experience in my days I would never have wanted to miss.

When John James Audubon was a boy, he believed that studying birds and other wildlife in their natural habitats was more interesting and informative than just reading about them in scientific publications. He pioneered a technique essential to the understanding of birds by describing their behaviors and "languages" in natural settings. He became America's greatest painter of birds by portraying them as they went about their natural activities - building nests, brooding, roosting, feeding their young, fleeing predators, catching prey, or simply striking a beautiful pose.

The following activity revisits a time when early American naturalists combined biology and art to capture the beauty and complexity found in the natural world. Take your students to the Bolivar Habitat Preserve. Students will need to bring along a blank (unlined) paper, a set of colored pencils, a pen or pencil, and something to write on.

Students will be working in groups of five. Each student is responsible for identifying a different bird. Students will be responsible for creating a botanical sketch and using a field guide to research information about their bird. When illustrating their bird, students should pay attention to its behavior, the shape of its beak, the structure of its legs and feet. Is it multicolored? Does it have large eyes? Is it feeding? Instruct students to sketch only what they see. Don't create a shape that isn't there. After students have completed their bird sketch, you may encourage them to fill in the immediate background - a simple branch, bulrushes, or a post, for example.

Help students to correctly identify the bird in their sketch and write down at least 3 observations directly below the sketch. When you return to the classroom, show students how to use a field guide to research additional information about your bird. Students should record at least 2 additional facts about their bird. Guide students toward noting identifying features of their bird as an individual: its color, wing, head and body shapes, and its common behaviors. In addition, encourage students to include information that connects their bird to its ecosystem: its food preferences, its migration patterns, its natural predators, and its relationship with humans.

Finally, have students present their bird to their group. During the presentations, sit in a circle. Ask students to bring paper and a pencil. Encourage students to take notes. For each presentation, the group is responsible for generating one genuine, science-based question about the presented bird. As the interpreter, you will also ask one question about each bird. Please note: it's okay if students don't know the answers to the questions they are asked! Simply instruct students to write down any questions they can't immediately answer and the name of the person who asked it. After everyone has presented, give students time to look up the answers to the questions they were asked. Then, call the group back together one last time and share the answers out loud. This is the process of becoming a naturalist!

What you will need:

- a blank sheet of sketch paper per student
- a set of colored pencils (24 or 36 count) per student
- A pen or pencil per student
- Something to write on

What you will know:

Jim Stevenson
John James Audubon
Ornithologist
Naturalist
Neotropic migrant birds

Instructor's Notes and Thoughts:

GLOSSARY

Abiotic: Nonliving substances that are factors influencing living organisms and the health of ecosystems

Álvar Núñez Cabeza de Vaca: Spanish explorer who spent eight years among the Karankawa along the Texas coast

Andy Goldsworthy: British environmentalist, photographer, and sculptor, famous for land art or site-specific art

Animal Behavior: All the ways animals interact with other organisms and the physical environment

Barometric: The pressure exerted by the weight of Earth's atmosphere (also called atmospheric pressure)

Biodiversity: The richness or variety (different) of species living in a particular region, area, time, ecosystem, habitat, etc.

Biotic: Refers to all living organisms existing in an environment, or the influence of living things on the environment

Bisque Firing: The very first firing of pottery before it is glazed

Bluestem Prairie: The very first firing of pottery before it is glazed

Botanical Sketch: The scientifically accurate illustration of plant species

Brackish Water: A mixture of freshwater from a river and saltwater from an ocean. This mixing process occurs in bays and estuaries where the rivers meet the seas

Brayer Roller: The hand tool used in printmaking

Brooding: When a bird sits on a clutch of eggs to incubate them

Cherokee, Choctaw, Creek, and Seminole Nations: Indigenous people of the Southeastern United States

Cirrus Clouds: Genus of atmospheric clouds characterized by thin, wispy strands

Coastal Prairie: Prairies are grass-dominated ecosystems maintained by the presence of periodic fires and marked by the lack of woody plants. The Texas coastal prairie is similar to the tallgrass prairie of the Midwest. It differs by having harder clays under the topsoil and a larger amount of annual rainfall.

Cubism: Early 20th century art movement, pioneered by Pablo Picasso, that changed sculpture and painting in Europe

Cumulus clouds: Low-level clouds that look puffy like cotton

Diffused root system: Small roots and rootlets that spread over a large area

Dormancy: A state of in activity, specifically with respect to growth. The seeds of many prairie plants lay dormant until fire removes accumulated plant debris that might hinder or compete with the native prairie grasses and flowers

Dredge: An apparatus employed by ports to maintain channels by scooping or sucking up mud, sand, rocks, and other things that may clog waterways. Dredges are used to deepen, widen, clear channels or harbors.

Ecosystem: A community of living organisms and their physical and chemical environment are interrelated, creating a system with specific characteristics. For example, a forest ecosystem is very different than a coral reef ecosystem.

Emergent Grasses: Any grasses living in an area that is continually flooded. These plants rise up out of the water and cannot live if continually submerged. The salt marsh is made up of emergent grasses like smooth cordgrass.

Erosion: A process by which land is lost to wave and wind energy. In the Gulf coast region marshes and dune habitats are often destroyed by wind and waves during hurricanes or tropical storms.

Estuarine: Refers to anything living in, formed by, or deposited in an estuary

Estuary: A body of water created by an inlet of the sea and the lower portion or wide mouth of a river, where the salty tide of the sea meets the freshwater of the river(s)

Fins: Flattened appendages on the bodies of aquatic organisms, used for locomotion

Fossils: Impressions or the remains of plants or animals from a past geologic age

Gills: The paired respiratory organ of fish

Glaze: A smooth, shiny coating or finish

Graphics: Visual images

Grasses: A family of monocotyledonous plant with long narrow leaves, jointed stems, flowering spikelets and seed-like fruit

Gyotaku: Japanese printing technique in which rice paper is placed over an inked specimen

Habitat: An area in which organisms lives and gains access to resources such as space, shelter, mates, food, and water

Habitat Fragmentation: Refers to the process by which a habitat becomes divided and not continuous. For example, the prairie is fragmented by conversion to agriculture and the building of fences. This process prevents communities of species from interacting and mating with each other. This is one of the largest threats to ecosystems, genetic diversity, biodiversity, and habitats. Fragmented habitats become islands in the midst of development.

Haiku: A Japanese poem of seventeen syllables, in three lines of five, seven, and five, traditionally evoking images of the natural world

Impressionism: A movement in art that studies how light falls on an object, body of water, or figure, represented by touches of broken color to model form and outline

Jim Stevenson: Author and photographer of *Birdlife of Galveston*

John James Audubon: American ornithologist, naturalist, and painter

Installation Art: A genre of artwork that is three-dimensional and often site-specific

Karankawa: Indigenous people of the Texas Gulf Coast

Land Art: Creating sculpture within a landscape using the natural materials immediately at hand, and the chance conditions of placement, time, weather and season

Landscape: All the visible features of an area of land

Marine debris: Trash found in the ocean or along shorelines, and consists of not only litter but also objects like abandoned crab traps or derelict boats. Some of the major forms of marine debris found in the ocean include aluminum cans, cigarettes, food packaging, and various plastic items like bottles, caps or lids, utensils, bags, and straws.

Microplastic: Plastic waste that breaks down into smaller particles

Mirror images: An image that is identical in form to another but with the structure reversed, as in a mirror

Naturalist: Someone who studies or is an expert in the natural sciences

Neotropic migrant bird: A bird that breeds in Canada and the United States during our summer and spends our winter in Mexico, Central America, South America or the Caribbean islands

Nesting: When a bird builds or occupies a nest

Oak motte: A grove or clump or oak trees in the prairie

Oil pastels: A painting or drawing medium that is similar to crayons

Ornithologist: a person who studies or is an expert on birds

Pablo Picasso: One of the world's greatest artists and innovative scholars, the pioneer of Cubism

Pattern: A design in which lines, shapes, forms or colors are repeated

Photo journalism: The art or practice of communicating news by photographs

Pierre-Joseph Redoute: A French botanical artist of the late eighteenth and early nineteenth centuries, who mastered the unusual technique of stipple engraving – the use of tiny dots, rather than lines, to create subtle variations in coloring

Plant press: A set of equipment used by botanists to flatten and dry field samples so that they can be easily stored

Predator: An animal that naturally preys on others

Prey: An animal that is hunted or killed by another for food

Rhizome: A modified, horizontal underground plant stem (also known as a rootstalk) that sends out roots and shoots from its nodes. The rhizome creates new plants along its nodes that are genetically identical to the parent plant.

Rookery: A habitat utilized by birds in large groups during breeding season to nest and raise young

Roosting: When birds settle or congregate for rest or sleep

Roseate spoonbill: Pink wading bird of the Americas

Salinity: The proportion of salts in a solution. It is typically measured in parts per thousand. Seawater is ~ 35 ppt and brackish water has a salinity lower than 35 ppt.

Samurai: The hereditary military nobility and officer caste of medieval and early-modern Japan

Sargassum: A genus of large brown seaweed (a type of algae) that floats in island-like masses and never attaches to the seafloor

Scales: Small, thin horn-like or bone-like plates that usually overlap to protect the skin of fish and reptiles

Seasonal trend: Any predictable fluctuation or pattern that recurs or repeats over a one-year period

Sedimentary Deposition: The process of depositing sediments. More specifically, it is the deposition of material from geological formations as they break down and travel through water to new locations.

Sedimentary rock: A type of rock, often layered and containing fossils, that forms through the deposition and solidification of sediment, especially sediment transported by water, ice, and wind

Sediment: Any material that settles out of a liquid. Sediments are solid fragments of inorganic matter that originated from the weathering of rocks by wind, water, and ice on rocks

Shorebirds: Birds that live, feed, or nest near the shore. These birds often migrate very far. For example, many plovers and sandpipers migrate from the Artic to winter on the Texas coast

Simpson's Index of Diversity: A measure of biodiversity which takes into account the number of species present, as well as the relative abundance of each species

Site Specific Art: Temporary works of art created outdoors from natural material found on-site

Species Evenness: The abundance of each species represented in a habitat

Species Identification: The process of assigning a pre-existing taxon name to an individual organism

Species richness: The number of different species represented in a particular habitat.
Specimen: An individual taken for scientific examination as an example of its species

Stippling: Adding depth or shade to your sketch by dotting

Stratus clouds: Low altitude clouds that are flat, hazy, and featureless, varying in color from dark gray to nearly white

Subsidence: A process by which the land or seafloor sinks to a lower level. For example, the Galveston Bay bottom sank as geological formations of oil and water were removed from below the bay bottom.

Sumi-e: Ink and brush painting, which originated in China over a thousand years ago

Taproot: The main large root responsible for stabilizing a plant, and depending on the species, may store food. The taproot and the roots coming off of the taproot are a plant's major mechanism for absorbing water.

Tidal Marsh: Marshes that are influenced by tides daily

Uplands: Land at a higher elevation than that of the marshes. The coastal prairie is an example.

Weed: Any wild plant growing unwanted among cultivated plants

William Bartram: America's first botanical artist

Zen Buddhism: A Japanese school of Buddhism that values meditation and intuition

Texas Essential Knowledge and Skills

K-2 TEKS

Lesson Plan	TEKS Alignment
Weed Watch	Science TEKS: K.1(A); K.2(A); K.2(B); K.2(C); K.2(D); K.2(E); K.3(C); K.4(A); K.4(B); K.5(A); K.9(B); K.10(A); K.10(B) Art TEKS: K.1(A); K.1(B); K.2(A) Science TEKS: 1.1(A); 1.2(A); 1.2(B); 1.2(C); 1.2(D); 1.2(E); 1.3(C); 1.4(A); 1.4(B); 1.5(A); 1.9(C); 1.10(B) Art TEKS: 1.1(A); 1.1(B) Science TEKS: 2.1(A); 2.2(A); 2.2(B); 2.2(C); 2.2(D); 2.2(E); 2.3(C); 2.4(B); 2.9(A); 2.9(B); 2.9(C); 2.10(B) Art TEKS: 2.1(A); 2.2(B)
Prairie Bird Walk	Science TEKS: K.2(A); K.2(B); K.2(C); K.2(D); K.2(E); K.3(B); K.4(A); K.4(B); K.5(A); K.6(C); K.6(D); K.9(B); K.10(B) Art TEKS: K.1(A); K.1(B); K.3(A); K.3(D) Science TEKS: 1.2(A); 1.2(B); 1.2(C); 1.2(E); 1.3(B); 1.3(C); 1.5(A); 1.6(C); 1.9(C); 1.10(A) Art TEKS: 1.1(A); 1.1(B); 1.3(D) Science TEKS: 2.2(A); 2.2(B); 2.2(E); 2.2(F); 2.3(B); 2.3(C); 2.4(B); 2.9(A); 2.9(B); 2.9(C); 2.10(A) Art TEKS: 2.1(A); 2.1(B); 2.3(D)
Capturing the Wind	Science TEKS: K.2(A); K.2(B); K.2(C); K.2(D); K.2(E); K.3(B); K.3(C); K.4(A); K.4(B); K.6(A); K.6(D); K.8(A); K.8(B) Art TEKS: K.1(A); K.1(B); K.2(A); K.2(B); K.2(C); K.3(A); K.3(D) Science TEKS: 1.2(A); 1.2(B); 1.2(C); 1.2(D); 1.2(E); 1.3(B); 1.3(C); 1.4(A); 1.6(A); 1.6(C); 1.8(A); 1.8(D) Art TEKS: 1.1(A); 1.1(B); 1.2(A); 1.2(B); 1.2(C); 1.3(A); 1.3(D) Science TEKS: 2.2(A); 2.2(B); 2.2(C); 2.2(D); 2.2(E); 2.2(F); 2.3(B); 2.3(C); 2.4(A); 2.6(C); 2.8(A) Art TEKS: 2.1(A); 2.1(B); 2.2(A); 2.2(B); 2.2(C); 2.3(D)
Beach Walk: Abiotic and Biotic Factors	Science TEKS: K.2(A); K.2(B); K.2(C); K.2(D); K.2(E); K.3(B); K.3(C); K.4(A); K.4(B); K.5(A); K.6(C); K.6(D); K.7(A); K.7(B); K.7(C); K.8(C); K.9(A); K.9(B); K.10(A); K.10(B); K.10(C) Art TEKS: K.1(A); K.1(B); K.2(A); K.2(B); K.2(C); K.3(A); K.3(D) Science TEKS: 1.2(A); 1.2(B); 1.2(C); 1.2(D); 1.2(E); 1.3(B); 1.3(C); 1.4(A); 1.5(A); 1.6(C); 1.7(A); 1.7(B); 1.8(A); 1.8(D); 1.9(A); 1.9(B); 1.9(C); 1.10(A); 1.10(B); 1.10(C) Art TEKS: 1.1(A); 1.1(B); 1.2(A); 1.2(B); 1.2(C); 1.3(D) Science TEKS: 2.2(A); 2.2(B); 2.2(C); 2.2(D); 2.2(E); 2.2(F); 2.3(B); 2.3(C); 2.4(A); 2.4(B); 2.6(C); 2.7(A); 2.7(B); 2.7(C); 2.8(A); 2.8(B); 2.9(A); 2.9(B); 2.9(C); 2.10(A); 2.10(B) Art TEKS: 2.1(A); 2.1(B); 2.2(A); 2.2(B); 2.2(C); 2.3(D)
Y-Sticks: Twig	Science TEKS: K.2(A); K.2(B); K.2(E); K.3(B); K.3(C); K.4(B); K.5(A); K.6(C)

Weaving	Art TEKS: K.1(A); K.1(B); K.2(A); K.2(B); K.2(C); K.3(A); K.3(D) Science TEKS: 1.2(A); 1.2(B); 1.2(C); 1.2(D); 1.2(E); 1.3(B); 1.3(C); 1.5(A) Art TEKS: 1.1(A); 1.1(B); 1.2(A); 1.2(B); 1.2(C); 1.3(A); 1.3(D) Science TEKS: 2.2(A); 2.2(B); 2.2(C); 2.2(D); 2.2(E); 2.2(F); 2.3(B); 2.3(C); 2.4(B) Art TEKS: 2.1(A); 2.1(B); 2.2(A); 2.2(B); 2.2(C); 2.4(A)
Gyotaku	Science TEKS: K.1(A); K.2(A); K.2(B); K.2(C); K.2(D); K.2(E); K.3(C); K.4(B); K.5(A); K.6(C); K.10(A) Art TEKS: K.1(A); K.1(B); K.2(A); K.2(C); K.3(A); K.3(D) Science TEKS: 1.1(A); 1.2(A); 1.2(B); 1.2(C); 1.2(D); 1.2(E); 1.3(C); 1.4(A); 1.5(A); 1.10(A) Art TEKS: 1.1(A); 1.1(B); 1.2(A); 1.2(C); 1.3(B); 1.3(D) Science TEKS: 2.1(A); 2.2(A); 2.2(B); 2.2(C); 2.2(D); 2.2(E); 2.3(C); 2.4(A); 2.4(B); 2.10(A) Art TEKS: 2.1(A); 2.1(B); 2.2(A); 2.2(B); 2.2(C); 2.3(B); 2.3(D)
Wetland Walk: Looking for Tracks	Science TEKS: K.2(A); K.2(B); K.2(C); K.2(D); K.2(E); K.3(B); K.4(A); K.4(B); K.5(A); K.6(C); Art TEKS: K.1(A); K.3(A); K.3(C); K.3(D) Science TEKS: 1.2(A); 1.2(B); 1.2(C); 1.2(D); 1.2(E); 1.3(B); 1.3(C); 1.4(A); 1.4(B); 1.10(A) Art TEKS: 1.1(A); 1.3(A); 1.3(C); 1.3(D) Science TEKS: 2.2(A); 2.2(B); 2.2(C); 2.2(D); 2.2(E); 2.2(F); 2.3(B); 2.4(A); 2.4(B); 2.10(A) Art TEKS: 2.1(A); 2.3(A); 2.3(D)
The Flower Hunter: Puc Puggy: A Study in Pressing Flowers and Leaves	Science TEKS: K.1(A); K.2(A); K.2(B); K.2(C); K.2(D); K.2(E); K.3(B); K.3(C); K.4(A); K.4(B); K.5(A); K.10(A); K.10(B); K.10(C); K.10(D) Art TEKS: K.1(A); K.1(B); K.2(A); K.2(B); K.2(C); K.3(A); K.3(C) Science TEKS: 1.1(A); 1.2(A); 1.2(B); 1.2(C); 1.2(D); 1.2(E); 1.3(B); 1.3(C); 1.4(A); 1.4(B); 1.5(A); 1.10(B); Art TEKS: 1.1(A); 1.1(B); 1.2(A); 1.2(B); 1.2(C); 1.3(C); 1.3(D) Science TEKS: 2.1(A); 2.2(A); 2.2(B); 2.2(C); 2.2(D); 2.2(E); 2.2(F); 2.3(B); 2.3(C); 2.4(A); 2.4(B); 2.9(A); 2.10(B) Art TEKS: 2.1(A); 2.1(B); 2.2(A); 2.2(B); 2.2(C); 2.3(C); 2.3(D)
Sound Walk	Science TEKS: K.1(A); K.2(A); K.2(B); K.2(C); K.2(D); K.2(E); K.3(B); K.3(C); K.4(B); K.9(A); K.10(A); Art TEKS: K.1(A); K.3(A); K.3(D) Science TEKS: 1.1(A); 1.2(A); 1.2(B); 1.2(C); 1.2(D); 1.2(E); 1.3(B); 1.3(C); 1.4(B); 1.9(A); Art TEKS: 1.1(A); 1.3(A); 1.3(D) Science TEKS: 2.1(A); 2.2(A); 2.2(B); 2.2(C); 2.2(D); 2.2(E); 2.3(B); 2.4(B); 2.7(C) Art TEKS: 2.1(A); 2.3(D)

3rd-5th Grade TEKS

Lesson Plan	TEKS Alignment
Landscapes in Oil and Water	Science TEKS: 3.2(A); 3.2(B); 3.2(D); 3.2(F); 3.9(A) Art TEKS: 3.1(B); 3.2(A); 3.2(B); 3.2(C); 3.3(D) Science TEKS: 4.2(B); 4.2(D); 4.2(F); 4.7(A); 4.7(B); 4.9(B); 4.10(A) Art TEKS: 4.1(B); 4.2(A); 4.2(B); 4.2(C); 4.3(D); 4.4(A) Science TEKS: 5.2(B); 5.2(D); 5.2(F); 5.9(A); 5.10(A) Art TEKS: 5.1(B); 5.2(A); 5.2(B); 5.2(C); 5.3(D); 5.4(A)
Beach Walk: What is in the Sargassum?	Science TEKS: 3.1(A); 3.2(A); 3.2(B); 3.2(C); 3.2(D); 3.2(E); 3.2(F); 3.3(A); 3.9(A); 3.9(B); 3.9(C); 3.10(A) Art TEKS: 3.2(B); 3.2(C); 3.3(D) Science TEKS: 4.1(A); 4.2(A); 4.2(B); 4.2(C); 4.2(D); 4.2(E); 4.2(F); 4.3(A); 4.9(A); 4.9(B); 4.10(A) Art TEKS: 4.2(B); 4.2(C); 4.3(D) Science TEKS: 5.1(A); 5.2(A); 5.2(B); 5.2(C); 5.2(D); 5.2(F); 5.2(G); 5.3(A); 5.9(A); 5.9(B); 5.9(C); 5.10(A) Art TEKS: 5.2(B); 5.2(C); 5.3(D)
The Man Who Drew Birds: John James Audubon	Science TEKS: 3.2(A); 3.2(B); 3.2(D); 3.2(E); 3.2(F); 3.3(C); 3.4(A); 3.9(A); 3.9(B); 3.10(A) Art TEKS: 3.1(A); 3.1(B); 3.2(A); 3.2(B); 3.2(C); 3.3(C); 3.3(D); 3.4(A) Science TEKS: 4.2(A); 4.2(B); 4.2(D); 4.2(E); 4.2(F); 4.3(C); 4.4(A); 4.9(A); 4.9(B); 4.10(A) Art TEKS: 4.1(A); 4.1(B); 4.2(A); 4.2(B); 4.2(C); 4.3(C); 4.3(D); 4.4(A) Science TEKS: 5.2(A); 5.2(B); 5.2(C); 5.2(D); 5.2(E); 5.2(F); 5.3(C); 5.4(A); 5.9(A); 5.9(B); 5.10(A) Art TEKS: 5.1(A); 5.1(B); 5.2(A); 5.2(B); 5.2(C); 5.3(C); 5.3(D); 5.4(A)
Hawk Walk: Prairie	Science TEKS: 3.2(A); 3.2(B); 3.2(D); 3.2(E); 3.2(F); 3.4(A); 3.9(A); 3.9(B); 3.9(C); 3.10(A) Art TEKS: 3.1(A); 3.2(A) Science TEKS: 4.2(A); 4.2(B); 4.2(D); 4.2(E); 4.2(F); 4.4(A); 4.9(A); 4.9(B); 4.10(A) Art TEKS: 4.1(A); 4.2(A) Science TEKS: 5.2(A); 5.2(E); 5.2(F); 5.4(A); 5.9(A); 5.9(B); 5.9(C); 5.10(A) Art TEKS: 5.1(A); 5.2(A)
Clay Tile Casting	Science TEKS: 3.1(A); 3.2(A); 3.2(B); 3.2(D); 3.2(E); 3.2(F); 3.4(A); 3.7(A) Art TEKS: 3.1(A); 3.2(A); 3.2(B); 3.2(C); 3.3(D); 3.4(C) Science TEKS: 4.1(A); 4.2(A); 4.2(B); 4.2(D); 4.2(E); 4.2(F); 4.4(A); 4.7(A) Art TEKS: 4.1(A); 4.2(A); 4.2(B); 4.2(C); 4.3(D); 4.4(C) Science TEKS: 5.1(A); 5.2(A); 5.2(B); 5.2(D); 5.2(E); 5.2(F); 5.4(A);

	5.7(A) Art TEKS: 5.1(A); 5.2(A); 5.2(B); 5.2(C); 5.3(D); 5.4(C)
Printing in the Round	Science TEKS: 3.2(A) Art TEKS: 3.2(A); 3.2(B); 3.2(C) Science TEKS: 4.2(A) Art TEKS: 4.2(A); 4.2(B); 4.2(C) Science TEKS: 4.2(A) Art TEKS: 5.2(A); 5.2(B); 5.2(C)
Wetland Walk: Casting Tracks	Science TEKS: 3.1(A); 3.2(A); 3.2(B); 3.2(D); 3.2(E); 3.2(F); 3.3(A); 3.4(A); 3.9(A); 3.9(B); 3.9(C); 3.10(A) Art TEKS: 3.1(B); 3.2(A); 3.2(B); 3.2(C) Science TEKS: 4.1(A); 4.2(A); 4.2(B); 4.2(D); 4.2(E); 4.2(F); 4.4(A); 4.9(A); 4.9(B); 4.10(A) Art TEKS: 4.1(B); 4.2(A); 4.2(B); 4.2(C) Science TEKS: 5.1(A); 5.2(A); 5.2(B); 5.2(D); 5.2(E); 5.2(F); 5.3(A); 5.4(A); 5.9(A); 5.9(B); 5.9(C); 5.10(A) Art TEKS: 5.1(B); 5.2(A); 5.2(B); 5.2(C)
Impressionism: A Study of Sunlight on Water	Science TEKS: 3.2(A) Art TEKS: 3.1(B); 3.2(A); 3.2(B); 3.2(C); 3.4(A) Science TEKS: 4.2(A) Art TEKS: 4.1(B); 4.2(A); 4.2(B); 4.2(C); 4.4(A) Science TEKS: 5.2(B); 5.6(C) Art TEKS: 5.1(B); 5.2(A); 5.2(B); 5.2(C); 5.4(A)
Prairie Butterfly Watch	Science TEKS: 3.2(A); 3.2(B); 3.2(C); 3.2(D); 3.2(E); 3.2(F); 3.4(A) Art TEKS: 3.3(D) Science TEKS: 4.2(A); 4.2(B); 4.2(C); 4.2(D); 4.2(E); 4.2(F); 4.4(A) Art TEKS: 4.3(D) Science TEKS: 5.2(A); 5.2(B); 5.2(C); 5.2(D); 5.2(E); 5.2(F); 5.2(G); 5.4(A) Art TEKS: 5.3(D)

6th-8th Grade TEKS

Lesson Plan	TEKS Alignment
Sumi-e: Contemplating and Recording Nature	Science TEKS: 6.2(A) Science TEKS: 7.2(A) Science TEKS: 8.2(A) Art TEKS: MS.1(A); MS.1(B); MS.1(C); MS.2(A); MS.2(C)
Beach Walk: Sargassum Species Diversity	Science TEKS: 6.2(A); 6.2(B); 6.2(C); 6.2(D); 6.2(E) Science TEKS: 7.2(A); 7.2(B); 7.2(C); 7.2(D); 7.2(E) Science TEKS: 8.2(A); 8.2(B); 8.2(C); 8.2(D); 8.2(E) Art TEKS: n/a
An Abstract Look at the Environment: Poster Art	Science TEKS: 6.2(A); 6.2(E); 6.3(A); 6.3(D) Science TEKS: 7.2(A); 7.2(E); 7.3(A); 7.3(D) Science TEKS: 8.2(A); 8.2(E); 8.3(A); 8.3(D) Art TEKS: MS.1(A); MS.1(B); MS.1(C); MS.1(D); MS.2(A); MS.2(B); MS.2(C); MS.3(A); MS.3(B); MS.3(D); MS.4(A); MS.4(B)
Human Impacts on the Environment: Beach Clean-Up and Marine Debris Art	Science TEKS: 6.1(A); 6.1(B) Science TEKS: 7.1(A); 7.1(B) Science TEKS: 8.1(A); 8.1(B); 8.11(C) Art TEKS: MS.1(A); MS.1(B); MS.1(C); MS.2(A); MS.2(B); MS.4(B)
Land Art	Science TEKS: 6.2(A); 6.2(B) Science TEKS: 7.2(A); 7.2(B) Science TEKS: 8.2(A); 8.2(B) Art TEKS: MS.1(B); MS.1(C); MS.2(A); MS.2(B); MS.2(C); MS.3(B); MS.3(C); MS.3(D); MS.4(A); MS.4(B)
Sound Maps	Science TEKS: 6.2(A) Science TEKS: 7.2(A) Science TEKS: 8.2(A) Art TEKS: MS.1(A); MS.2(A); MS.2(B)
Karankawan Shell Technology	Science TEKS: 6.2(B); 6.3(A) Science TEKS: 7.2(B); 7.3(A) Science TEKS: 8.2(B); 8.3(A) Art TEKS: MS.1(A); MS.2(A); MS.2(B); MS.2(C); MS.3(A); MS.3(B); MS.3(C); MS.3(D); MS.4(B)
A Photo Journalistic Study	Science TEKS: 6.2(A); 6.2(D); 6.2(E) Science TEKS: 7.2(A); 7.2(D); 7.2(E) Science TEKS: 8.2(A); 8.2(D); 8.2(E) Art TEKS: MS.1(A); MS.2(A); MS.2(C); MS.4(C)
Oak Motte Walk: Neotropic Bird Migration	Science TEKS: 6.2(A); 6.2(E) Science TEKS: 7.2(A); 7.2(E) Science TEKS: 8.2(A); 7.2(E) Art TEKS: MS.1(A); MS.1(B); MS.1(C); MS.2(A); MS.2(B); MS.4(B)

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