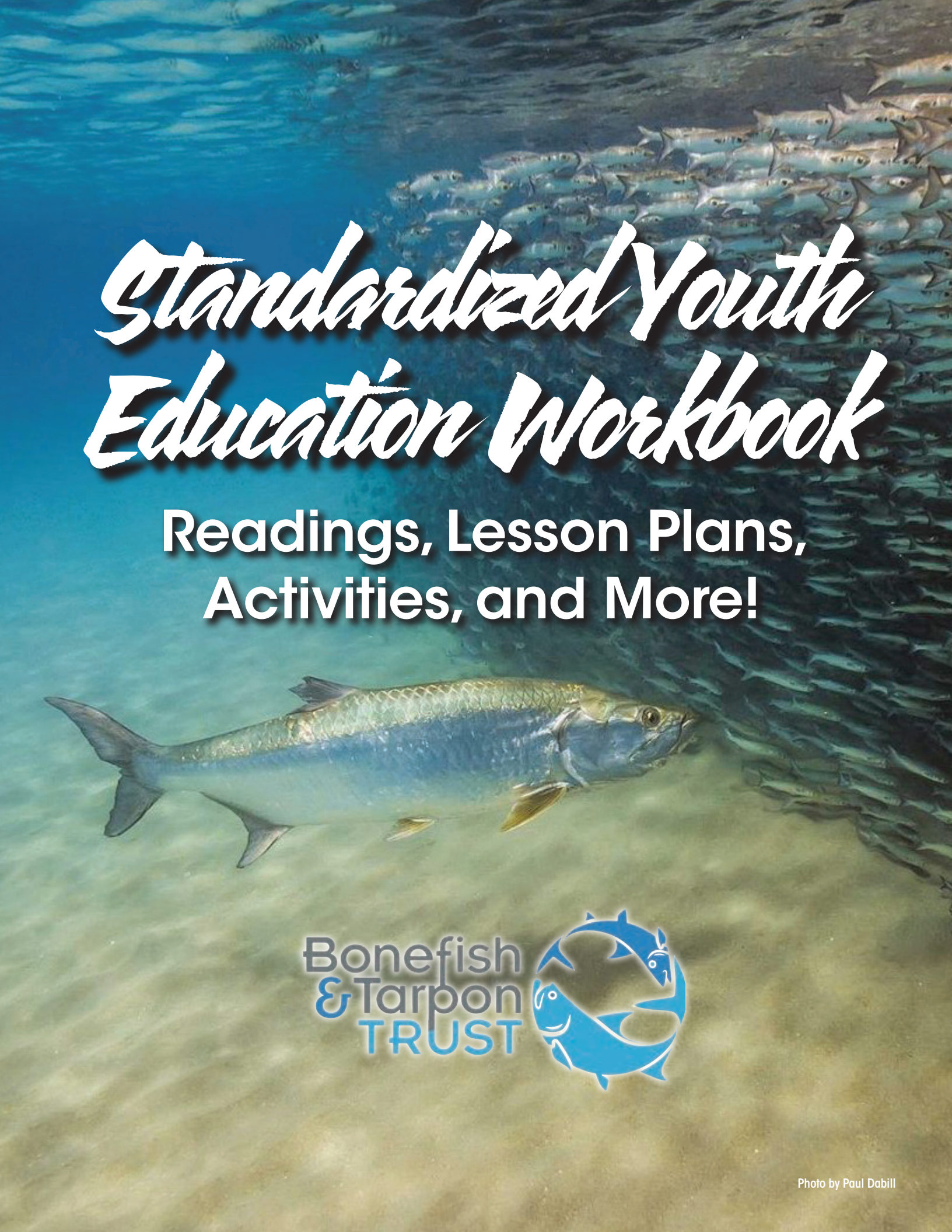

Standardized Youth Education Workbook

Readings, Lesson Plans, Activities, and More!

Bonefish & Tarpon TRUST

Photo by Paul Dabill

TARPON

BONEFISH

SNOOK

PERMIT

APPENDICES

Bonefish & Tarpon TRUST
2937 SW 27th Avenue
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Miami, FL 33133
www.btt.org

Dear teachers,

Here at Bonefish and Tarpon Trust (BTT), we are excited to offer you this workbook full of engaging readings, lesson plans, and activities that will help teachers and students learn about the life cycles of four of the most interesting and important fish species pursued in Florida. We've focused on how four fish species depend upon diverse, essential habitats, and how they connect and support those habitats through their spawning migrations, foraging, and other behaviors. Students will learn about tarpon, bonefish, snook, and permit, and about the habitats and conditions needed to produce them.

With this workbook, we have placed an emphasis on how healthy fisheries, or unhealthy fisheries, impact human communities on social and economic levels. Those four fish are some of Florida's most ecologically and economically important species. Their stories provide great insight into the ways in which natural and social systems are joined and related, and what we need to do to restore and protect them.

While the topics are profound, this workbook is designed to be fun, accessible and engaging. It was designed by a team of Florida educators, including public school biology teachers, with guidance and oversight from leading scientists in the fields related to the study and management of the four species. By design, the workbook satisfies Florida public school standards and provides learning scaffolds. Our hope is that it will provide a basis of knowledge that empowers students to engage in the world of fisheries management, whether as more enlightened anglers, as budding scientists, or future policy experts, or some combination of the three. BTT maintains that experience with fishing, science, and policy is complimentary to student development in interdisciplinary ways.

The readings, activities and materials are designed to keep classroom costs down. They can be photocopied and require no additional resources. Additionally, BTT plans to present digital versions of the workbook so that teachers can incorporate the use of electronic devices into their lesson plans, or download our lessons from our website.

In this workbook, you will find…

- We have created materials that are age-appropriate for students in grades two to five, especially those in more advanced stages of their educations. Connections to both Florida State Standards and Next Generation Science Standards are provided at the beginning of each activity, and a lesson breakdown sheet is provided as an appendix at the end of the workbook as an easy reference. The readings included in this workbook were written for a range of abilities, with the expectation that you will choose those which are most appropriate for your individual classroom.
- We have included basic information on Kagen Structures that can be used with this workbook as an appendix.
- For younger students, we have provided simplified materials and activities designed as entry-level introductions to the world of marine ecology. These readings, illustrations and activities explain the basics, including how food webs function, beginning with the role of sunlight all the way up to roles that apex predators play in coastal ecosystems.
- For teachers to feel more comfortable explaining important concepts and terminologies specific to these topics, we have provided reading materials written at higher cognitive levels. If students demonstrate greater interest and experience with disciplines related to marine ecology, we encourage teachers to share these readings with those students as well.

We are in the process of expanding our education program, and we hope that you will grow with us. If you have any questions, please do not hesitate to contact our Education Coordinator, Maggie Winchester by emailing Maggie@bonefishtarpontrust.org. We rely on your feedback to make our education program the best it can be!

Sincerely,
The scientists and staff at Bonefish and Tarpon Trust

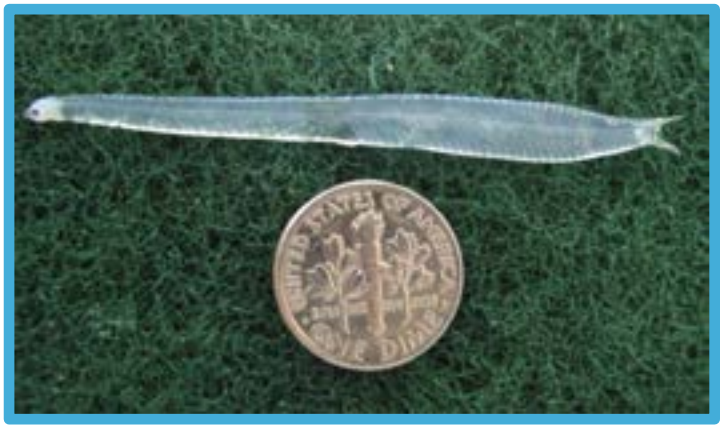
Student reading

Tarpon Spawning

The goal for all living things is to create a new generation to carry on their genetic information. For tarpon this is a goal too! Tarpon do not give birth to live babies, instead they broadcast spawn. This means the male fish release sperm in large amounts and the females release large amounts of eggs. They do this in the deep ocean away from land, or "offshore". Large groups of tarpon go offshore to spawn.

Adult tarpon gather in large groups before swimming to deep water to spawn.

These groups are called spawning aggregations. A spawning aggregation can be hundreds of fish. They are usually far offshore in the pelagic ocean. "Pelagic" means that the bottom is very far down, maybe hundreds to thousands of feet deep. In the pelagic ocean there is very little "life" like you might see on a coral reef. It is deep, and the water tends to be very dark past 500 feet since light does not travel through the water deeper than that. At 1,000 feet the ocean is completely dark! The pelagic zone is where many of the large ocean animals you can think of live like whales, large sharks and manta rays. When tarpon move offshore to spawn, they do not stay out there for very long. They spawn and then head back toward shallow areas close to shore such as bays and estuaries. An estuary is an area where fresh and salt water mix, creating a food-rich environment that gives tarpon the energy they need after their journey offshore.



Tarpon larvae do not look like adult tarpon! Instead, they have long, thin bodies that look almost like eels.

Once the fish all meet in a large group to spawn in the pelagic ocean, they release millions of sperm and millions of eggs that start forming tiny baby fish! Where tarpon spawn offshore, there are many fish, sharks, birds, and whales that come to feast on the millions of eggs and sperm that are released. It is a giant buffet for these animals that live near the ocean's surface. Since other fish and other sea animals eat them, many of the sperm and eggs never become baby fish, called larvae.

A fisherman lets a large juvenile tarpon go after catching and tagging it. Tags help scientists see where the tarpon goes after it is let go.

Juvenile tarpon look just like adult tarpon, but are much smaller in size.

The spawning sites are usually in areas of the ocean where water flow, waves and winds are most likely to carry the sperm, eggs and eventually the tiny larvae into habitats that are close to shore. These are safe places that they will need to survive and grow.

In Florida, tarpon are ready to spawn when they reach ages seven to twelve. But it gets more complicated: how big a tarpon can grow; how long a tarpon lives; and the age when a tarpon can spawn changes based on where they live. For example, tarpon in Costa Rica spawn when they are much younger, but these tarpon do not grow to be as large as the tarpon in Florida waters. The size differences in fish appear to be natural and related to what they can find to eat in that area and also how many predators there might be. Scientists do not know whether each mature tarpon spawns every year. We do know that spawning tends to happen in the late spring and through the summer months. But research has shown scientists that tarpon tend to spawn when the moon is at its biggest and brightest or on nights when you can't see a moon.

Fishermen can be a really great help to scientists by recording and tracking fish behavior. Volunteers help scientists' catch, tag, and release tarpon and other species. Scientists sometimes "tag" fish with tracking tags. These tags show scientists the long distance movements of these tarpon without the scientists having to follow the tarpon around. Tags like this also record where tarpon swim and how deep they go. Because of these tags, some scientists have recorded tarpon swimming over 100 miles offshore to spawn. One study of tagged tarpon showed that some fish can even dive as deep as 400 feet right before the full and new moons. Scientists think that this behavior might have to do with the fish getting ready to spawn.

Bonefish & Tarpon TRUST

Student reading

Tarpon Larval and Juvenile Stage

Tarpon larvae are called leptocephalus, and are small, tin and see-through so that predators have a hard time seeing them.

After adult tarpon spawn, sperm and eggs that were released join together and form the tiny baby tarpon. The baby tarpon are considered to be "larvae" at this point and this is their "larval stage" in their life cycle. The larval stage is the first month of their life. These tiny tarpon are transparent like a jellyfish body and are long and thin like little eels. A tarpon's larvae type is special to just a few species of fish. It is called a leptocephalus. In the clear open ocean where these little larvae start their lives, being transparent is a form of camouflage. This transparent camouflage also helps them make the long journey back safely into the shallow areas around the coast such as estuaries, tidal creeks and mangrove areas. They will spend the juvenile stage of their lives in these areas.

The age of the larvae can be determined by small bones called otoliths. These bones gain a new layer each day that the larvae is alive. If a scientist catches a larva, he or she can look at the otolith and count the layers to figure out how many days old the fish is.


Juvenile tarpon grow up in mangrove-lined creeks, because it is hard for predators to get into these areas.

A leptocephalus can grow to be about three to four inches long and must swim towards shore and find an opening, or inlet, into an estuary. Once inside this inlet, the leptocephalus is a little bit safer, but it still has a long way to go. The little tarpon must travel through seagrass beds, oyster reefs and shoals full of hungry predators looking for a meal. The leptocephalus that make it across these habitats and travel into shallow water with lots of protection can enter their next life stage, the juvenile stage. The juvenile stage is the first time that a tarpon begins to really look like what you think of as a tarpon, just in miniature version. The ideal habitat for this young fish is a mangrove area deep in an estuary. You might be wondering why they would want to live

there. Well, there is a maze of mangrove roots and oysters back in those areas. This maze makes it hard for a large predator fish to chase and eat a small juvenile tarpon. Tarpon are also special because they use their swim bladder (an organ fish have that helps to keep them floating when they stop swimming) to breathe in low-oxygen environments like mangroves. A tarpon can breathe by rolling over the surface and gulping air. They store the air in their swim bladder where they can then absorb the oxygen. This allows them to live back in these mangroves where most other fish would not be able to survive due to lack of oxygen in the water.

This happy angler releases a juvenile tarpon far back in a beautiful mangrove setting.

Juvenile tarpon need to live in this specific type of habitat, and cannot live in other places. This can mean trouble if that habitat is removed. Mangrove habitats have been destroyed very quickly by humans building and changing the land. For a hundred years in Florida, people thought mangroves were a problem because they blocked our beaches and they got in the way of building houses, hotels, and marinas. Now that we understand that mangroves are important habitat for tarpon and other fish, governments have enacted strict laws about protecting them. But now we need to fix all the mangroves that have been cut down or destroyed, which is very expensive. Trying to fix these habitats is important because the mangrove roots act as protection for the juvenile fish and as a place for them to get food.

The Cafeteria

Just about every predator fish eats shrimp, especially when the fish are young.

Juvenile tarpon are "opportunistic feeders." This means that they are not picky. They will eat anything that might be around that they can fit into their mouths. The size of their mouth is important for juvenile tarpon. A tarpon has to "grow into" what it can eat. When tarpon turn from leptocephalus into juveniles, they can only eat small shrimp, crabs and worms. As they grow larger they can start to eat small fish like mosquitofish. The changes in their food choices is similar to that of any living thing. As they grow larger, the prey they eat usually gets larger (and harder to catch, too!)

Bonefish & Tarpon TRUST

Student reading

Tarpon Sub-Adult to Adult

Sub-adult tarpon are like teenagers. They look like an adult. They act like an adult sometimes, but they are still not an adult yet. A tarpon this age looks just like an adult tarpon but still acts like young tarpon. They are big fish that can start to swim into new places, and eat new things. They explore open areas away from the mangroves and even swim into the open ocean. At this life stage they eat crabs, fish, shrimp and worms.

Scientists do not think that sub-adult tarpon migrate and that they generally stay close to the area where they spent their juvenile stage.

Sub-adult tarpon are big fish, but they will still grow a lot more once they become adults.

HABITAT	LOOKS	FOOD			
					
Mangrove community	Visually look like adult tarpon	Shrimp	Fish	Worms	Crabs

Fishermen in Florida love tarpon because they are huge fish that are hard to catch. They also jump high out of the water while being caught.

Adult Tarpon

Two of the most impressive things about tarpon are their great size and long life! They grow to more than 200 pounds and can live over 80 years. That is amazing for a fish and also is part of why they are such important fish to protect and preserve. Tarpon have been swimming in oceans since the dinosaurs roamed our planet, so it is our job to make sure these "silver kings" can continue to spawn, grow and eventually spawn again.

Tarpon take years to reach maturity.

For a tarpon, true adult maturity is the point in their life when they are able to make the long journey offshore and spawn. Adult tarpon spawn in the open ocean where there is not much food nor many places to hide. This journey can be dangerous because they are swimming long distances through habitats of many predators, such as sharks, barracudas and other large fish.

Even big tarpon are in danger if they are let go when big sharks are around.

Another danger of this long journey is the possibility of being caught by an angler. In Florida, tarpon are not caught for food but instead are caught and released as a fun sport. Tarpon are very fun to fish for because they fight as hard as they can, and make big leaps into the air. All this fighting makes the tarpon really tired, and sometimes the fishermen can hurt the tarpon by picking it up or taking it out of the water for too long. A tired or hurt tarpon has a harder time swimming, which can make it easier for predators to catch and eat the tarpon. If a fisherman is careful, tarpon fishing doesn't have to be deadly. There are lots of things that fishermen do to make sure their tarpon swim away healthy.

Some fishermen use circle hooks while fishing. These hooks take some practice to use but they help ensure that the fish doesn't get "gut hooked", meaning the fish doesn't swallow the hook so deep that it catches its stomach. Because the hook rounded, it pulls out of the throat and hooks on the side of the mouth instead of inside the stomach.

Circle hooks are most likely to hook the lip of the mouth, instead of deep in the belly where the hook is hard to take out safely.

Many fishermen try to reel in their tarpon as fast as they can once they have hooked it. If you fight a tarpon for too long, it will get too tired to swim away after it is let go. Fighting a tarpon for a long time also makes a lot of splashing and noise that will bring predators like sharks to the area. Sharks can eat the fish while it is still on the line and unable to escape. This ruins a day of fishing.

Many fishermen try to keep tarpon in the water next to the boat instead of holding it up. They will pull it up next to the boat and drive the boat slowly so that water is entering the mouth (and flowing across the gills) so they can take a good photo. Taking the tarpon out of the water makes it hard for the fish to breathe, but also, it is really easy to hurt the body of a tarpon by holding it.

All of these practices help the tarpon swim away in good health after it is released. You can make a big difference in a tarpon's health if you keep these things in mind when you go fishing.

Bonefish & Tarpon TRUST

Student reading

Tarpon: The Silver Kings

Did you know that the tarpon were swimming in the oceans as dinosaurs roamed our planet? They have been swimming around for millions of years, since the mighty T-Rex was causing havoc on land. These fish are giant and mighty just like their long-lost dinosaur friends were.

An adult tarpon attacks a school of silver mullet, a forage fish species that is important in a tarpon's diet.

In Florida, tarpon are catch-and-release only and it is illegal to keep them. Because of these laws and the good practices that fishermen use to keep their tarpon healthy while fishing, tarpon are able to live long lives and grow very large in Florida. This means that anglers can catch a four- or five- foot tarpon right off the shore. Tarpon are a unique species because of their huge size and their mighty fight when they get hooked. A tarpon is an athlete in the water, leaping and jumping through the air trying its best to get rid of your hook and not get caught. These giant leaps are part of what makes this fish such a prized catch by anglers around the world.

Tarpon use their huge bony mouths to inhale large fish, crabs, and shrimp. The larger the mouth, the larger the food.

The number of tarpon in the ocean has gone down over time because other countries still catch them for food, and because sometimes anglers do not treat them well and the tarpon die during fishing. This is why Florida has laws to protect them, and why the laws ask anglers to release them. But tarpon are a difficult fish to protect, because they can travel long distances and they are found all over the warm parts of the Atlantic Ocean. There is only one species of tarpon (*Megalops atlanticus*) in the Atlantic Ocean. This means that tarpon caught in South America, the Gulf of Mexico, The Florida Keys, or even along the west coast of Africa are all probably related. This is really amazing, but it means that all the countries where tarpon live need to work together if we want more tarpon to be swimming around in the Atlantic Ocean. It takes a long time to get other countries and states to make laws to protect tarpon, but there are still lots of things we can do here in Florida to help tarpon.

There is a lot we do not know about tarpon and what they do during their lives. Learning more about where they go and what they do is important in protecting them and taking care of them. It is hard to take care of tarpon when we do not know much about their lives. Here is some of what we DO know about tarpon:

Tarpon scales are large and mirror-like. Scientists think that by reflecting light the scales help camouflage the fish from predators.

In the oceans and environments around the globe it is said that everything is connected. This is really true with tarpon. A tarpon's journey starts far offshore in the deep blue sea (the pelagic zone) where it begins life as a tiny baby fish, called a larva. It can't swim well on its own, so it is swept by the wind, currents and waves around in the open ocean. After about a month, the ocean carries it into shallow estuaries, which is where rivers meet the ocean. Here in the shallow water, the larvae can grow and develop into juvenile fish.

During this juvenile stage, a tarpon looks exactly like a grown adult, just smaller in size. The shallow estuaries where the fish grow up are full of mangroves, plants, and other small fish. The winding mangrove roots in these shallow areas create safe places for the fish to grow in size while hiding from bigger fish that could eat them. One really amazing adaptation (a way to deal with a negative situation) is that sometimes tarpon can breathe air! Tarpon live in water that has little or no oxygen in the water while they are juveniles. Fish need to breathe the oxygen in the water, so most fish are not able to live in this type of habitat. Tarpon take gulps of air into a special organ called a swim bladder – which most fish use to balance themselves underwater – but tarpon can also use that air to breathe. This means that the tarpon is able to live in areas where there are fewer large predator fish that could eat them.

Tarpon need to grow up near mangroves, because mangrove roots protect small fish from large predators.

Scientists know that tarpon need mangrove and wetland habitats to survive during this life stage, but unfortunately this is a habitat that is quickly being lost because of people building on the coast. One question scientists have is exactly what makes juvenile tarpon choose specific spots over others. It's an important question because if the best spots for juvenile fish to live are all destroyed, the number of adult tarpon will start to drop.

Adult tarpon can live up to 80 years and these old fish are very wise to the ways of anglers. This is part of why catching these silver kings is such a skill and why people want to catch them so badly. Tarpon take many years to reach the adult stage. An adult is about four and a half feet for females and males are about 4 feet. When most tarpon reach the adult stage they really start to travel! Tarpon have been tagged and tracked to migrate as far as 1,200 miles. That is as far as South Florida to New York City in mileage! However, some fish stay close to the place they grew up.

A thoughtful and aware angler will help keep this ancient species of fish around. Tarpon are big business in the places that they are caught and bring lots of money into the economies of these communities. It is very important that the species thrives for the ocean's sake and also for the people whose livelihoods depend on them.

Thoughtful anglers catch tarpon as quickly as possible, because keeping the fish on the line for a long time can tire it out and make it easier for nearby predators to find and eat it. Fighting a fish for a long time can also stress the fish out, making it more likely to get sick and possibly die. It is also good to keep the fish in the water for photos when you get it to the boat. A fish can only breathe if its gills have water going through them, so taking it out of the water even for a quick photo can be too long for a tarpon and cause it to suffocate and possibly die. When you are handling the fish after catching it you should always use specially designed tackle pliers to safely remove the hook. These important steps can help keep your prized catch alive and also leaves your fish to fight another day.

Though tarpon are predators near the top of the food web, sharks eat tarpon, including tired tarpon that anglers fought too long.

Bonefish & Tarpon TRUST

Tarpon Scale Mail

Objectives:

At the end of the activity students will demonstrate their understanding of the tarpon life cycle and habitat of a specific stage in that life cycle. Students will also demonstrate their understanding of visual appearance of both the life stage and the habitat through creation of a drawing or collage depicting colors, features or species living in chosen habitat.

Differentiation:

You can help students who are struggling to write their postcards by creating a writing prompt or using the provided one. The planning worksheet can be done in small groups or with the help of a teacher. For students who are unsure of their ability to draw a habitat or tarpon life stage you can ask them to collage their postcard or use the appropriate colors and do the best drawing that they can. Assure them that drawing is only a small part of the activity and not related to their grade or completion at all. If a student feels that his/her writing is too limited due to a postcard's size, then encourage him/her to write a letter using paper rather than the template and he/she should include a picture and strong descriptive words in the writing.

Lesson background:

Many fish spend parts of their life cycles in unique habitats. These habitats are often long distances from each other and this requires that the tarpon travel either via wind, waves or their own swimming capability. This concept is something that every child can understand and also is a concept addressed in the state science standards. This lesson gives the chance for the students to demonstrate their understanding of the life cycle stages as well as the unique habitat in which each stage is spent. It is imperative that the teacher NOT introduce this lesson until the students have shown a firm understanding of both of these topics in order for them to have the most successful experience with this activity. The planning page should be completed prior to the activity and after the students have had an opportunity to read about the life cycle stages.

Florida State Standards (NGSSS)

- SC.2.L.16.1: Observe and describe major stages in the life cycles of plants and animals, including beans and butterflies.
- SC.2.L.17.1: Compare and contrast the basic needs that all living things, including humans, have for survival.
- SC.2.L.17.2: Recognize and explain that living things are found all over Earth, but each is only able to live in habitats that meet its basic needs.

National Standards (NGSS)

- 1-LS1-2: Growth & Development of Organisms
- 2-LS2-1: Interdependent Relationships in Ecosystems
- 2-LS2-2: Interdependent Relationships in Ecosystems
- 2-LS4-1: Biodiversity & Humans

Activity:

Tarpon Scale Mail

Procedure:

- Introduce the life cycle of the tarpon as well as the various habitats that these life cycle stages occur in. If students have not read the life cycle student reading(s), they should at this time. They can be provided with copies of the student reading to use small group or individually or can just read it aloud as a class.

- Start by filling out the Activity Background sheet as a class. Start by clarifying any words from the readings that students may not understand. Identify 5-10 vocabulary words that they can use in their postcards, but encourage them to write down more on their own if they wish.

- On the board make a list of the distinct life cycle stages (larvae, juvenile, subadult, adult). Under each life stage, make notes about unique features or characteristics of these life stages. Name preferred food for each stage.

- Finally, write the habitats that each stage takes place in (deep ocean, inshore coral reefs, inlets or estuary, creeks or shallow areas) make notes about what these places each look like or what plants, animals that might live in each habitat and environmental factors in each habitat (wind, waves, algae blooms, mangrove deforestation, water quality issues from rain events or man-made discharges)

- Using these created lists the students will brainstorm which life stage they will imagine they are when writing their post card. Their postcards should be written in "first person perspective", so they should understand that they need to imagine they "are the tarpon". Students should consider what activities a tarpon in this life stage might take part in (this can be a mixture of activities a fish that age would do). They will use the postcard template to write a message from them (the tarpon) to a person of their choosing (a friend, a relative, another tarpon).

- On the front of the postcard the student will sketch a picture of the habitat that their tarpon currently lives in and a message of their choosing. The teacher could google examples of postcards if the students do not demonstrate previous knowledge or experience with postcards and how they are set up or look visually.

Name: _____ Date: _____

Tarpon Scale Mail

Activity Background

You will be creating a postcard from a tarpon who is in a specific habitat and at a certain life stage. On the front of the postcard draw a picture of your tarpon at the age you would like it to be (larvae, juvenile, sub-adult or adult) and the habitat that a tarpon that age would live in (pelagic ocean, nearshore reef, mangroves, estuary). On the back of the postcard write a message from your tarpon to a person of your choice (it could be a friend of theirs, a family member or anyone you can imagine). In your writing please include details about where your tarpon lives, what it eats, and what life is like for it. Be sure to use this pre-writing page to guide your writing and to use the vocabulary learned in your life stages reading.

Vocabulary

(What vocabulary words can you use from your reading?)

Life Stages

(What are the different life stages of a tarpon and unique characteristics and habits/needs of each?)

Habitat

(What habitats do the life stages take place in and what are unique characteristics of those ecosystems?)

Activity Rubric:

You should check to see if you meet the following criteria at the level "4"

Area	1 Does not meet expectations	2 Partially meets expectations	3 Meets expectations	4 Exceeds expectations
Science Content	The postcards do not mention life stage/ habitat or do not properly match the life stage with the correct habitat	The postcard mentions a life stage or habitat with details about either but does not go into adequate detail	The postcard mentions a life stage or habitat with details about either but does not go into adequate detail	The postcard mentions a life stage or habitat with details about either and goes into adequate detail
Use of science vocabulary	The postcard does not use any scientific vocabulary words from the life stage reading	The postcard uses some scientific vocabulary from the life stage reading but has major gaps where science vocabulary could have been used	The postcard uses multiple scientific vocabulary from the life stage reading with no major gaps where science vocabulary could have been used	The postcard uses a large amount of vocabulary from the life stage reading and has no obvious areas where a more scientifically informed word could have been used
Writing fluency	Writing flow and errors in sentence structure are multiple, making the postcard close to impossible to comprehend	Writing flow and errors are evident, but few, and make the postcard difficult to comprehend	Writing flow and errors are few, and the postcard is easy to read and understand	Writing flow and errors are not present, and the postcard is easy to comprehend and follow the information presented to the reader
Conventions	Spelling, capitalization, and punctuation errors are numerous and make the written narrative difficult to understand	Spelling, capitalization, and punctuation errors are evident and make the written narrative difficult to understand	Spelling, capitalization, and punctuation errors are few	Spelling, capitalization, and punctuation errors are not in the writing at all

POSTCARD FRONT

POSTCARD FRONT

POSTCARD BACK

PLACE STAMP HERE

POSTCARD BACK

POSTCARD FRONT

POSTCARD FRONT

POSTCARD BACK

PLACE STAMP HERE

PLACE STAMP HERE

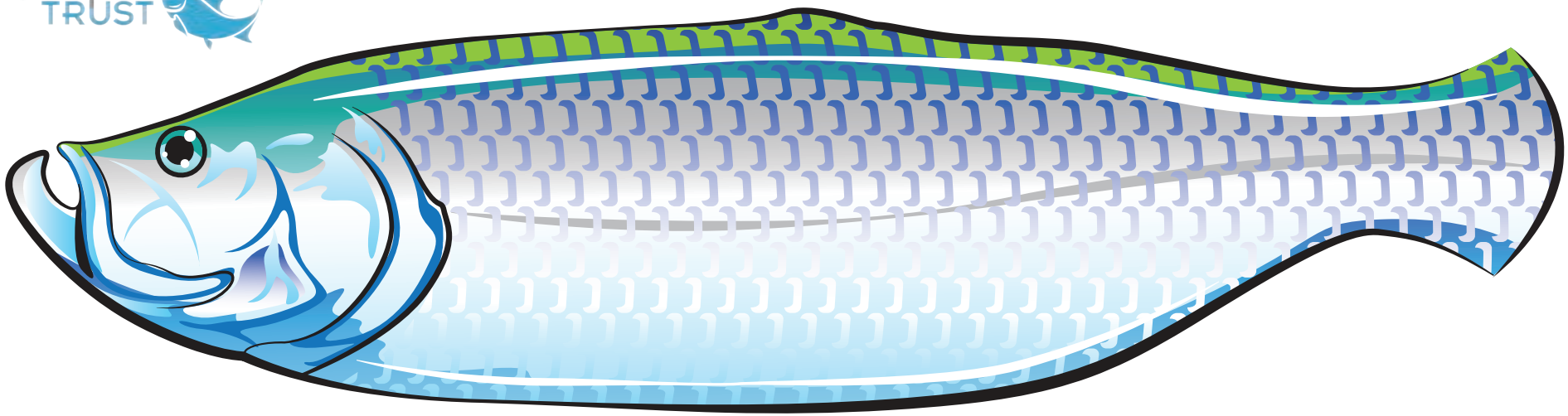
POSTCARD BACK

TARPON FIN FORM AND FUNCTION

FIN NAME:
FUNCTION:

FIN NAME:
FUNCTION:

Bonefish & Tarpon TRUST



FIN NAME:
FUNCTION:

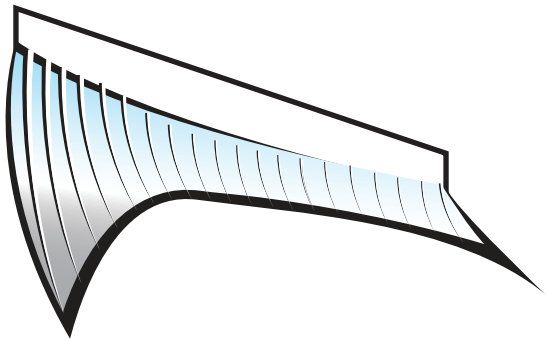
FIN NAME:
FUNCTION:

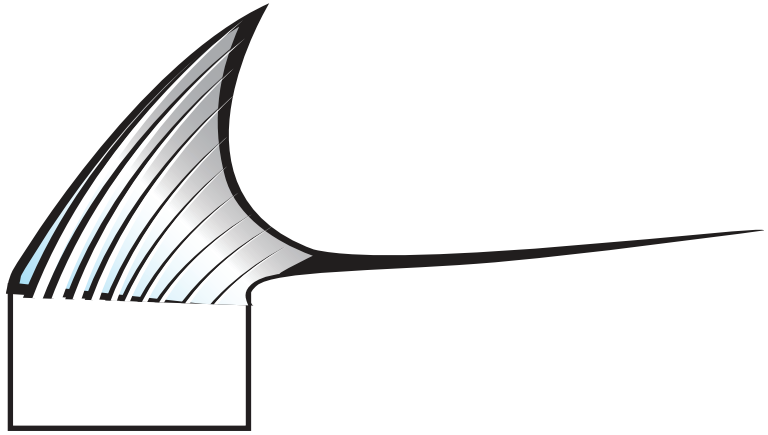
FIN NAME:
FUNCTION:

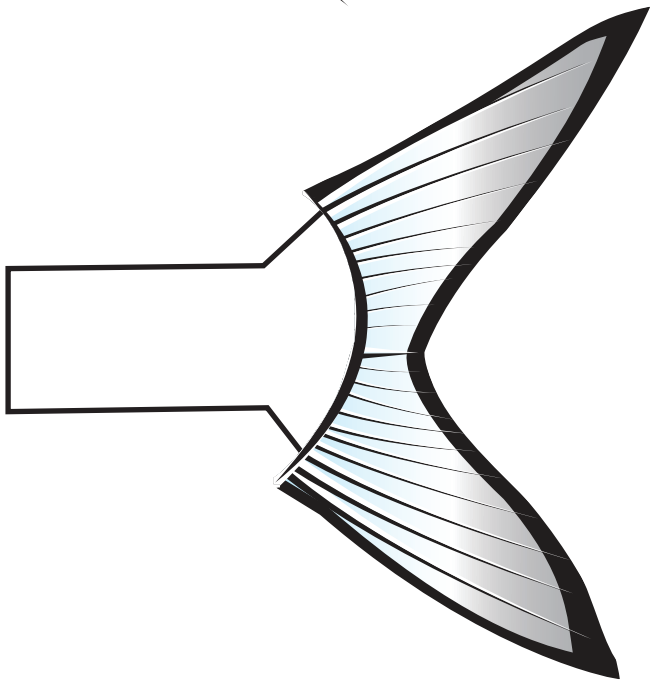
TARPON FIN FORM AND FUNCTION

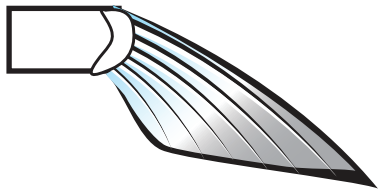
DIRECTIONS

You have been studying fin types and their function. Using the tarpon template and the fins on this page you are going to show your knowledge. Carefully cut the fins on this page out. Place a small amount of glue on the tab located on each fin and glue them to the tarpon body where they belong. There are 5 fin types and 5 boxes surrounding the fish. Write the name of each fin in a box and write a detailed description of what that fin does for the tarpon.









Tarpon: Funny Fish with Flapable Fins!

Objectives:

At the end of the activity students will demonstrate their understanding of tarpon body shape and fin placement with an overall focus on fin shape, location and function in regards to finfish in general and different scale types that fish possess.

Differentiation:

Students with fine motor skill issues can be grouped with more able students in pairs and the more able student can do cutting and the second student can glue and place the fins. Students who might experience issues with writing in the limited space allocated could list the function of the fins or body anatomy on the bottom of the page or may use the teacher example/answer key in place of hand-writing the answers.

Lesson background:

Finfish have multiple fins and body structures that all are imperative for their survival. Just as humans have legs for running or walking fish have specific fins that aid them in movement forward, backward and within the water column. In this lesson students will explore these fins, their functions as well as scale types and other anatomy parts that finfish depend on for survival.

Florida State Standards (NGSSS)

- SC.2.L.14.1: Distinguish human body parts (brain, heart, lungs, stomach, muscles and skeleton) and their basic functions.
- SC.2.L.16.1: Observe and describe major stages in the life cycles of plants and animals, including beans and butterflies.
- SC.2.L.17.1: Compare and contrast the basic needs that all living things, including humans, have for survival.

National Standards (NGSS)

- 2-LS2-2: Interdependent Relationships in Ecosystems
- 2-LS4-1: Biodiversity & Humans
- 3-LS4-2: Natural Selection
- 3-LS4-3: Adaptation

Activity:
Form and Function

Procedure:

• Prior to teaching the lesson, the teacher should review readings about tarpon and personally familiarize him/herself with tarpon as a finfish, including fin form and function along with body scale types as described below. This page talks about life cycle, habitat and anatomy for teachers to best be prepared to present the material to the students.

• Students should be asked to name their common (school/camp appropriate) anatomy. Students will likely say common anatomy such as eyes, nose, teeth, ears etc. and their function. The teacher can draw these parts on human figure or just list the part and their function. The students are going to be aligning their body parts which they are familiar with to the function. This will pave the way for early introduction and understanding of fish anatomy and the function. Students will have their own anatomy worksheet in which they can list their answers as well.

The list may look like: (There is no right or wrong answer, only inappropriate for camp or school)

Nose	Smelling
Eyes	Seeing
Hands	Picking things up/ hugs/ touching
Feet/ legs	Movement
Ears	Hearing

As the students name the parts of the fish the teacher can draw the parts onto the oval. If making a list the teacher will list the part named and what the students think the function might be. The list might look like this:

Eyes	Seeing
Fins	Swimming/ movement
?	

Teachers might want to hit on the fact that they know that fins are used for swimming but can pique students' interest in the activity by asking them if they can name the fins or the scale types. If students can in fact name the fin types, continue the conversation and start listing the fin types that students do name and then use this as a lead in to the activity and begin to pass out the student worksheets that they will use for the activity at this time. Once students have the activity sheets in their possession have them write the list of body parts and functions on their sheet and then continue with the introduction of the fins and purposes.

This is the complete listing of the fin types. The student version is missing keywords (which are highlighted in this version) so it is imperative that teachers stress these missing pieces and also allow ample time for the students to fill in the missing pieces.

FIN TYPE	FUNCTION
Dorsal	Located on the **back** of the fish; keeps fish from rolling over; assists in **sudden stops and turns.**
Caudal	Tail fin located on the **back** of the fish. Used for **propulsion** and fast **forward** movement.
Anal	Located on the **underside** of the fish in the **rear**. Used for keeping the fish **stable** while swimming.
Pectoral	Allows fish to maintain **depth** in the water. They are found in pairs and assist with turning **sharply** and **stopping** quickly. Located on each side of the fish and are the equivalent of human's **arms**.
Ventral	Found behind the **pectoral** fin on the **bottom** of the fish. They help in **turning** sharply and **stopping** quickly.
Finlets/Keels	Help stop "turbulence" on **very fast** swimming fish (species like tuna etc. often have finlets)

SCALE TYPE	DESCRIPTION
Cycloid	**Circular** and **smooth**. They overlap in a pattern and this helps them to reduce drag on the fish as it swims through the water 
Ctenoid	Have a "**toothed**" edge and are commonly found on **spiny** fin ray fish. 

Tarpon: Funny Fish with Flapable Fins!

(say it three times fast!)

You will be learning about finfish fins and anatomy along with their form and function (another tongue twister!) You will explore a tarpon to learn about this. Tarpon are amazing fish that have swum the world's oceans since the days of the dinosaurs. Tarpon are popular sportfish because they are smart, difficult to catch, and make great leaps into the air when hooked. They are also long distance swimmers. Just like an Olympic swimmer, tarpon are speedy and streamlined, which they owe to their fins. We are going to dive into what those fins are called and their role in this speedy fish's survival.

Fill in the chart below with some common **HUMAN PARTS** and their **FUNCTION**:

HUMAN PART	FUNCTION

Now let's learn about finfish anatomy and their form and function.

Fill in the chart below with the **FUNCTION** of each <u>fin</u> as you read or discuss these features with your group, partner or teacher.

FIN TYPE	FUNCTION
Dorsal	Located on the _____ of the fish; keeps fish from rolling over; assists in _____.
Caudal	Tail fin located on the _____ of the fish. Used for _____and fast _____ movement.
Anal	Located on the _____of the fish in the _____. Used for keeping the fish _____while swimming.
Pectoral	Allows fish to maintain _____in the water. They are found in pairs and assist with sharply _____ and _____quickly. Located on each side of the fish and are the equivalent of human _____.
Ventral	Found behind the _____fin on the _____of the fish. They help in _____sharply and _____quickly.
Finlets/Keels	Help stop "turbulence" on very _____ swimming fish (species like tuna etc. often have finlets)

All finfish have SCALES and they need these to help protect their soft and fleshy bodies. These scales come in multiple shapes and different fish have differently-shaped scales. Below are three common scale types. Fill in the chart to complete what type of fish has which scale type and the general appearance of each scale type.

SCALE TYPE	DESCRIPTION OF THE SCALE	DRAWING OF THE SCALE
Cycloid	They are _____and _____. They overlap in a pattern and this helps them to reduce _____on the fish as it swims through the _____.	Cycloid
Ctenoid	Have a " _____" edge and are commonly found on _____fin ray fish.	
		Ctenoid

Activity Rubric:

You should check to see if you meet the following criteria at the level "4"

Area	1 Does not meet expectations	2 Partially meets expectations	3 Meets expectations	4 Exceeds expectations
Science Content	NONE of the fish anatomy is placed in the correct location for any of the specified parts. Function or purpose is not listed on any parts.	SOME of the fish anatomy is placed in the correct location and some specified parts are missing. Function or purpose is not listed on most of the parts.	MOST fish anatomy is placed in the correct location. Function or purpose is listed on most parts correctly and with detail.	ALL anatomy is placed in the correct location and great detail and explanation of purpose is present on all of the pieces.
Use of science vocabulary	NONE of the introduced scientific vocabulary is present in the writing portion of the activity on the varied fish pieces.	SOME of the introduced scientific vocabulary is present in the writing portion of the activity on the varied fish pieces but many key terms are missing.	MOST of the introduced scientific vocabulary is present in the writing portion of the activity on the varied fish pieces and few key terms are missing.	ALL of the introduced scientific vocabulary is present in the writing portion of the activity on the varied fish pieces. no key terms are missing.
Writing fluency	Writing flow and errors in sentence structure are multiple, making the activity close to impossible to comprehend.	Writing flow and errors are evident, but few, and make the activity difficult to comprehend.	Writing flow and errors are few, and the activity is easy to read and understand.	Writing flow and errors not present, and the activity is easy to comprehend.
Conventions	Spelling, capitalization, and punctuation are numerous and make the written narrative difficult to understand.	Spelling, capitalization, and punctuation errors are evident and make the written narrative difficult to understand.	Spelling, capitalization, and punctuation errors are few.	Spelling, capitalization, and punctuation errors not in the writing at all.

Teacher reading

Bonefish

Bonefish are predominantly schooling fish that feed in shallow habitats, such as seagrass meadows and sand flats.

Bonefish (*Albula spp.*) are one of the world's most exciting and challenging shallow-water recreational fisheries. Anglers stalk various bonefish species in shallow-draft skiffs called flats boats, or wade after them where they feed in water that is sometimes less than shin deep. Anglers must make a delicate, pinpoint presentation with a fly, lure or natural bait, such as a shrimp or crab; otherwise these incredibly wary and speedy fish will flee the flat, leaving a "rooster tail" of wake as they go.

As their common name suggests, bonefish aren't targeted for food except in developing nations. Dead, they are worth little. Alive, each fish is a major economic driver. The passion for bonefishing with fly rods and other light tackle supports a major global travel, boat-building and tackle industry – one that generates well-paying jobs and vital local and regional tourism revenues. Some Iconic destinations are: southern Florida; The Bahamas; Turks & Caicos; Cuba; Puerto Rico; the U.S. Virgin Islands, Belize; Mexico; the Seychelles; Hawaii; and Christmas Island. Greater public education and ongoing research are imperative if we are to protect these economically and ecologically vital species.

The name "bonefish" is given to multiple species in the same taxonomic family. Thanks to advances in genetic research, scientists have discovered multiple species with regional distributions around the globe. As many as 11 species and subspecies are now recognized, but there may be more species remaining to be discovered. For example, the roundjaw bonefish (*Albula glossodonta*) and the smallscale bonefish (*Albula oligolepis*) occur in the Indian Ocean and parts of the Pacific. And for most researchers and anglers fishing in the northwestern Atlantic – in the waters in and around The Bahamas, Florida, the Gulf of Mexico, and the Caribbean Sea – *Albula vulpes* (or the "white fox" as it is known) is the species of greatest interest. At least three other species occur in those waters, and one other species, the roundeye bonefish (*Albula garcia*), is encountered and targeted specifically in the southern shallows of Florida's Indian River and Lake Worth lagoons. Our lessons will focus on *Albula vulpes*, because it is the most popular, valuable and best understood species in the western North Atlantic.

Ontogeny

A large spawning aggregation heads offshore to reproduce.

It's often and accurately stated that in nature everything's connected – coastal and marine aquatic habitats included. For example, air and water currents, water chemistry, and geology (to name a few natural forces) create linkages between habitats including seagrass meadows, coral reefs and the blue pelagic ocean. So do animals. It becomes most evident how these different habitats are closely connected when observing the migration routes of a fish throughout its life cycle. As fish grow in size and age, their needs change; this growth over a life cycle is referred to as ontogeny. Small fish are most easily eaten by other fish, and therefore need to live in areas with lots of places to hide and access to small food. Larger fish need less protection, larger food, and access to mating opportunities. Therefore, they move on to new habitats that meet these needs. The ontogeny of bonefish is particularly complex, making them a fascinating model to study.

Bonefish, especially *Albula vulpes,* are specifically targeted in clear, shallow waters called "flats" that consist of coral back reef flats, or sandy and/or grassy areas often bordered by mangrove shorelines. Thus, anglers think of the species as solely occupying shallow water. However, *A. vulpes* requires a variety of inshore, nearshore and offshore habitats at various life stages. Like many marine fishes, the bonefish's life cycle or "life history" connects diverse, important habitats.

As with all life, bonefish exist to perpetuate their species. Bonefish reach sexual maturity between ages three and four and can live as long as 23 years in some regions. Individuals spawn many times in the course of their lives.

During spawning season – roughly November through April in the Western North Atlantic – adult bonefish assemble into large groups called "spawning aggregations" before migrating offshore to release their sperm and eggs. There's evidence of "site fidelity" to pre-spawn rendezvous locations called "pre-spawning aggregation sites," meaning that the same fish often return to the same pre-spawn locations year after year. Bonefish schools that typically forage in different areas around the Caribbean all meet in strategic locations, resulting in mixed schools that number in the thousands of fish. The locations are usually next to a channel that offers quick access to the open ocean.

Protecting pre-spawning aggregation sites, and spawning aggregation sites – (the latter are still unknown for bonefish) – is essential if we are to conserve these extremely valuable resources. Efforts are underway to identify pre-spawn and spawning aggregation sites. For example, researchers with Bonefish and Tarpon Trust (BTT) and fishing guides working on Andros Island, The Bahamas, recently identified a new pre-spawning aggregation site – raising the total known number of such vital locations to six in The Bahamas. The fish were gulping air and porpoising, behaviors that signal an imminent departure to offshore spawning grounds, typically around the full and new moons be- tween October and April. There is a video of this behavior included in our online materials.

It is not known where exactly bonefish spawn offshore, or what the cue(s) are for the fish to release eggs and sperm using a strategy known as "broadcast spawning." But early research using ultrasonic tags on bonefish in The Bahamas strongly suggest that spawning takes place offshore – likely in places where and at times when currents are most likely to spread fertilized eggs to ideal settling

locations that enable larval bonefish to survive. Bonefish do not waste any energy building nests or caring for their offspring. They simply gather in large schools and more or less simultaneously release their eggs and sperm together to be fertilized in the currents that will carry those zygotes off – hopefully toward juvenile habitats.

Lunar phases are a key element in spawning success. Bonefish spawn around the new and full moons, when currents are stronger and tides more extreme. Stronger tides can carry the gametes farther. Post-larval bonefish settle in sand- and mud- bottomed bays where they mix with other silver species. It is a safety-in-numbers strategy.

Bonefish Larvae

Bonefish spend about 40 to 70 days in a leptocephalus larvae stage, an ancient survival strategy employed by tarpon (*Megalops atlanticus*) and myriad eels. In fact, bonefish and tarpon are much older than most species pursued by modern anglers. Bonefish fossil ancestors date back to the Cretaceous Period, more than 140 million years ago at the end of the dinosaur era when the oceans were much warmer and more acidic.

Bonefish leptocephalus are thin and translucent as a camouflage during their open-ocean

Their translucence served them well in those acidic times; it continues to provide them protection in the clear and relatively barren tropical oceans of today. It may serve them well in the future as our oceans become more acidic again due to oceans' abilities to absorb human-induced carbon dioxide emissions — the same gases causing global climate change. Acidic waters cannot supply sufficient minerals for calcifying plants such as sargassum – an algae that floats in the open ocean which provides cover for myriad marine life including juvenile sea turtles and many species of fish, shrimp and crabs. So, larval bonefish survive hidden in plain sight by their translucence.

Early Juvenile Stage

Bonefish offspring undergo a three-step process of metamorphosis as they settle in bay bottoms. Early in stage one, when the animal is less than 30mm, leptocephali lack dorsal, anal and pectoral fins. Late in stage one, those fins appear as the larval animal reaches its maximum size of about 63mm. During stage two, larvae shrink rapidly to about half their original length. The anal and pectoral fins move forward and the snout projects beyond the mandible. During stage three, scales appear, followed by pigmentation and crossbands. At stage three, bonefish are officially "juveniles."

Early juvenile bonefish are incredibly vulnerable to predation, pollution and sedimentation – the latter creating turbidity and undermining their ability to find food. They also tend to be more dependent on specific types of habitat than at any other life stage. This vulnerability and habitat specificity is not unique to bonefish; newly settled tarpon require small, shallow and relatively low oxygen creeks in marsh/mangrove ecosystems. Such creeks are too shallow for predator fish to access. They're also low in dissolved oxygen, so other species have a difficult time breathing in the low-oxygen environment, while juvenile tarpon have the ability to breathe air. Such creeks are also often covered by vegetation, which blocks the views of birds. And, they are full of the types of food that juvenile tarpon prefer, such as amphipods, copepods and shrimp, as well as mosquito fish that provide nourishment once the tarpon are able to catch more mobile prey. Researchers have found

that early juvenile *A. vulpes* settle and grow as juveniles in sandy or muddy bottomed, protected bays of a few feet deep or so – typically close to channels for larval access. Learning more about such habitats are high research and conservation priorities. We cannot protect the species without protecting bonefish nurseries.

Juvenile Bonefish

Juvenile bonefish prefer mud/sand bottoms in calm bays where they are well-camouflaged and don't have to work too hard to catch the food they need to grow.

Large Juvenile Bonefish & Sub-Adults

Though researchers aren't quite sure why, large juveniles and sub-adults live mostly on open sandy bottoms in deeper water than where anglers tend to fish for adults. Large juveniles and pre-adults dominate many of the large 'muds' of bonefish. As the school feeds, it roots into the bottom, suspending sediment into a smoky trail.

Silver scale and dark green streaks help the bonefish blend in on the grass flats where they feed.

Adult Bonefish

Except in pre-spawn and spawning modes, adult bonefish spend most of their lives in intertidal flats, man- groves, and creeks. Often congregating in schools of 100 or more, bonefish generally follow a daily pattern of coming up onto the flats as the tide rises and retreating to deeper water as it falls. Water and air temperatures, as well as the availability of prey, influence their feeding patterns. Larger bonefish tend to travel in twos or threes, and the trophy specimens are solitary. Bonefish feed by digging through the sandy bottom to root up prey, which are crushed in the fish's powerful pharyngeal teeth. They also feed on small fish and epibenthic species.

Bonefish & Tarpon TRUST

Student reading

Bonefish

Most anglers use fly-fishing tackle for bonefishing. Some even tie their own flies to look like shrimp and crabs.

Bonefish (*Albula spp.*) are amazing fish! They are extremely fun but hard to catch. It's all about the challenge. Anglers stalk bonefish in shallow-water boats called flats skiffs. These boats can get into the really shallow places where bonefish like to live and eat when they are adults. Sometimes these areas are less than knee deep. Bonefish are very easily scared away, so an angler trying to catch a bonefish has to be very careful and gentle when fishing. The angler has to convince the bonefish to eat a fly or lure that looks just like food, or with natural bait like a shrimp or crab. It really helps if you're casting something that looks a lot like what they're eating. When the angler tosses a lure or fly toward the bonefish, he or she has to be very careful. If the bait or fly lands too close or too loud, the fish will quickly swim away from the flat, stirring up the sand and water as it goes and likely scaring its friends away too.

As their name suggests, bonefish are not a good fish to eat. Instead, bonefish are worth a lot of money to the communities in the areas where they are caught. Anglers from around the world travel to catch the elusive bonefish and this tourism creates jobs in the boat-building, travel, tackle and tourism industries. Some of the places that make lots of money off the bonefishing industry are South Florida; The Bahamas; Turks & Caicos; Cuba; Puerto Rico; Belize; Mexico; the Seychelles; Hawaii; and the Christmas Islands. All of these places make money off tourists coming to fish their beautiful waters for this important species.

Originally we thought there was only one type of bonefish. But as we learn more, research scientists have actually found 11 species of bonefish and the possibility of more discoveries exists. These species live in different areas around the globe, but a few live in the same places. There are three species of bonefish found in Florida alone! The species that is found most often around Florida, the Bahamas and the Gulf of Mexico is *Albula vulpes*. Those Latin words translate as "white fox," due to the fish's whitish coloring and its fast swimming speed. In fact, its mirror-like scales make it almost invisible, and the shape of its body allows it

A pre-spawning aggregation of bonefish heads offshore to reproduce. Some pre-spawning aggregation spots, where the fish meet up, have been discovered. These areas need to be protected, and so do the places we've yet to discover where they spawn offshore.

to reach great speeds very quickly. *Albula vulpes* is one of the most valuable, popular and best understood species of bonefish that lives near us. Generally, we agree that most things in nature are "interconnected" and in the marine environment this is especially true. The waves caused by winds (air currents), tides (water currents), moon phases and the chemistry and geology of the oceans and lagoons are all interconnected. The animals who live in these habitats (like bonefish) rely heavily on strong, healthy connections between different parts of nature to live, eat and reproduce.

Many people think bonefish spend their entire lives in shallow seagrass meadows and back reef flats, because that's where the adults are fished for. But bonefish actually need many habitats throughout their lives. A bonefish relies on habitats as different as coral reefs, the open ocean, and seagrass meadows all within one lifetime – even within a given season or year!

Bonefish may spawn many times over their lifespan and are able to produce young once they reach three or four years of age. During spawning season, which is roughly November through April in our part of the world, they gather in large groups called "spawning aggregations." Imagine thousands of adult fish realizing they all need to meet in a certain place at a certain time to reproduce. That's what a pre-spawning aggregation is for bonefish. Those large groups of bonefish have been observed and recorded next to channels that offer a quick way for the fish to go into the open ocean where they actually spawn.

Bonefish larvae are called leptocephalus. They are almost clear because they drift around in the open ocean.

Bonefish use a reproduction method called broadcast spawning, where all the fish release eggs or sperm into the water at the same time

Adult bonefish blend in with the sand and seagrass on the flats where they feed.

Most angler use fly-fishing tackle for bonefishing. Some even tie their own flies to look like shrimp and crabs.

while swimming in a group.

This spawning usually happens when the tides and currents are the strongest. This time period typically occurs on a new moon and a full moon.

During those moon phases, the eggs and sperm they release meet in the water, where they combine in the act of fertilization and start the cell division process that eventually will make, in the case of a bonefish, a tiny eel-like baby fish called a leptocephalus larvae. Most fish begin their lives as larvae before changing into the shape of a fish.

After the egg and sperm meet and the egg is fertilized, the fertilized egg can be carried away by these tides and currents. At some point, a larva with some luck settles in an area where the tiny bonefish can grow. The best place for bonefish to settle based on the current research is a shallow flat protected from waves and current where the tiny baby fish could be safe from larger predators.

Larval bonefish are tiny and transparent! Their small size and transparency makes them almost invisible, which helps them avoid being eaten by larger fish. After about 40-70 days in this stage they change into little fish with some silvery coloring and begin to look more like a mature bonefish. When they are completely done morphing into the tiny bonefish they leave what scientists consider the "larval stage" and become "juveniles."

Even when bonefish become juveniles, they are still small fish that have a high risk of being eaten by a predator. These small juveniles need to find a shallow creek or area of the lagoon with plants in and above the water. These plants will help block the view of the juveniles from birds, larger fish and other predators that want to eat the small fish.

There are still lots of things that scientists need to learn about this stage of bonefish life. But there's a basic understanding that when the bonefish are "teenagers," or sub-adults, they like to live in calm sandy or mud-bottomed areas. Scientists are not sure why this is where they

live during this portion of their lives. The theory is that their mirror-like scales camouflage them well in these habitats.

Adult bonefish spend most of their time in the flats, mangroves and creeks that are flushed by the incoming and outgoing tides. They can live in areas in schools of up to 100 fish! Larger bonefish adults tend to be found in smaller groups of two to three and the very large bonefish are found by themselves and not in groups at all.

Bonefish tend to have patterns to their days, coming to specific areas in the morning and then another area mid-day. They tend to move into shallower water as the tide rises and then move out to deeper water as the tide goes low.

Water and air temperatures can affect where in the water the bonefish can be found too. For example, if the water is too hot, it won't have enough oxygen to support a bonefish. Climate change threatens bonefish habitat because a warming planet can make their feeding areas too hot to hold oxygen.

Bonefishing brings lots of tourists to The Bahamas, and the Bahamian government recognized the species- importance by putting images of bonefish on their dime.

Bonefish & Tarpon TRUST

Student reading

What is a producer and what is a consumer?

We all eat! Actually, everything in the entire world has to get its energy from somewhere. We all need energy so we can live, grow, move, or do anything at all! Even though we all need energy to live, there are different ways that living things get their energy. There are some living things in this world that produce their energy and there are other living things in this world that consume to get their energy.

The most common producers are plants, so if you are a producer then there is a really good chance you are green. Producers are usually green in color because of cells with chlorophyll in them. Producers use the sun to make their energy in a process known as photosynthesis. There are plants in water bodies including oceans, lakes and rivers, and there are plants on the land like trees, bushes and grasses. When a cow chomps down on sweet spring grass it is eating a producer. When you eat all your broccoli at dinner, you're eating a producer. When a small fish eats algae off a rock, he is eating a producer too! Producers are the base of the food webs that our world depends on. They get their energy not by eating a large dinner but by pointing their chlorophyll-rich bodies toward the sun.

What exactly do we mean by "living things"?

When we talk about food webs or chains, we are talking about energy moving between "living things," mostly through eating. A "living thing" can be an animal, a plant, algae, or anything that needs energy to live and grow. Seagrass, shown here, is another example of a living thing.

Chlorophyll has the ability to turn water, carbon dioxide and sunlight into sugars that then give the plant energy to grow and live its life. The energy that plants produce also gives the living thing that eats the plant energy too! So when you eat your broccoli or that cow eats the grass it is actually consuming the energy that the plant produced from the sun. Where a living thing gets its energy from is how we decide if it is a producer or a consumer. If the living thing gets energy only from the sun, then it is considered a primary producer. If the living thing eats a primary producer then it is considered a consumer.

There are also producers who make their energy from deep vents in the bottom of the ocean. These producers use a process called chemosynthesis to produce their energy, and this process is not seen anywhere on Earth except these deep sea vents. Now that you really understand the difference between a producer and a consumer, let's talk more about different types of consumers. Consumers are broken down into different groups. If an animal is eating a producer then it is considered a primary consumer. This would be a cow eating grass, for example, or you – if you only eat fruits and vegetables. If a consumer eats another consumer that ate a producer, then it is a secondary consumer. An example of this is if you

eat a hamburger. The sun gave the grass or hay energy (the primary producer); the cow came along and ate the grass (the primary consumer) and then you are eating that cow in the form of a hamburger. You are the second consumer in the line.

Now Imagine a bonefish swimming around off the tip of South Florida, looking for a meal. It finds a delicious-looking mud crab walking around the flats, catches it, and enjoys a great meal. That mud crab had eaten an oyster off the oyster reef nearby, and that oyster had filtered out algae from the water. The bonefish is an example of a tertiary consumer. He was third on the list of things that got their energy from somewhere else!

These producers and consumers are all the players in the giant web that is created by living things on Earth. Getting energy to live and grow are the most important things to staying alive and are the focus for living things no matter how big or small they might be. So now that you have a better understanding of how these relationships work you will be better able to create a food chain and web of your own!

Bonefish & Tarpon TRUST

Bonefish: Feeding Frenzy!

Objectives:

At the end of the lesson students will be able to explain how energy is passed between organisms in a food chain and a food web. Students will be able to explain the idea of ecological niche and energy transfer.

Differentiation:

Students with fine motor skill issues can be grouped with more able students in pairs and the more able student can do the work that they feel most comfortable within their groupings. Students who might experience issues with writing in the limited space allocated may use an open sheet of paper to write their answers for the vocabulary or have a group member act as a scribe to assist them.

Lesson background:

Bonefish are ecologically important species and are often found in varying habitats in warm waters around the world. Bonefish have different dietary needs throughout their lifecycle. During their juvenile and adult life cycles they rely on shallow grass flats, mangroves and near shore reefs to get the energy that they need. The bonefish diet is a great example of the many consumers and producers present in these habitats and this is a perfect species to use to teach food chains, food webs, animal niches and dependency. This lesson does exactly that. Using the reading on bonefish (both student and teacher versions for their respective audiences and abilities) and the reading on consumers and producers the students should be able to complete the vocabulary and also their group food chains. These chains are then combined as a class into a larger web. This combination will show the students that individual food chains create these larger and more complex webs. The students will also be able to connect their new knowledge to appreciate and recognize that each organism plays an important role in the chain and web.

Florida State Standards (NGSSS)

- SC.4.L.17.2: Explain that animals, including humans, cannot make their own food and that when animals eat plants or other animals, the energy stored in the food source is passed to them.
- SC.4.L.17.3: Trace the flow of energy from the sun as it is transferred along the food chain through the producers to the consumers.
- SC.4.L.17.4: Recognize ways plants and animals, including humans, can impact the environment.

National Standards (NGSS)

- 5-LS1-1: Organization For Matter & Energy Flow in Orgs
- 5-LS2-1: Cycles of Matter & Energy Transfer in Ecosystems
- 5-PS3-1: Energy in Chemical Processes & Everyday Life

Instructional Materials Needed:

- Flats Vocabulary sheet
- Food Web cards (one set per group)
- Scissors, Pencils, Glue
- Paper for food group food chain to be glued onto

Activity:

Bonefish: Feeding Frenzy!

Procedure:

- The class should be started off with the important vocabulary words that are listed under "Fishing Flat Vocabulary" document. These words are likely new to the students and would need to be covered with the teacher prior to thereading exercises.

- Break the class into small groups of 4 and have the students read the bonefish student document. *"Rally reading" is a great reading strategy to use for this document. One student reads a paragraph and then another the next and so on.*

- Here, there is some flexibility depending on the needs of classroom. The teacher may choose to discuss the Producer and Consumer document as a class and write key words on the board, or have the class continue reading the Producer and Consumer document in groups.

- The teacher should have the students fill in their "my cue" section of the vocabulary after they have read. This is their own explanation of what each vocabulary word means. After the students have completed reading and their vocabulary sheet, the teacher should start the food webactivity.

- Each group should get their own food chain to complete. Alternatively, you may have the class brainstorm different aquatic animals they know, make a list on the board, and ask the students to draw their animals. This can be independent of or in addition to the included food web cards.

- Using what they have studied about food chains and webs, they should work hierarchically through the chain, putting the cards in order of primary producer to top consumer. Students should be prepared to individually answer questions about their food chains that are created within the group. Each student should understand how the parts connect and be prepared to describe the energy flow if called upon.

- As they are getting their chains in order, the teacher should provide individual group feedback. The teacher should pay attention to group dynamics and assure that all group members are participating. The students should underline or highlight any words or facts that they are struggling with for clarification post reading.

- The food webs are chains that interconnect. After all groups are finished with their chains, each group should share their food web and the teacher may use this opportunity to talk more about food webs. Then, using tape or magnets, the teacher should ask each group to come and hang their food chains in a manner so that it creates a food web. One way to proceed is to have two groups come up at a time and interconnect the arrows of energy transfer between their individual food chains and then invite two more groups up to then topresent their interpretation.

Name: _____ Date: _____

Bonefish Feeding Frenzy!

Looking at your food chain answer the following questions:

1. Looking at your group's food chain, how many "living things" are in the chain you created? _____

2. When a crab is eaten by a bonefish, what happens to the energy of the crab that was eaten? Explain what happens using your own words.

_____

_____

_____

3. Looking at your chain, if one of your living things was no longer there how would it impact your food chain? What other creatures in the food chain would still be able to eat, and what would not?

_____

_____

_____

_____

4. Who were the producers in your food chain?

_____

5. Who were the primary consumers in your food chain?

_____

6. Who were the secondary consumers in your food chain?

_____

Looking at your class food web answer the following questions:

1. Looking at your entire class food web how many living things are in the entire web?

_____

2. How many chains do you see within your class's food web?

_____

3. If you took out one of the food chains how many animals would be impacted?

_____

4. Does each living thing play a role in the balance of the food web? Explain your answer.

_____

_____

_____

_____

5. How do environmental issues like extinction of a species impact a food web in a habitat? Explain your answer.

_____

_____

_____

_____

Name: _____ Date: _____

Fishing Flats Vocabulary

WORD	MEANING	MY CUE
Angler		
Elusive		
Spawn		
Spawning Aggregations		
Broadcast spawning		
Cell Division		
Larvae		
Flat		
Transparent		
Juvenile		
Sub-adult		

Activity Rubric:

You should check to see if you meet the following criteria at the level "4"

Area	1 Does not meet expectations	2 Partially meets expectations	3 Meets expectations	4 Exceeds expectations
Science Content	NONE of the cards interlink to create a food chain. The group does not have the chain moving from producer to consumer in the correct order.	SOME of the cards interlink to create a food chain. The group has some of the chain moving from producer to consumer in the correct order but there are major problems.	MOST of the cards interlink to create a food chain. The group has most of the chain moving from producer to consumer in the correct order.	ALL of the cards interlink to create a food chain. The group has all of the chain moving from producer to consumer in the correct order and can explain in detail why the organisms interlink.
Use of science vocabulary	NONE of the introduced scientific vocabulary is adequately defined in the vocabulary portion of the activity and the answers on the worksheet are lacking entirely or incomplete.	SOME of the introduced scientific vocabulary is not adequately defined in the vocabulary portion of the activity and the answers on the worksheet are lacking or incomplete.	MOST of the introduced scientific vocabulary is adequately defined in the vocabulary portion of the activity and the answers on the worksheet are complete.	ALL of the introduced scientific vocabulary is adequately defined and extremely detailed in the vocabulary portion of the activity, connections are present in the writing and the answers on the worksheet are complete and detailed in their explanation.
Writing fluency	Writing flow and errors in sentence structure are multiple, making the activity close to impossible to comprehend.	Writing flow and errors are evident, but few, and make the activity difficult to comprehend.	Writing flow and errors are few, and the activity is easy to read and understand.	Writing flow and errors not present, and the activity is easy to comprehend and follow the information presented to the reader.
Conventions	Spelling, capitalization, and punctuation errors are numerous and make the written narrative impossible to understand.	Spelling, capitalization, and punctuation errors are evident and make the written narrative difficult to understand.	Spelling, capitalization, and punctuation errors are few.	Spelling, capitalization, and punctuation errors are completely absent from the writing.

Uca pugnax

I am a FIDDLER CRAB.

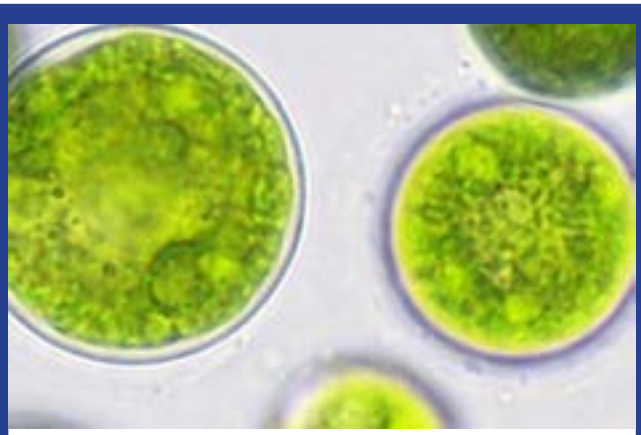
I live in sandy areas and dig holes in the sand for shelter and protection. I can be found in mangrove communities or shorelines too.

I Eat

I am the SUN.

I shine down during the day and help warm the earth.
I play an important role in the world and nothing could live without me.

I am the start of EVERY food web or chain



I am ALGAE.

I am found in the water and can be tiny – so small you can't see me with your eyes – or large like seaweed that floats up on the shore. I can be green, red or brown. I am VERY important to the entire habitat.

I Am Eaten

Albula vulpes

I am a BONEFISH.

I love to swim in shallow grassy areas when I am fully grown. I am fast and anglers strive to catch me for sport.

I Eat

I am ALGAE.

I am found in the water and can be tiny – so small you can't see me with your eyes – or large like seaweed that floats up on the shore. I can be green, red or brown. I am VERY important to the entire habitat.

I Am Eaten

Bonefish & Tarpon TRUST

Limulus polyphemus

I am a HORSE SHOE CRAB LARVAE.

I am a tiny, developing horseshoe crab. My mother laid me in a nest of sand with thousands of my brothers and sisters. We will hatch about 20 days after she lays us in the sand. We will then float in the water when I am first born. I am tiny so I eat tiny things.

I Eat

Bonefish & Tarpon TRUST

Chelonia mydas

I am a GREEN SEA TURTLE.

I love to swim around on coral reefs and in seagrass beds. I am called a green turtle because I eat so much of one thing that the inside of my fatty tissue and muscle actually turns green! I have a shell that is about 3 to 4 feet long when I am fully grown.

I Eat

Bonefish & Tarpon TRUST

Carcharhinus leucas

I am a BULL SHARK.

I love to live and swim in warm, tropical waters. I am one of the more aggressive sharks but I do a great job of keeping the reefs, near shore and estuary populations in check by eating lots of things. I have a unique adaptation. I can swim upstream into freshwater rivers, unlike any other type of shark. I have even been found up in the Mississippi River!

I Eat

Bonefish & Tarpon TRUST

Rhizophora mangle – Red Mangrove
Avicennia germinans - Black Mangrove
Laguncularia racemosa - White Mangrove

I am MANGROVE LEAVES.

I am the leaf of the mighty mangrove! I help the mangrove live and grow by capturing sunlight and doing photosynthesis. I help shade the water below and offer cover to many animals that live in and below the mangroves. I fall off when I get old or when a strong hurricane comes through and blows me into the water below.

I Am Eaten

Bonefish & Tarpon TRUST

Aratus pisonii

I am a MUD CRAB.

I can be brown or olive green. I live on the mangrove trees and can be found scurrying through the canopy or digging around in the mud near the roots at low tide. I have two claws that protect me but they are often not enough to keep me from becoming another animal's meal.

I Eat

Bonefish & Tarpon TRUST

Lutjanus griseus

I am a MANGROVE SNAPPER.

I am a medium size fish who reaches about 35 inches when I am an adult. I have small teeth on both my upper and lower jaw. I love to live near inlets and in mangrove areas. I swim around the mangrove roots and in the seagrass beds looking for my next tasty meal.

I Eat

Bonefish & Tarpon TRUST

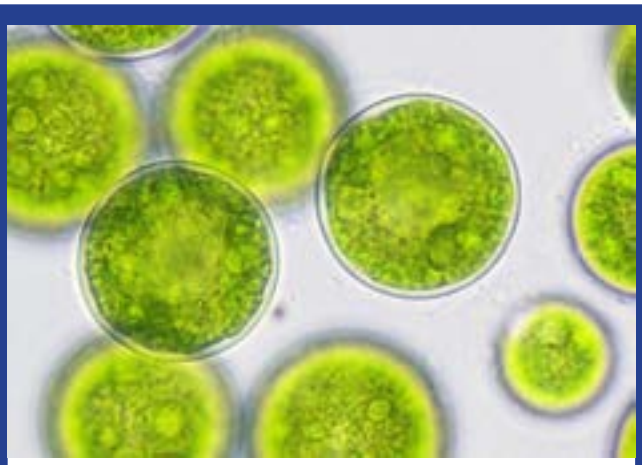
Ardea herodias

I am a GREAT BLUE HERON.

I am a tall, slim bird with a very long neck. I am the largest heron in North America. I am a graceful flying bird and you will often see me perched in the sun or sitting on top of the mangroves, looking for lunch or dinner. I am unique since I like to nest in monospecific colonies. This means I will only nest near other Great Blue Herons.

I Eat

Bonefish & Tarpon TRUST



I am MICROSCOPIC ALGAE.

I am found in the water and can be tiny, so small you can't see me with your eyes. I can be green, red or brown. I am VERY important to the entire habitat.

I Am Eaten

Bonefish & Tarpon TRUST

Mugil cephalus

I am a MULLET.

I can get to be about 18 inches long and weigh up to 3 pounds. I do not have any teeth and can be found swimming in large schools with all my friends and family. I swim in these schools as a form of protection from predators. You might see me leaping from the water. No one is sure why I do this.

I Eat

Bonefish & Tarpon TRUST

Synodus foetens

I am a LIZARD FISH.

I am a long and thin fish that you will often find in warm tropical waters. I can be found inside an estuary cruising through the mangrove roots or seagrass beds. I have a mouthful of long, slender teeth. I am an ambush predator. This means that I like to lay still and wait for a meal to swim by. I will dart out and bite it.

I Eat

Bonefish & Tarpon TRUST

Sciaenops ocellatus

I am a REDFISH.

I am a large saltwater and brackish fish that can be found in tropical and subtropical waters around the world. I can be brown, red or orange looking. My belly is almost always light in color and the most distinguishing mark I have is the large spot found near my tail. It almost looks like an eye!

I Eat

Bonefish & Tarpon TRUST

I am a FISHERMAN.

I care about the environment and have a deep respect and understanding for the creatures that call the waters home. I know that I can only continue to fish if I protect the animals, ecosystems and habitats that surround me. I might have grown up fishing with my parents or I might have taken it up as a hobby on my own. Either way, I understand the importance of being an ethical angler and I hope to leave the environment a better place after I am done.

I Eat

Bonefish & Tarpon TRUST

Enteromorpha flexuosa

I am HOLLOW GREEN ALGAE.

I am a thin green algae that grows in strands like thick hair. I am found worldwide in estuaries and near shorelines. I am found in large quantities, especially during the summer when the sun shines bright and the waters are warmest.

I Am Eaten

Bonefish & Tarpon TRUST

Caprella spp.

I am an AMPHIPOD.

I am an amphipod. I am a tiny, often microscopic animal that lives in the water column and the sand. I can dig and run around but I am not very good at swimming and tend to just go where the water takes me.

I Eat

Bonefish & Tarpon TRUST

Lagodon rhomboides

I am a PINFISH.

I might be a small baitfish but I play a big role in the food chains that are found near reefs and in estuaries. I have sharp dorsal fins, that is where my name "pin" fish comes from.

I Eat

Bonefish & Tarpon TRUST

Cynoscion nebulosus

I am a SPOTTED SEA TROUT.

I am found in the Indian River Lagoon and I am a prized meat fish! Anglers love to catch me and take me home for dinner. I have beautiful spots on my long, slender body. I can reach a maximum length of about 3.3 feet when I am a grown adult.

I Eat

Bonefish & Tarpon TRUST

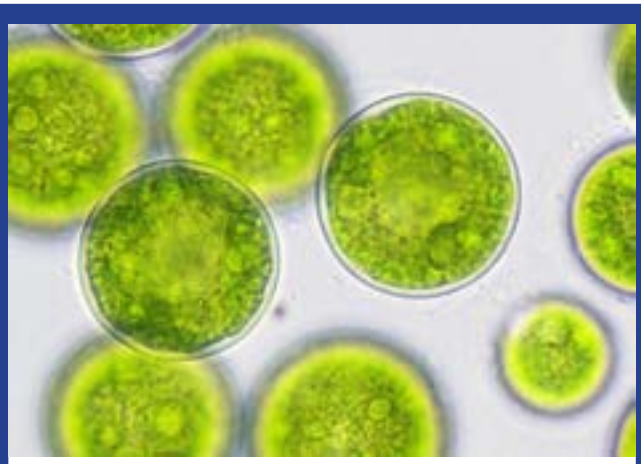
Tursiops truncatus

I am a BOTTLENOSE DOLPHIN.

I am actually a type of toothed whale, kind of like the killer whale but smaller. I have large, cone shaped teeth and I am a very social creature. I am a marine mammal, meaning I give birth to live babies, and they drink milk. I am a fast swimmer and I love to work with my pod mates to catch a fresh meal.

I Eat

Bonefish & Tarpon TRUST



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I am found in the water and can be tiny, so small you can't see me with your eyes. I can be green, red or brown. I am VERY important to the entire habitat.

I Am Eaten

Bonefish & Tarpon TRUST

Lysiosquilla scabricauda

I am a MANTIS SHRIMP.

I am a crustacean and I look much like my cousin, the lobster. I am often found in seagrass beds or within the rocks of a coral reef. I am fast and fierce! I have special claws on the front that can be great for defense and for always catching my meals.

I Eat

Bonefish & Tarpon TRUST

Albula vulpes

I am a BONEFISH.

I love to swim in shallow grassy areas, as well as through mangrove creeks, over shallow reefs and over sand/mud flats. I am fast and anglers strive to catch me for sport.

I Eat

Bonefish & Tarpon TRUST

Sphyraena barracuda

I am a BARRACUDA.

I have a long, slender but powerful body. I am often silver and shine in the water. I have large spots as I get older. I am a fierce predator who swims slowly waiting for a meal to come close and then I can dart out after it and catch it in my jaws filled with sharp teeth! I am a predator often found on grassflats, coral reefs and shipwrecks.

I Eat

Bonefish & Tarpon TRUST

Caulerpa sertulariodes

I am GREEN FEATHER ALGAE.

I grow in long running lines and can be found in shallow water with good sunlight penetration. I look just like a green feather too!

I Am Eaten

Bonefish & Tarpon TRUST

Petrochirus spp.

I am a HERMIT CRAB.

I am found on the sea floor looking for my next meal. I have large pinching claws and live in shells that I scavenge from the sea floor. I am an important part of the food chain because I am the "clean up crew" of the ocean and often go around looking for things to eat.

I Eat

Bonefish & Tarpon TRUST

Archosargus probatocephalus

I am a SHEEPSHEAD.

You can easily identify me by my large black stripes that go down my body. I am found all over, in inlets, on reefs and wrecks and in the nearshore environment. I am good to eat and I can get pretty big too! I have a mouth full of teeth that help me eat my meals.

I Eat

Bonefish & Tarpon TRUST

Epinephelus itajara

I am a GOLIATH GROUPER.

I am a huge grouper when I am fully grown and I play an important role in the reefs around Florida. I have been recently found to eat lionfish, an invasive species of fish that are doing damage to the reefs. I am a protected fish in Florida. Divers love to see me as I lazily swim in and out of my hiding places on reefs and wrecks.

I Eat

Bonefish & Tarpon TRUST

I am the SUN.

I shine down during the day and help warm the earth. I play an important role in the world and nothing could live without me.

I am the start of EVERY food web or chain

Bonefish & Tarpon TRUST

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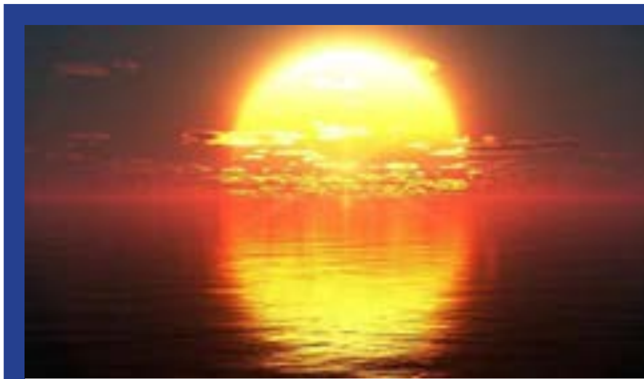

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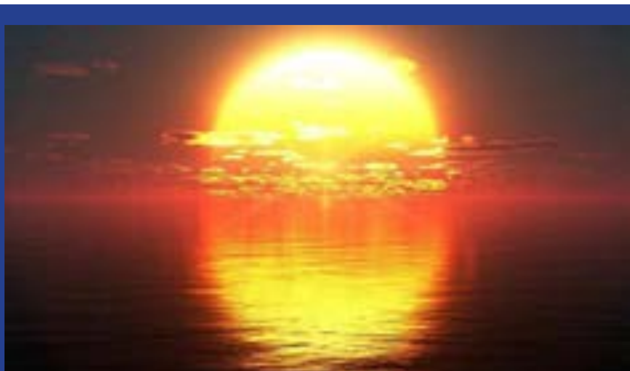

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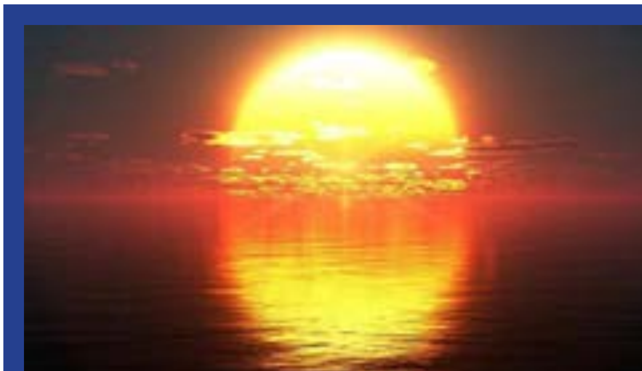

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Student Reading

Mangroves

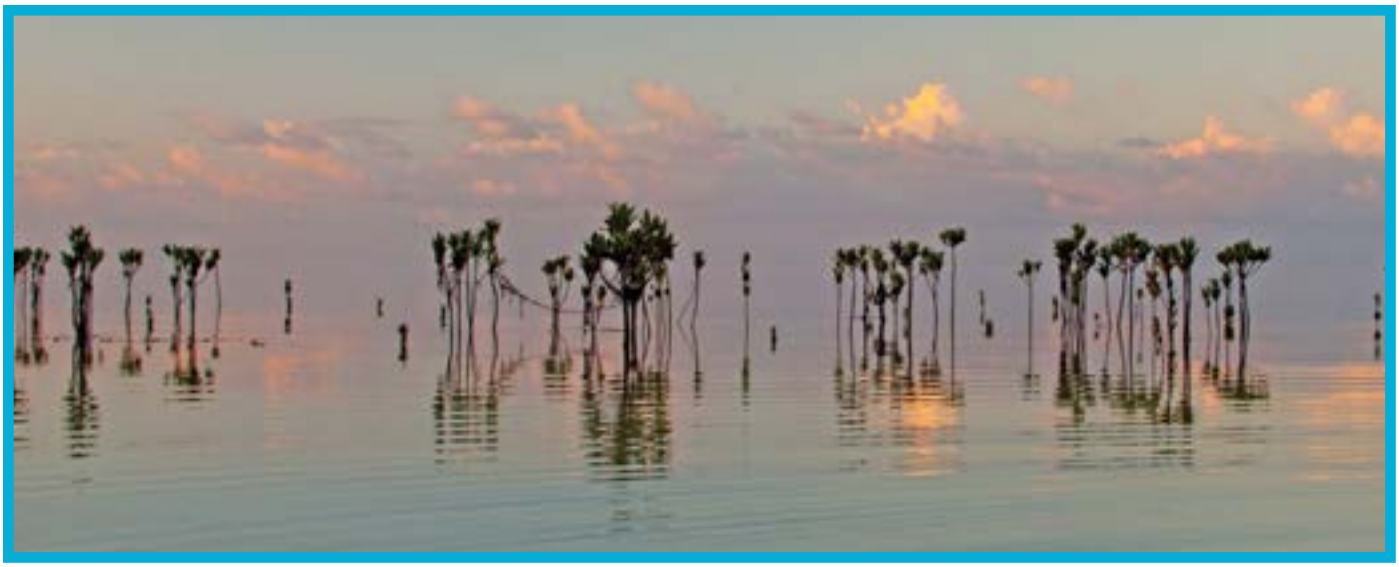
Worldwide, more than 50 species of mangroves exist. In Florida, we are lucky to have three species that call our peninsula home! The red, black and white mangrove can all be found in different places within the Sunshine State. Mangroves are often found along coastal areas and in shallow flats, thriving in the salty water by using special adaptations that allow them to absorb fresh water in various ways. In Florida, white mangroves are rooted higher up on land, while red mangroves sit almost fully submerged in deeper waters, and black mangroves grow in the shallow waters in between. Each species lives in its own specific habitat, and they all help their surrounding environment in different ways.

Red mangroves are nicknamed "walking trees" because the roots capture sediments, making the depth shallower so they can stretch farther out into the water.

Red Mangroves

Mangroves tend to grow in specific depths of water or along the shoreline, with the red mangrove usually growing deepest in the water. You might recognize the red mangrove by its "legs," which are the prop roots that help anchor it into the sand and keep it stable. Those roots help keep the plant firmly in the sand during storms such as hurricanes, and keep the branches and leaves above the water. Mangrove roots also hang on to sand, keeping it in place even when water is moving all around it. Removing mangroves means the sand becomes loose and free to drift away. This may not sound like a big deal, but when large numbers of mangroves are removed from an area, large amounts of

Mangrove roots make great hiding places for small fish.



Young red mangroves colonize calm shallow areas that are often dry at low tide.

sand – even entire beaches – can wash away in a process called erosion. Mangroves are one of the best lines of defense in protecting areas from tropical cyclones, and they do a great job of preventing erosion.

Red mangroves, however, have another important purpose for the animals living in and around the mangrove community. The complex maze of prop roots below the surface of the water create an amazing resource for fish in their smallest stages. Many different species call red mangrove legs or limbs "home," or at least use them to hide from predators. Birds, fish, shrimp, crabs, and so many more organisms call them home. Mangrove crabs scuttle across them and baby snook hide around the tangled roots. Little blue herons and brown pelicans nest in the tops of their canopies. You might find mangrove snappers dashing back and forth through them at high tide, and puffer fish swimming around eating algae off the roots. Mangroves offer a safe place that physically keeps out predators, while providing lots of food and activity for many different creatures.

Shallow mangrove creeks like this one are great habitats for juvenile snook and tarpon. Small forage fish provide them with food.

Mangroves don't just guard against erosion. They also help a shoreline "accrete," or build up, and actually catch sand and leaves that might fall and grow the shoreline larger. A small sandbar today might be an entire island in 50 years if mangroves take root.

Red mangrove seeds are unique too. They are long and very skinny. These seeds, called propagules, grow on the tree near the leaves and have a soft fleshy inside. When the seeds are ready to grow into new trees they fall off the mangrove and can

travel to a new place and grow their roots. What would be the best way to travel if you're a seed from a tree that lives in the water? These seeds are able to float! Propagules are unique to this amazing tree.

Black Mangroves

Black mangroves can also be found growing in saltwater, but typically shallower than red mangroves and closer to land. In the shallow waters right next to land, water does not usually move very much; it gets very hot, and as a result, is low in oxygen and really salty! This creates a harsh environment that is difficult for any plant's survival, but black mangroves have unique features that allow them to grow well in these habitats. The black mangrove has special types of roots, called pneumatophores, that actually take in oxygen so that the tree can live in such a harsh environment! These roots act like "snorkels" by taking in oxygen for the black mangrove, and also help to accrete sand and sediment too.

These roots, called pneumatophores, allow black mangroves to breathe air.

The black mangrove has another special feature that allows it to grow well in the salty water. The leaves of black mangroves push out salt, or "sweat," through special salt pores found on the leaves. The reason for doing this is simple: all plants need water to survive but the black mangrove lives in really salty water. So for the tree to thrive in this environment, it takes in the saltwater around it through its roots and then pushes the salt out of the water, keeping only freshwater for it to live off of. Pretty amazing!

Each type of mangrove has a different type of leaf. Red mangroves have round, dark green leaves. Black mangroves have pointier, silvery leaves that are often speckled with salt. White mangrove leaves are light green and round, with fuzzy white undersides.

White Mangroves

The next type of mangrove found in Florida is the white mangrove. This species grows the highest up on the shore and further away from the water. This mangrove is the least able to handle cold weather so it is mostly found from Central Florida southward, in warm, tropical areas. The white mangrove has soft leaves that have a white fuzz on them, which is where it gets its name. The white mangrove, similar to the black mangrove, also sweats out salt.

Threats

Mangroves are vital to the survival of so many species that are fun to catch and eat, and are important to the coastal ecosystem. Mangroves act as a nursery for fish, crustaceans, birds and more, and removal of mangrove communities can harm habitat health. Not only do these communities stop erosion and protect coastlines, but fish species that are popular among catch-and-release fishermen around Florida – such as snook and tarpon – rely on these ecosystems as safe places to grow up.

Snook are a species that uses mangroves a lot when they are young. As adults, they are really popular catch-and-release fish.

Unfortunately, mangroves are under threat across the world. In the past, the important role that mangrove communities play in habitat health was not well known, so mangroves were cut down to make room for beaches and houses. Out of all of the mangroves around the world, about 35 percent have been removed, and about two percent of existing mangroves still disappear every year. In Florida, about half of all mangroves have already been lost. Luckily, we have learned more about how helpful mangroves are through scientific studies and observations, and now there are laws to protect mangroves and keep them healthy. Today, cities and towns along with the state have created laws that limit further removal of mangroves, imposing fees and even jail time if you illegally cut or trim mangroves. Over 80 percent of the mangroves living in Florida today are protected by laws.

Other issues, like pollution, can still harm mangroves even though they have not been cut down. Researchers are still learning about how fertilizers, medicines, and other human products that end up in the ocean might hurt important habitats like mangroves. The more we learn about mangroves, the better we can take care of them. And since mangroves are important homes for small snook and tarpon, taking care of the mangroves means we will see more fish in the ocean, and catch more on our fishing lines!

Bonefish & Tarpon TRUST

Teacher Reading

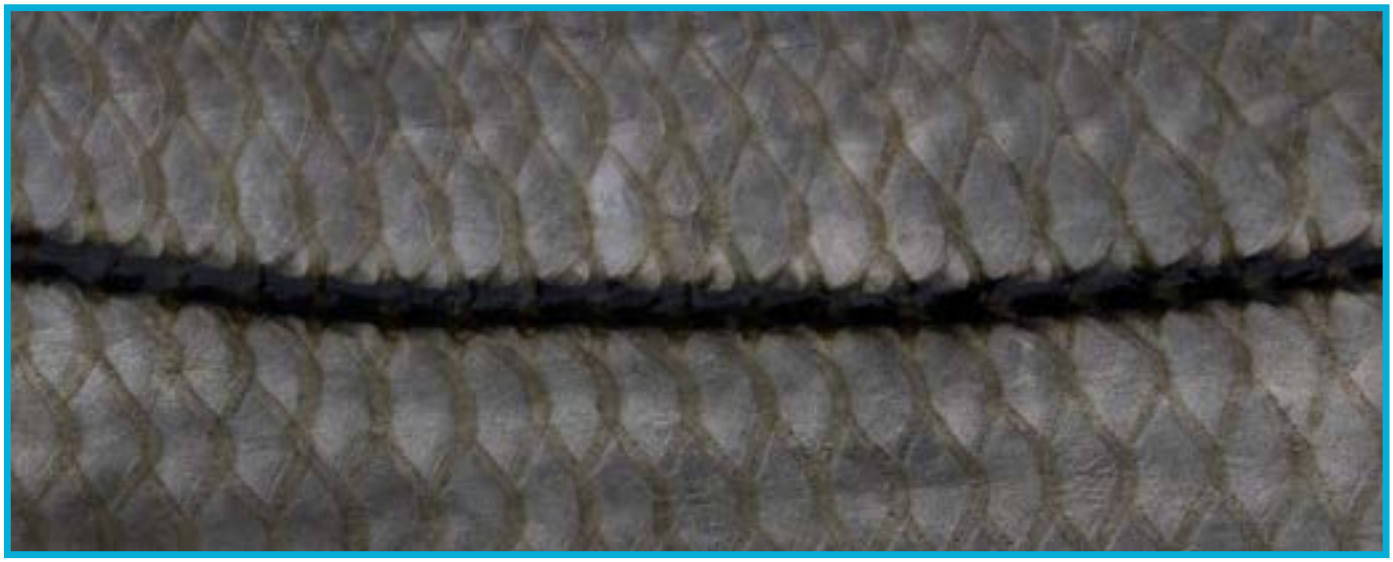
Snook

Snook feed on a wide variety of forage fish. In order to achieve relative safety in numbers, forage fish "school up" in large groups that may include several species that look like each other. Here, a school of forage fish pass over prowling snook.

Globally, fishermen target 12 species of snook, (*Centropomidae spp*.). These species primarily live in the warmer waters of the western Atlantic, including Florida's Atlantic Coast; the southern latitudes of the Gulf of Mexico; Cuba; the western Caribbean; and in the eastern Pacific. In the United States, several of these tropical and sub-tropical species occur only in Florida and Texas, where they are managed as recreational fisheries, with limits concerning which fish an angler can keep, and when. Elsewhere, combinations of tourists and other recreational anglers, subsistence fishermen, and commercial fishermen compete for the species, which provide great sport and boast firm and flaky white filets. The roe of females is also a fried delicacy.

Snook are targeted almost exclusively in shallow coastal waters: in fresh, brackish, and saltwater. Natural habitats include: fresh- , salt- and brackish creeks and rivers; beaches; mangrove shorelines; seagrass meadows; oyster reefs; nearshore hardbottom; sandy surf zones; coral reefs; and rocky "live bottom." Snook also take advantage of manmade structures including: docks, bridges, piers, jetties, seawalls, and artificial reefs. Recreational anglers target snook with fly rods and light tackle – generally by wading, fishing from a canoe or kayak, or fishing from an outboard-powered shallow-draft vessel. In countries where commercial fishing is allowed, commercial and subsistence fishers may use gillnets, seines, and handlines. Sadly, dynamite is still used to harvest snook and other species in developing nations. Dynamite fishing kills indiscriminately and does significant harm to habitats.

The passion for snook fishing with fly rods and other light tackle supports a major global travel, boat-building, and tackle industries which generate well-paying jobs and vital local and regional tourism revenues. Iconic destinations include southern Florida; Cuba; both coasts of Costa Rica; both coasts of Panama; Nicaragua's Caribbean Coast; Belize; and Venezuela.



Snook possess a vivid, black "lateral line." Most fish species have this sensory organ, which allows the fish to feel vibrations in the water from potential predators and prey. The lateral line assists the other senses in efforts to feed and escape larger predators that may eat them.

There are strong economic and ecological incentives to keep snook populations healthy. However, snook have a very complex life history and diverse habitat needs, and people fish for snook for a wide variety of different – even conflicting – reasons. This makes managing those species quite challenging. But such challenges are part of what makes this species so fascinating and important.

Etymology

All described fish species have a scientific name—usually Latin or Greek—and a common name or names used by fishermen. All scientific names are unique and may reflect the species' physical attributes. Or, they memorialize a scientist or naturalist who first described the species, or something important about it.

The snook's family name probably describes physical attributes. It likely earned its scientific name because of the razor-like gill plate. Centromidae likely comes from the Greek, kentron = "thorn" or "sting," while pomas,-atos means "cover."

Some fish species wind up with funny-sounding common names, and several species share the same name. Snook – originally pronounced with a long "o" – is the common name of several unrelated species. The word, "snook" may be derived from an old Anglo-Saxon word for "long nose," or the Dutch word for the weapon called a "pike." It's quite appropriate that the word "snook" describes a pointed weapon. In a variety of ways, a snook's head is indeed a weapon.

Ontogeny

Snook, like many other animals, experience changes throughout their life cycle that alter their habitat needs. It is generally accepted that everything in nature is connected, and the movement of animals throughout their life cycle can create linkages between habitats including seagrass meadows, coral reefs and the blue pelagic ocean. Indeed, one of the most interesting and telling ways to examine ecological connectivity is to examine how the migration routes of a fish species, throughout its life cycle, create an atlas of essential habitats. There's so much more ontologically to these animals than meets the eye. That's especially true of snook.

Snook species share a similar life history, or ontogeny, though there is some variability depending upon species and geography. Let's focus on *Centropomus undecimalus*, the common snook – one of the largest and most popular of species that occurs in the western Atlantic, including the Gulf of Mexico and Caribbean Sea.

Spawning

As with all life, snook exist to perpetuate their species. Female snook can live to 21 years and about half of the female population reaches sexual maturity by age five. About half of all males reach sexual maturity by age two, and can live 15 years.

Snook often hide among manmade structures, such as dock pilings, pictured here. They also use artificial reefs and jetties in addition to natural habitats like mangroves, seagrass meadows, and natural reefs.

Like many boney, ray-finned fish species (teleosts), snook adopt an R-Strategy for reproduction, vs. a K-strategy. Animals that use the R-strategy usually invest energy into a multitude of offspring that receive little or no parental care, whereas animals using the K-strategy invest energy into a few, large offspring that require considerable parental care.

Humans, for example, obviously invest in the K-strategy. We care for our young beyond their sexual maturity. But snook, and most bony fishes, will spawn as individuals many times in the course of their relatively long lives. Their strategy of broadcast spawning means that fertilized eggs are cast out into the currents and left to survive completely on their own. Each spawning season, an individual female may only produce one to four individuals that survive to reproduce – despite generating several million eggs.

An individual snook will spawn many times throughout its life – possibly even as a male and as a female. Yes, snook change sex. They are called protrandric hermaphrodites, meaning that all snook are born male and turn into females. This change occurs during the fall, after the spawning season, in as little as 90 days. It occurs in fish between one and seven years of age. Biologists have documented this phenomenon by holding snook that were definitely male (because they were producing sperm) in a pond during the summer, and then during the fall, discovering some females in the group. It is not known what triggers the sex change.

Snook spawn in aggregations between spring and early fall. In the Northern hemisphere, common snook typically spawn April through September. The date is far less important than water temperature and salinity level, and length of daylight and lunar phase. Spawning begins when water temperatures rise to 22 to 23 degrees Celsius, when salinity levels are about 27 parts per thousand or higher; and when the photoperiod (length of daylight hours) exceeds 13 hours.

Spawning efforts increase around the new and full moons, when tides are more extreme and fertilized eggs are likely to travel farther with the currents. In Florida, Gulf of Mexico snook show strong site fidelity to specific spawning aggregation sites – typically Gulf passes. Gulf snook spawn on the outgoing tide, so that eggs are dispersed into the open water. Winds, swells and tides return the larvae into the estuaries.

Snook along Florida's Atlantic coast do not always go back to the same area time after time, meaning they do not show "site fidelity." In fact, these snook migrate north and south, roughly from Port Canaveral to Government Cut in Miami. About half the common snook caught in Florida Bay are Gulf fish; the other half are from the Atlantic population. Atlantic snook spawn multiple times in multiple sites – typically inlets and nearshore reefs – on the incoming tide. The incoming tide sucks the gametes directly into the local estuary. But because the fish migrate up and down the coast, spawning here and there, this mode of roving and spawning maintains genetic diversity. The fish are constantly intermingling with and spawning with diverse individuals. This tactic produces stronger, healthier populations of snook.

Broadcast spawning requires snook to be highly fecund (produce large amounts of sperm and eggs). Females ovulate as often as every two weeks, and depending on the fish's size and age, can produce hundreds of thousands of eggs. They are what's called indeterminate or "batch" spawners; snook spawn multiple batches of eggs per spawning seasons.

A spawning aggregation of common snook swims into the tide as they prepare to spawn in an Atlantic inlet.

Until recently, it was thought that all female snook return to the same spawning aggregation sites every year. But recent studies show that in fact they are "skip spawners." Some females spend years far up rivers and springs without spawning. The assumption is that some of the female population is left behind during spawning, in case a devastating event such as a red tide happens suddenly enough to wipe large percentages of spawning fish. It would make no sense for all of the sexually mature females to put themselves in a place where predators or harmful algae blooms could wipe them all out at once.

Snook Larvae

Snook larvae are "pelagic." That is, fertilized eggs float high in the water column for about 18 hours before the larvae hatch. Larvae then are subject to the whims of winds and tides until a very late stage in the larval cycle when they may settle in certain microhabitats. Very few larvae survive to become juvenile snook, which is why snook produce so many eggs each spawning season.

Early Juvenile Snook

Late-stage larvae recruit to vegetated shorelines of quiet, shallow-water creeks, canals, and lagoons in both low-salinity (riverine) and high-salinity (mangrove swamp and salt marsh) environments. Once "settled," tiny, early juvenile snook can't venture from microhabitats along shorelines with limited water movement, moderate slopes, and vegetation extending over/under the water. If they attempt to leave these habitats, swift tidal movement would wash them away. Steep shoreline slopes would allow predator fishes enough depth to attack them, and the vegetation provides them with complex cover and food sources.

Like most predatory fish, early juvenile snook depend upon calorie-rich, easy-to-catch prey to make it through this period of rapid growth and extreme vulnerability. Early juveniles (<40 mm in length) feed on copepods and other tiny crustaceans. Slightly older, larger and more capable juveniles (40-50 mm in length) switch to small fish, minnows including mosquitofish and killifish, as well as crustaceans (mainly palaemonid shrimp). The larger prey items offer more energy for the rapidly growing snook.

Juvenile Snook

Throughout their lives, snook primarily associate with structure, including mangroves, docks and jetties, and natural and artificial reefs. But they do forage on grass flats and along beaches as well. Juvenile snook become "braver" and move about more as they grow in size. Though they feed day and night from ambush points in structure, they risk the open flats because the flats offer larger and more nutritious prey items such as blue crabs, mullet, and other forage fish.

Mature Snook

Big female snook often carry eggs that may be crushed if the fish is held out of the water for too long. It's best to leave at least the belly in the water for photos, and to take photos quickly in order to let the fish breathe properly in the water.

Snook become sexually mature adults at about four or five, and at lengths of about 24 to 26 inches. The females all start life as males. Once sexually mature, their movements and feeding patterns tend to revolve around a lengthy spawning season – roughly April through September in Florida.

It takes a great deal of energy to generate gametes and to migrate to a spawning aggregation site. Therefore, snook feed more aggressively "pre-spawn," and during the warmer months, vs. the colder months when their metabolisms are slower and they aren't making eggs and moving around much.

Snook are voracious. Though they depend less on crustaceans as they mature, snook feed on shrimp, crabs and other invertebrates throughout their lives. Three of the most important forage fish that snook eat include the pinfish, mullet, and menhaden. Those oily, fat-rich fish provide them with lots of energy year-round. Other favorite forage fish species include small drums called "croakers," catfish, and a small grunt called a "pigfish." They also dine on several species of herring, anchovy, and sardine.

The ways that snook feed – including the form and function of their head, eyes, and neck muscles – is truly fascinating. A snook's eyes are essentially on the top of the head, so that it can see best looking up—which is important for an ambush predator that spends most of its life lurking on the bottom. Snook feed mostly in low-light conditions, such as shade, or are nocturnal feeders. Their eyes are uniquely evolved to gather what little ambient light is available. One of the most important elements of a snook's eye is called the "tapetum lucidum" – a membrane that gathers and reflects light back toward the fish's photoreceptor, which receives the image for the brain. It's the same type of membrane that makes the eyes of a dog, cat, or deer glow.

When a snook attacks its prey, it opens its large jaws so that a suction forms and the prey item is pulled backwards as the snook lunges forward. The suction sound is the loud "pop" anglers often hear when a snook attacks a lure or live bait.

Stressors

Habitat loss due to coastal construction poses the greatest threat to snook populations in Florida and other places facing development pressure where snook species occur. Mangrove and spartina shorelines are often replaced by seawalls and bulkheads. Those structures do not provide juvenile snook with the cover or food that they need. Hard structures also reflect wave energy instead of absorbing it. The waves can re-suspend sediments and block sunlight from plants such as seagrasses that provide cover, food, and oxygen for entire ecosystems.

Even worse, human alterations to watersheds adversely affect snook populations. In Texas, fresh water that flows out of once-great rivers such as the Rio Grande is now measured in trickles. People pull so much water from the Rio Grande and its source rivers for irrigation and consumption that very little brackish habitat remains along the Texas Coast.

Throughout Florida, the natural "sheet flow" of water has been diverted into canals and ditches. Instead of storm water flowing slowly across flat, vegetated landscapes, into filtering wetlands and then into estuaries, the water now drains rapidly into canals and ditches. Such flood-control measures work to keep homes and roads dry. But they cause extreme flushing effects in habitats where juvenile snook and other predators live.

Coming from canals and ditches, the water is much dirtier. While sheet-flowing water carried essential nutrients from soils and arrived very clear, dirty runoff carries pollution from products such as oil and fertilizer directly into the nursery habitats. Scientists studying nursery habitats in Southwest Florida, crisscrossed with canals and ditches, found much less diversity and abundance of forage sources for juvenile snook. The implication is that fewer juvenile snook will make it to

spawning age because they could not get the calories and diversity of nutrition they need in such a dirty, contaminated environment.

Factors other than fishing regulations that affect survival of adult snook include human impacts on habitat quantity and quality and natural perturbations such as cold kills and red tides. Some of these same factors may also affect the survival of larval and juvenile snook.

Fishing is a cherished form of recreation for couples and families. Here a couple of fly angler release a snook. They want to ensure the opportunity for future generations of anglers.

Setting Snook Limits

In terms of harvest, Florida and Texas manage snook with size limits, bag limits, and closed seasons. Florida keeps the fishery closed to all but catch-and-release fishing during December and January, when this tropical species is vulnerable to cold snaps, and June through August – the peak of the spawning season.

Importantly, scientists set catch limits based upon the number of offspring each fish is likely to generate on an annual basis or inter-annual average. This figure is called a Spawning Potential Ratio (SPR). The ratio is based upon the ratio of the amount of spawn produced by a cohort of snook (or other species) over its lifespan under a specific fishing regime relative to the spawn that would have been produced over the cohort's life span had there been no fishing.

A "cohort" is a group of fish that hatched at one time. "Year class" is another term for fish populations stratified by age. Over time, these fish die one way or another – either from natural causes, like predation, or being caught by fishermen.

"Spawn" is the number of eggs produced by a cohort over its life span. In some cases, the number of eggs is proportional to the total weight of mature females, or the "spawning stock biomass." In others, where the ratio of egg number to fish size isn't so proportional, scientists use estimates of egg numbers based on other information. In either case, scientists use schedules of life history to calculate SPR. Older fish are typically more fecund. Therefore, the more mature, fertile fish in the population, the lower managers can set the SPR, which means more fish get to be harvested. This is the case for maintaining a healthy age structure in any given fish population.

Student Reading

Snook

Big snook hunt in a school of many small fish, called forage fish.

Snook, like many other animals, use different habitats during their life as they grow and start eating different things. We often say that everything in nature is connected, and the movement of animals over their lifetimes can link habitats including seagrass meadows, coral reefs and the blue pelagic ocean. A really interesting way of looking at how habitats and ecosystems are connected to each other is by following the movements of fish during their lives. That's especially true of snook.

When we talk about snook, we are actually talking about a group of 12 different species. Here in Florida we can find the common snook, which is one of the largest species and really popular among fishermen. We are going to focus on this species.

Spawning

Female snook can live to 21 years and about half of female snook can start producing eggs at five years old. About half of all males can start reproducing at age two, and can live 15 years. When snook are ready to reproduce, large groups from different places will all meet up in specific areas in "spawning aggregations." They will meet at specific times and places – usually in deeper waters between April and September. These times are chosen for a reason. Snook are fish that "broadcast spawn," which means the females all release their eggs and males all release their sperm into the water column at the same time. The eggs and sperm will hopefully meet as the water swirls them all around, and if they do, they will start to grow baby

Many snook group together to spawn. This group is called a "spawning aggregation."

fish larvae. If snook spawn at just the right time, the currents of the ocean will carry the tiny fish larvae into shallow coastal waters, the larvae will be able to stay safe and begin to grow.

When snook spawn, they will release hundreds of thousands of eggs and sperm with the aim of making just one or two more snook. Because each spawning event might only make a couple baby snook, adults will spawn many times during their life. Snook are also one of the many kinds of fish that will spawn as a male, then spawn as a female. Yes, like many fish, snook can change from male to female! This means that there are always plenty of females that can make eggs, and snook can always reproduce.

Snook Larvae

Snook larvae are "pelagic." That means that snook larvae float around in the open ocean, without any protection or places to hide, until they have grown a little bit. Once they are big enough, larvae become juveniles and can settle into safe shallow waters. Very few larvae survive to become juvenile snook, which is why the adult snook produce so many eggs when they spawn.

Juvenile Snook

Tiny juvenile fish are still in danger from predators, even after they settle. During their tiniest juvenile stage, snook hide in quiet, shallow creeks and mangroves. These habitats have lots of plants and vegetation to hide around, as well as plenty of small copepods, crabs, and shrimp for food. Predators cannot reach the baby snook in these places. As the snook grow, these habitats still have larger crabs, small fish, and other food items that the snook can eat. It is really important that the snook stay in these habitats while they are young in order to stay safe and still have lots of food.

Snook like to hide around underwater structures. These can be natural, like coral reefs and mangroves, or manmade like this dock.

As they grow up, juvenile snook start to become "braver," and can start to venture into new areas. They will always stay near structure of some kind, like mangroves, docks, or jetties. Being near something like a dock or mangrove roots will keep them safe from predators, but they can also hunt without their prey seeing them. When they are big enough that they don't have to worry about predators, they will look for bigger prey like blue crabs and mullet on grassy or sandy flats.

Mature Snook

Snook become mature adults at age four or five, and at lengths of about 24 to 26 inches. Even as adults, snook like to hide near structures like mangroves or docks. This is because of their feeding strategy. Snook are called "ambush predators," meaning they will hide and wait for their prey to swim by, then they will attack out of nowhere. They are specially designed to do this well. Their eyes are placed almost on top of their head so they can hide low on the bottom and see prey above them. They also have special eyes that can see well in the dark, so they can hunt well at night, or at times when there is little light. These adaptations make adult snook great predators.

Here a couple of fly anglers carefully release a snook. They want to ensure the opportunity for future generations of anglers.

Problems for Snook

Using many different habitats – including open ocean, mangroves, and flats – is a common strategy that many different animals use during their life cycles. But it can also make life more difficult for these fish. The number of fish in a population depends on the quality of the habitat, so If one or more of these habitats is damaged, it can hurt population numbers. Preserving all the habitats that snook use is a constant battle.

Habitat loss because of construction is the greatest threat to snook populations in Florida. Snook spend their juvenile stage – and much of their adult lives – in and around mangroves. Half of the mangroves in Florida have been removed, and many are replaced with manmade structures instead. These structures do not give juvenile snook places to hide, and usually remove food sources as well. This means juvenile snook are no longer able to live in these habitats.

In the mangroves and grassy flats that are not developed by construction, there are still other problems. These habitats are usually right next to the coast, and water that flows into these habitats is often full of pollution from nearby cities and farmlands. Even though the mangroves and grasses have not been cut down, they are still suffering. We need to take care of these habitats, and restore those that have been removed, if we want to keep enjoying snook and learning about this amazing species!

Bonefish & Tarpon TRUST

Snook: Home Sweet Home

Objectives:

At the end of the activity students will demonstrate their understanding of mangrove species, characteristics, location and reproduction. They will also be able to communicate the importance of mangroves in the saltwater and brackish habitats they are found.

Differentiation:

Students with differing abilities can be paired with classmates or group mates who may better be able to scribe answers to questions. Students with differing abilities can also complete the matching activity with the help of a group member rather than working solo.

Lesson background:

Mangroves are extremely important not only to species like snook that call this habitat home but also because they create and stabilize coastal shorelines. Mangroves are unique in the ability to live in such a salt-rich environment; to deal with these aquatic hurdles, they have developed salt excretion techniques, specialized seeds and also specialized root systems.

Florida State Standards (NGSSS)

- SC.5.L.17.1: Compare and contrast adaptations displayed by animals and plants that enable them to survive in different environments such as life cycle variations, animal behaviors and physical characteristics.
- SC.5.L.15.1: Describe how, when the environment changes, differences between individuals allow some plants and animals to survive and reproduce while others die or move to new locations.

National Standards (NGSS)

- 4-LS1-1: Structure & Function
- 4-ESS2-1: Earth Materials & Systems
- 5-LS1-1: Organiz. for Matter & Energy Flow in Organisms
- 5-ESS3-1: Human Impacts on Earth Systems

Activity:

Snook: Home Sweet Home

Procedure:

- Prior to teaching the lesson the teacher should review the species page about snook and mangroves and also personally familiarize him/herself with snook, their life stages and then mangrove adaptations and their locations and environmental role. The student readings and teacher reading material pages discuss life cycle, habitat and anatomy for the mangrove as well as the snook and are tools to best be prepared to present the material to the students.

- Using the provided mangrove student reading and with the help of a teacher students should break into small groups of 2-5 and be given the mangrove benefits worksheet to fill out in the group. The group will work for roughly 10 minutes reading the sheet, highlighting or making notes on the sheet that they think are important and then they will fill out the benefits sheet as a group. These benefits are theirs to complete and there are no true "wrong" answers if they can synthesize and explain their reasoning. The groups should all be instructed to pick their TOP 3 benefits that they were able to come up with, encourage them to think of non-traditional benefits or ones that might not have been directly given in the reading.

- Once the class groups have completed this portion then the class should come together again and the teacher will make a list of the group's top 3 benefits from each group. The teacher will push each group to explain the rationale for their picks and the teacher can make note of these reasons under each top 3 given.

Post Lesson Assessment:

Once the lesson has been presented you can move onto the next activities, "Mangroves, Anything but Mundane" and "Mangrove Moves," which dive deeper into the ethical reasons for protecting mangroves. If you are choosing to stop at this activity then you could quiz students on the mangrove types, locations, seeds and salt exclusion and extruder methods that each mangrove possesses. Either way you have done a great job of informing students on to the importance of mangroves and why they should continue to be protected and respected.

Snook hide in the prop roots of red mangroves which often form points like this one. Such configurations make excellent ambush spots.

Names: _____ **Date:** _____

_____

_____

_____

_____

Snook: Home Sweet Home

You have now learned all about mangroves, and understand what they do for snook, the coastline, and even us as people! Use this worksheet to take notes about the BENEFITS of the different mangroves, and brainstorm with your classmates to think of benefits that were not listed. It is okay to list more benefits for one type over another (for example, you may think of many benefits of red mangroves), but try to **list at least one benefit for each type**. When you have completed this sheet, decide as a group which 3 benefits are MOST important and prepare to share them with the class.

Red Mangroves	Benefits
	_____ _____ _____ _____ _____ _____ _____
Black Mangroves 	_____ _____ _____ _____ _____ _____ _____ _____
White Mangroves 	_____ _____ _____ _____ _____ _____ _____

Name: _____ **Date:** _____

Mangroves, Anything but Mundane

You will be learning about mangrove habitats, their importance to the coastal environment, and their adaptations that help them survive and thrive. Mangroves are commonly referred to as nursery habitat and are responsible for creating and maintaining the health of coastlines around the world. As important as mangroves are to our planet, they have been (and continue to be) destroyed at alarming rates. One way to stop this destruction is through education. If you can learn about mangroves, how they survive and why we should protect them then you can use your voice and knowledge to help ensure their long-term survival.

Mangrove Type	Location on shoreline	Seed and leaf description -or- drawing	Adaptations of root systems and salt excretion
Red Mangrove			
Black Mangrove			
White Mangrove			

Name: _____ Date: _____

Mangrove Moves:

Red mangrove prop roots stabilize sediment and provide cover for diverse forms of prey.

Now let's take some of what we have learned about mangroves and what they do for their environment and put it in our own words. Word bank has been provided but give yourself a challenge and attempt to fill in the words you think belong there BEFORE you look at the word bank. Once you have completed what you think you know LOOK at the word bank and add the words from the bank to any areas where you were unsure. Now, go back and see if the words that you filled in before you looked at the word bank are in your answers. How did you do? Are you on your way to being a mangrove specialist?

Mangroves are important to _____ habitats. These are ecosystems that have _____ or _____ water. Mangroves are _____ but they are really special since they can live in and actually take in _____ water through their roots. This would _____ most other types of trees. There are _____ species of mangroves common to Florida and the Caribbean. The _____ mangrove is said to have "walking roots". The roots of this mangrove look like long legs and help to securely hold the tree against _____ and _____. The red mangrove is often found the furthest in the _____ and this makes it the most _____ tolerant. The red mangrove has a long, thin seed which is also known as a _____. This seed is very well adapted to survival since it can _____. The fact that it can do that means when it drops off the tree it can go with the wind and waves and with any luck end up far away and produce the start of another mangrove habitat. The _____ mangrove is usually the next mangrove found higher in the location from water to shore. The black mangrove has tall "snorkels" that help is take in _____ from the air around it. The black mangrove excretes _____ from the bottom of the leaves. The black mangrove is also a _____ species.

WORD BANK: Salt, brackish, trees, propagule, salt, kill, three, red, salt, coastal, salt, protected, float, wind, waves, water, black, oxygen.

TEACHER KEY

Mangrove Moves:

Red mangrove prop roots stabilize sediment and provide cover for diverse forms of prey.

Now let's take some of what we have learned about mangroves and what they do for their environment and put it in our own words. Word bank has been provided but give yourself a challenge and attempt to fill in the words you think belong there BEFORE you look at the word bank. Once you have completed what you think you know LOOK at the word bank and add the words from the bank to any areas where you were unsure. Now, go back and see if the words that you filled in before you looked at the word bank are in your answers. How did you do? Are you on your way to being a mangrove specialist?

Mangroves are important to **coastal** habitats. These are ecosystems that have **salt** or **brackish** water. Mangroves are **trees** but they are really special since they can live in and actually take in **salt** water through their roots. This would **kill** most other types of trees. There are **three** species of mangroves common to Florida and the Caribbean. The **red** mangrove is said to have "walking roots". The roots of this mangrove look like long legs and help to securely hold the tree against **wind** and **waves**. The red mangrove is often found the furthest in the **water** and this makes it the most **salt** tolerant. The red mangrove has a long, thin seed which is also known as a **propagule**. This seed is very well adapted to survival since it can **float**. The fact that it can do that means when it drops off the tree it can go with the wind and waves and with any luck end up far away and produce the start of another mangrove habitat. The **black** mangrove is usually the next mangrove found higher in the location from water to shore. The black mangrove has tall "snorkels" that help is take in **oxygen** from the air around it. The black mangrove excretes **salt** from the bottom of the leaves. The black mangrove is also a **protected** species.

WORD BANK: Salt, brackish, trees, propagule, salt, kill, three, red, salt, coastal, salt, protected, float, wind, waves, water, black, oxygen.

Activity Rubric:

You should check to see if you meet the following criteria at the level "4"

Area	1 Does not meet expectations	2 Partially meets expectations	3 Meets expectations	4 Exceeds expectations
Science Content	NONE of the facts relating to each mangrove species are written in, and the locations of each mangrove were all incorrect	SOME of the facts relating to each mangrove species are written in, and the locations of each mangrove were only partially correct	MOST of the facts relating to each species are written in, but all locations of mangroves were correct.	ALL of the facts relating to each species are written in, and all locations of mangroves were correct.
Use of science vocabulary	NONE of the vocabulary from the reading on snook or mangroves is used in the writing of answers	SOME of the vocabulary from the reading on snook or mangroves is used in the writing of answers	MANY of the vocabulary from the reading on snook or mangroves is used in the writing of answers	A LARGE AMOUNT of the vocabulary from the reading on snook or mangroves is used in the writing of answers
Writing fluency	Writing flow errors create issues with sentence structure, making the activity close to impossible to comprehend	Writing flow errors are evident, but few, and make the activity difficult to comprehend	Writing flow errors are few, and the activity is easy to read and under-stand	Writing flow errors not present, and the activity is easy to comprehend and follow the information presented to the reader
Conventions	Spelling, capitalization, and punctuation errors are numerous and make the written narrative difficult to understand.	Spelling, capitalization, and punctuation errors are evident and make the written narrative difficult to understand.	Spelling, capitalization, and punctuation errors are few.	Spelling, capitalization, and punctuation errors not present in the writing at all.

Student Reading

Permit

Permit *(Trachinotus falcatus)* are a popular fish for recreational (sport) fishing, and the fishery draws in visitors from around the world. People in Florida enjoy permit fishing in many different ways. Some people enjoy "sight fishing," where they look for the fish and cast to it, on flats with fly rods. Other people fish on offshore reefs with traditional fishing gear instead of fly rods. Some fishermen practice catch-and-release, while others keep the permit they catch. There is also a small commercial fishery for permit in Florida. And surf fishermen—commercial and recreational fishermen that cast from the beaches—also catch permit while looking for the species' close cousin, the pompano.

BTT's Dr. Aaron Adams demonstrates how to hold a fish without harming it.

The permit that swim around offshore reefs are usually the biggest and largest fish, but this means that sometimes they are breeding fish. These fish group together to reproduce around these reefs, and keeping breeding fish instead of releasing them can really hurt the permit fishery. Captured permit do not get the chance to reproduce and make more permit, so fishing on these offshore reefs can actually lead to less permit in the area.

The thrill of permit fishing brings in lots of money for local businesses and cities. People travel from all over the world to Florida for the fishing, spend lots of money on boats and fishing gear, and pay fishing guides and captains well so they can catch a big permit. These fish, when released alive after being caught, are really good for cities and towns.

Since these fish are so important and bring in so much money for cities and towns, it is important that we take care of them and do not keep too many of the fish that are caught. This is harder than you might think. Permit use many different habitats over their life cycle, and since they move a lot, it is hard to learn about them and see where they move. We don't know much about permit life cycles, but we are going to talk about what we do know.

Ontogeny

There are not many animals that only use one type of habitat or one food source for their entire lives. As an animal grows, it's needs change. For example, a small fish may eat worms and crabs, but as it grows, it might need to move to a place where there are bigger crabs and small fish to eat. These changes that naturally happen during a lifetime are called the "ontogeny" of the animal. In nature everything is connected, and animals can link different habitats, like seagrass meadows, coral reefs and the blue pelagic ocean, during their lives.

Permit use many habitats too. Permit are usually fished in clear, shallow waters called "flats" that can have shallow corals or sandy and/or grassy areas that are sometimes next to mangrove shorelines. Because permit are caught in these areas a lot, some anglers think permit live in these areas all the time. But permit actually live in many other habitats during different parts of their lives. Just like other fish, the permit's "life history" connects different, important habitats.

Permit use many different types of habitat throughout their lifespan. For small, juveniles, seagrass beds are particular important.

Spawning

Permit usually move offshore to deep waters when they meet to reproduce several times every year in groups called "spawning aggregations." As many as 250 to 500 mature fish travel from different places to offshore reefs or wrecks. Here, they will "broadcast spawn," where all the fish will release eggs and sperm into the water at about the same time. In Florida, this happens in the months between February and July.

Not a lot is known about how permit reproduce, but scientists think that permit spawn in the same place, year after year. The places where they spawn are called "spawning aggregation sites." Sometimes other fish, like snapper, grouper, and other jacks – the permit is a kind of jack – will also use the same place to spawn. When this happens, the place is called a "multi-species spawning aggregation site."

The reason that many different types of fish would use the same place to spawn is because of the water currents in those areas. When all the fish send their sperm and eggs out into the ocean, they are hoping that the baby fish that are made will be carried to a safe place to grow up. The baby fish, called larvae, cannot swim well when they are first born. The adult fish have to pick places to spawn where the water will carry the new larvae to safe habitats like mangroves and shallow, sandy beaches.

Riley's Hump in Florida's Dry Tortugas National Park, southwest of Key West, is an example of a multi-species spawning aggregation site. It is a spawning site for mutton snapper, cubera snapper, and permit, as well as other species. It's an underwater, coral-covered hill right in the middle of currents that carry larvae to mangroves and grass flats. Some of the winds and currents bring larvae to safe habitat nearby, while the swift Florida Current carries some larvae long distances, up along Florida's mainland eastern coast and beyond.

Conservation

In the 1990s, a few caring fishermen successfully battled to stop fishing in spawning areas around the Dry Tortugas. Because of this, many fish species – including mutton snapper – have grown in number in many different places. We do not know a lot about the

number of permit in the U.S., but fishermen think that protecting that spawning site has brought permit numbers up and made fishing better. Since then, Florida has been stopping people from fishing for permit during permit spawning season, which seems to have helped permit numbers too.

Finding and protecting spawning aggregation sites and multi-species spawning aggregation sites is really important for researchers and people who care about the ocean and the fishery. After all, taking care of these important areas usually means more permit and better fishing.

Fly fishing for permit by casting to fish you can see is an exciting and challenging style of recreational fishing.

Larval and Early Juvenile Permit

Once larvae have been carried away from spawning sites, they settle in coastal areas and begin development. The larval duration for permit is short—about 15 to 20 days. Studying permit around Belize's Turneffe Atoll and the Florida Keys has shown that almost all juvenile permit settle quickly on sandy windward beaches, and hunt in the seagrass beds nearby. Windward beaches face the wind direction, which means the sand is always being stirred up by wind and wave action. Surf zones, where the waves are crashing on the shore, are full of crabs, shrimps and worms that provide young permit with the energy to grow.

Permit like nothing better to eat than a small blue crab.

Larval permit are tiny when they settle, between 8 and 10mm. Around Belize's Turneffe Atoll and the Florida Keys, juvenile permit can be found along most windward beaches, where they feed on the crabs and worms and start to grow. Juveniles on these beaches around the Florida Keys can grow as large as 157 millimeters.

Adult Habitats

Larger, near-adult and adult permit swim between many different types of habitats. As mentioned earlier, fly anglers usually target them in the shallows, in places such as back reef flats, seagrass meadows, and along mangrove shorelines. Surf zones full of crabs also attract adult permit, and so do crab trap floats, channel markers, and other floating manmade structures.

Fishermen fish for permit on both shallow and deep reefs, natural or manmade. There's growing concern that targeting permit on offshore reefs means catching fish that are about

to spawn. We do not know much about how many permit there are, or how permit numbers have changed over time in Florida or internationally. We do know that other fish species – like snapper, groupers, and other jacks – can really drop in number when people fish their pre-spawning or spawning aggregations. Because we have seen the numbers of other fish drop when these spots are fished at spawning times, we have a good reason to believe that permit numbers would drop too.

Seagrass meadows are favorite foraging areas for permit.

Diet

As permit get older, they eat different things. Early juveniles hunt along windward beaches for tiny crab-like creatures called amphipods, copepods, and mysids—a tiny species of shrimp. Older juveniles feed on bottom-living prey like small crabs, surf clams and worms, and some types of small urchins and sand dollars. Softer prey items are more important for juveniles since they do not yet have the teeth to crush the hard shells of larger crabs. Adult permit feed in the shallows—mostly on crabs, clams, and urchins. Adult permit have small conical (cone-like) teeth that let them feed on larger, harder, more nutrient-rich prey like blue crabs.

Threats

Overfishing and habitat loss or habitat degradation can threaten permit by making their population numbers go down. Researchers are worried that removing fishing from offshore reefs, on or near spawning aggregation sites, could bring the number of spawning fish to dangerously low levels. There are other threats to permit populations that we know less about, too. Bycatch, or accidental catch of permit by fishermen who are targeting other species, is another issue. Even if these fish are let go, they are usually tired from fighting the fishermen, which leaves them in danger if there are predators nearby. There is even more danger if the fish has been caught offshore, where sharks and barracuda are more likely to hear the fish splashing and stop by to see what's going on. Other threats are damage to juvenile habitats, which can stop larvae settlement in these important habitats, leading to fewer juveniles in that area. Climate-change, coastal construction, and pollution are also hurting offshore reefs, seagrass meadows, and beaches, which are all important habitats that permit use during their life cycle.

Climate Change

Coral bleaching happens when zooxanthellae, the small organisms that live in the coral and provide food for the corals to live and grow, cannot live in the water anymore and have to leave the coral.

Permit spawn and spend time near or on coral reefs. One of the effects of climate change is the pH of the ocean becoming more acidic, which has big impacts on coral reefs. As humans, we cannot feel the small changes in ocean pH that are happening with climate change, and most fish cannot feel them either. But the minerals that coral use to grow can dissolve more easily when the ocean gets more acidic, so the corals have a harder time growing. Meanwhile, climate change is also making sea temperatures rise. Rising sea temperature is killing corals very quickly by causing coral bleaching and spreading coral diseases. Increasing water temperatures can kill healthy corals, and make life even harder for suffering corals that can be a "tipping point." The corals cast off their "zooxanthellae," which are small organisms that give corals their color and most of their food supply. When zooxanthellae leave the coral, the coral turns white in color and cannot feed, so it usually dies.

Also, increasing air temperatures are causing water temperatures to rise quickly in clear, shallow waters where seagrasses live. Seagrasses have certain temperatures they survive best in, which are growing warmer in many areas, making the waters too hot for seagrasses to live in. Climate change is also changing rainfall patterns, and in some places – especially in Florida's Everglades – too much or too little water is causing massive seagrass die-offs.

As tropical cyclones become worse and sea level rises, more people are building structures on the coast that are meant to keep their houses and land safe. But this development has consequences that are not always expected. The roots of mangroves and seagrasses hold sand firmly in place. Removing seagrass and mangroves, while also stirring up the water during the building process, actually makes the coast less stable because the sand can be easily swept away by the sea. Not to mention all the fish that are no longer able to live in these places.

"Beach nourishment" projects are also very bad for permit and other fish. These projects are meant to make beaches bigger and draw in more people. To do this, people will dig up tons (literally) of sand from deep offshore and dump the sand onto the beach. You can imagine this is not great for those offshore environments, but it also buries any crabs, worms, or fish that are trying to live in the surf zone of the beach. This means that permit can no longer live or feed on these beaches.

Bonefish & Tarpon TRUST

Student Reading

Seagrass

Healthy seagrass meadows are becoming rarer in Florida because of pollution and water mismanagement.

Seagrasses are amazing plants. Did you know that they are the ONLY aquatic plants that have flowers? They are an actual plant, not a seaweed – like the types of algae that you might have encountered at the beach or offshore. Seagrass meadows are important for the survival of entire ecosystems and entire species. Seagrass grows in calm, sandy environments most often found in estuaries and bays. These areas are often referred to as seagrass meadows or "grass flats." Grass flats play incredibly important roles. They act as nursery areas for lots of juvenile fish and are important feeding grounds for larger fish. Even sharks can be found swimming in grass flats looking for a tasty snack.

Erosion Control

Seagrasses help in other ways, too. They prevent erosion and sedimentation. Especially during hurricanes and other strong storms, sandy areas are very likely to get washed around or even away when the waves and wind kick up. That makes the water murky and a far from ideal place for many organisms to live. The seagrass roots and "rhizomes" – the horizontal stems that run just below the sandy substrate – help to hold the bottom sediments in place. The thicker and healthier the seagrass meadow, the better it is at erosion control!

Permit and Seagrass

Green plants perform photosynthesis, where they convert light into energy they can use to grow. Photosynthesis creates oxygen as a byproduct, but one that fish and other organisms – including us – need to breathe. Take in a big, deep breath and thank a tree and seagrass

too!

Seagrass is an important food source for lots of animals that live in the areas where it grows. Some animals that live in those areas rely only on seagrass as their food. Green sea turtles and manatees would really suffer if the seagrass is wiped out of an area. Forage fish, especially pinfish, eat seagrasses. In turn, larger fish including tarpon and snook rely on pinfish as an essential food source.

There are many types of seagrass. Turtle grass, eel grass, shoal grass, manatee grass, paddle grass, star grass, Johnson grass and widgeon grass are some species that are commonly found in Florida. Each species has a unique size and shape and each one is very important to the ecosystems where they are found. Some of these grasses, like Johnson grass, are very rare and only grow in specific areas and even then are hard to find. Johnson seagrass is actually listed as a federally "threatened species," which means that it is very important to keep the areas where it is found growing safe and environmentally secure. Otherwise, the species, and the benefits it provides, could completely disappear.

Anglers often first spot a permit when its tail waves above the surface as it roots in the seagrass for worms, shrimp and especially, blue crabs.

Permit are a fish that rely on healthy grass flats to live and thrive. This species is extremely important for charter fishermen who make their living taking people to catch these elusive, wary fish.

Permit primarily feed on grass flats and have a unique set of teeth designed to devour their prey. Permit have hard mouth plates that are used to crush crustaceans (crabs and shrimp) and mollusks (oysters and clams). Permit dig into the seagrass and sand below looking for their prey. They are often found in schools of about ten fish, but tend to hunt in solitude once they are older adults.

Permit are a prime example of a species that depends on seagrasses. If the seagrasses disappear, the fish move on to another location. Fishermen and tourism businesses such as hotels and tackle shops suffer when permit leave an area due to habitat loss.

The money they make catering to fishermen goes away when the fish go away. This can mean a large economic loss for a community. Permit and seagrass communities have a symbiotic relationship. This means that if the seagrass disappears then so will the permit.

Seagrass: Send Me Over

Objectives:

At the end of the activity students will have a better understanding of the role and purpose of lush seagrass beds on sand and sediment trapping and how these seagrass beds help stop sediment erosion and movement.

Differentiation:

Students with differing abilities in terms of walking/running or putting their arms out can be the "caller" in place of the teacher. Students could also complete the activity with a "buddy" who helps them go to the other group of students. For students who have verbal ability issues the teacher can meet with them one on one to discuss their experience within the activity.

Lesson background:

Seagrass plays an important role in stopping erosion and catching sediment in place. This aids in the building of sandbar areas and most importantly offers a home, hiding place and protection to many species who live in the estuary and nearshore environments where seagrass is often found. Seagrass is also a primary producer, meaning that it is the bottom "rung" of many food chains/webs and seagrass plays a very important role in the diets and life cycles of many species. It is imperative that students understand and can synthesize this information into their own words. Studies have shown that active learning is a wonderful way to take classroom material outside and also aides in the retention and understanding of material introduced.

Florida State Standards (NGSSS)

- SC.4.L.17.4: Recognize ways plants and animals, including humans, can impact the environment.

National Standards (NGSS)

- 4-LS1-1: Structure & Function
- 4-ESS2-1: Earth Materials & Systems
- 5-LS2-1: Interdependent Relationships in Ecosystems
- 5-ESS3-1: Human Impacts on Earth Systems

Activity:

Seagrass: Send me over!

Procedure:

- Prior to teaching the lesson the teacher should review the reading pages about permit and seagrass. He/she should become personally familiarized with permit and seagrass to best be prepared to present the material to the students.

- Prior to this outside activity it might be a great time to review expectations in terms of noise level, safety, courtesy to others and the fact that this lesson involves running and calling to classmates and that it is intended to be a "fun" activity and hurting each other would not be fun and result in the lesson ending.

This activity is to be done after the readings of the seagrass information has taken place. After the readings students should discuss the importance and value of seagrass as well as the environmental purpose of seagrass. This activity is much like the old favorite game "red rover" but with seagrass as the focus. The lesson was developed with a class count of about 25 in mind but can easily be increased or decreased to meet your personal class size and space allotment. The activity would best be done in an open area (like a field or playground) where running and being loud would be acceptable. Feel free to change the activity as needed to meet the needs of your students and the available play space.

- Ask students if they have ever played the game "red rover". Many likely have. Ask them to raise their hands and tell the class what they know about the game and how it is played. Once students have a general idea of how the game red rover is played explain to them that they are going to be playing a similar game today, but they will have a "role" to play in addition to just playing the game. Some students will be "sand" and some students will be "seagrass" when they play the game today. You will be dividing the class into these roles and the number of sand and the number of seagrass will change as the game goes on. You might want to explain that as the game is played you will be stopping in between sessions to ask questions and let them discuss points and that their active participation in the discussions is vital for them to be able to continue playing the fun part of the game.

- Taking the class of 25 (this can go up or down based on your actual class size) you should **break the class into a group of 20 "seagrass" and 5 "sand" kids.** The 20 seagrass kids should go to one side of the field and the 5 sand kids should go to the other side of the field. ****There needs to be some sort of marking showing the left and right boundary for where the students can stand. This will be vital to show the point that less seagrass means more sediment gets through. These boundaries will stay the same the entire activity**** The seagrass kids should put their arms out and just hold their arms out, not locking hands like a normal game of red rover would but just "flowing in the water" like a blade of sea grass would do. These kids might (should) be reminded that the goal is not to get hurt or hurt anyone but they are just going to be simulating what sea grass might do in the water. The sand kids will stand on the other end and the teacher will be the caller who calls which student to come over (all 5 will come over eventually). The seagrass kids with the prompting and aid of the teacher will call:

"Seagrass, seagrass, that waves and bends,
send (insert kids name here) over to your seagrass friends!"

- The student called will come running across and try and make it through the crowd of seagrass without being touched (this will be nearly impossible to do) and each sand student will be called over one at a time.

- After all the students who are "sand" have been called over the class should come into a group and the teacher should lead a discussion about what just happened with the following questions:
  - We had 5 friends come through the seagrass. How many of them got "touched" by the seagrass? (The answer is likely all of them.)
  - What would you call this amount of seagrass? (Words like lush, full, crowded, etc. are fitting.)
  - Would you consider this a healthy seagrass bed with lots of seagrass? (Yes or no and push them to explain why/why not.)

Seagrass: Send Me Over!

- Now break the group up again with a new number of sand and seagrass. This time there should be less seagrass and more sand. ******It is important to keep the seagrass kids within the same boundary as the lesson started with***** **The number of seagrass should be 15 and the sand should be 10.** The procedure of calling sand over should be repeated and the discussion questions asked again. The question "how did this compare to when we had 20 seagrass friends" should be asked and a discussion relating to this should be pursued. The takeaway point is that there were less seagrass kids and more sand got through. It should also be deduced that the seagrass bed was less full, lush etc then it was when there were 20 seagrass kids.

- You should lead a discussion about what just happened with the following questions:
  - We had 10 friends come through the seagrass, how many of them got "touched" by the seagrass? (Likely most of them, maybe not all.)
  - What would you call this amount of seagrass?
  - Would you consider this a healthy seagrass bed with lots of seagrass? (Yes or no and push them to explain why/why not.)

- Now **break the class into 10 seagrass and 15 sand**. Repeat the exercise and the questioning. It should be getting clearer that the number of seagrass has a dramatic impact on if the sand is touched or not.

- **Finally break the class into 5 seagrass and 20 sand**. This should demonstrate what a barren seagrass bed looks like. This portion should lead to a more robust discussion on the impacts of seagrass and now you can introduce and really emphasize the concept that if there was no seagrass what would happen. Touch on the following points in this final discussion:

  - We know that seagrass catches sand and sediment. What do you think would be happening to the sand and sediment in a seagrass bed that was as barren as our last bed was? (They should be able to verbalize that the seagrass wouldn't stop much sand and that there would be lots of sand moving around.)

  - When they get to the understanding that the sand would be moving all around, touch on the water clarity and how much clarity there would be with that much sediment moving around. You can trigger their prior knowledge at this point by asking them if anyone has ever walked on a river or lake bed with no seagrass or rocks and mud in it? What happened to the water? How clear or murky was it before you walked and compare that to after you walked through it. Now ask them how they think the water would look on that seagrass bed when the wind kicked up and the waves increased?

  - Point out that they learned about photosynthesis. What were some of the things needed to complete photosynthesis? Light will be one thing that should be named. Use this as your opportunity to point out how little light will be getting to that seagrass when the water is murky and full of sediment. This will make the grass unable to do photosynthesis and lead to death or at the very least inadequate growing.

- Your goals for leading this discussion should be the following takeaways:

  - Seagrass is important at stopping sediment and sand from moving around in the aquatic environment.
  - Seagrass beds need to be lush in order to stop sediment transport and also lush to provide habitat for animals that require it.
  - Seagrass beds can change over time due to natural and human impacts.
  - Seagrass beds need clear water to do photosynthesis.
  - Seagrass beds are vital and should be protected and respected for the role that they play in the ecosystems in which they are found.

Activity Rubric:

You should check to see if you meet the following criteria at the level "4."

Area	1 Does not meet expectations	2 Partially meets expectations	3 Meets expectations	4 Exceeds expectations
Science Content	NONE of the discussion questions are answered and students appear to be lost as to the concept being presented.	SOME of the discussion questions are answered and students appear to be lost as to the concept being presented.	MOST of the discussion questions are answered and students appear to have a general and adequate grasp as to the concept being presented.	ALL of the discussion questions are answered and students appear to have a fully developed and above grade level grasp as to the concept being presented.
Use of science vocabulary	NONE of the introduced scientific vocabulary is present in the discussion portion of the activity	SOME of the introduced scientific vocabulary is present in the discussion portion of the activity	MOST of the introduced scientific vocabulary is present in the discussion portion of the activity and they are using vocabulary that has not been directly introduced	ALL of the introduced scientific vocabulary is present in the discussion portion of the activity and students are bringing in outside experiences and complex understandings to the discussions.
Writing fluency	This activity does not address writing	This activity does not address writing	This activity does not address writing	This activity does not address writing
Sportsmanship	Students are not able to follow directions and the activity had to end early.	Students are having difficulty following directions and the activity had to end without full discussion.	Students are able to follow directions and the activity was completed with discussion.	Students were able to complete the activity and participate in a deep discussion on the subject.

Standardized Youth Education Workbook

Appendix I: Lesson Breakdown

Grade Theme	Page	Title of Lesson Summary of Lesson	CPALMs Standards	Next Generation Science Standards
Second Grade Tarpon have complicated life cycles, and use many different habitats and resources.	12	Tarpon Scale Mail Students will learn about tarpon life cycles and the many different habitats and resources these fish need as they grow. They will create postcards as "tarpon" in different life stages, explaining what their life is like at that point in their life cycle.	SC.2.L.16.1 SC.2.L.17.1 SC.2.L.17.2	1-LS1-2 2-LS2-1 2-LS2-2 2-LS4-1
Second Grade Tarpon are well adapted to their environments, which is why this species lived at the same time as the dinosaurs.	22	Funny Fish with Flapable Fins Students will learn how body shape and fin placements make tarpon efficient swimmers and leapers that are well adapted to their environments. They will complete exercises that help them understand the function of each fin, and they will create their own paper tarpon.	SC.2.L.14.1 SC.2.L.16.1 SC.2.L.17.1	2-LS2-2 2-LS4-1 3-LS4-2 3-LS4-3
Fourth Grade Food webs show the transfer of energy of living things, and producers and consumers get their energy in different ways.	36	Bonefish: Feeding Frenzy! Students will learn about energy transfer between organisms, and understand the different roles that organisms can hold in a food web. They will use cards to create food webs as groups, then combine all their food webs into one large ecosystem.	SC.4.L.17.2 SC.4.L.17.3 SC.4.L.17.4	5-LS1-1 5-LS2-1 5-PS3-1
Fourth Grade Seagrasses are important in an ecosystem by providing habitat, food, and coastline stabilization.	78	Seagrass: Send me over Students will learn about the role of seagrass as stabilizers in an ecosystem. This is an outdoor class game where students will be assigned the role of either a seagrass or a piece of sand, and the seagrass will try to "catch" the sand, much like the game "Red Rover."	SC.4.L.17.4	4-LS1-1 4-ESS2-1 5-LS2-1 5-ESS3-1
Fifth Grade Mangroves are important members of ecosystem, providing shelter, creating coastline stability, and even protecting shorelines from natural disasters.	64	Snook: Home Sweet Home Students will learn about the services that mangroves provide to an ecosystem, besides just being a home for snook. They will think fill out different worksheets using the readings as well as their own critical thinking.	SC.5.L.17.1 SC.5.L.15.1	4-LS1-1 4-ESS2-1 5-LS1-1 5-ESS3-1

Appendix II: Kagen Structures

Kagen Structures is a teaching/classroom management strategy that is currently being pushed and applied heavily in Florida classrooms. It services the common core objectives well. Kagen Structures are especially helpful in more technical and difficult reading activities, such as science reading. For teachers interested in using these techniques in their classrooms, we have highlighted a few recommended Structures for this workbook and listed lessons where these Structures may be used.

Rally Reading

Break the class into groups of 4 – 6 students. In each group, members will take turns reading one paragraph aloud, then another member reads the next and so on. The students should offer their own understandings of what they read, try to understand new vocabulary words through context, then return to the teacher for clarification.

Suggested lessons: Bonefish Student Reading, Seagrass Student Reading.

Timed Pair Share

Following a reading or discussion, students break into pairs. Choose a specific amount of time (1 minute, etc) where one student will share what they learned from the activity and the other student will listen. After the time is up, the students will switch and the student who listened will now share. You may adjust the topic for the activity, for example, you may ask the students to share as much as they can remember about tarpon lifecycle, or you can ask them to discuss what makes life difficult for a baby tarpon. You can even use this as a tool to engage students and have them share what they thought was most interesting about the reading.

Suggested lessons: Tarpon student readings, Mangrove and Snook student reading.

Rally Robin

Following a reading or discussion, students break into pairs. This is a particularly useful Structure following readings or activities that involve lists or include many steps or pieces. The teacher will give a topic (for example, threats to mangrove communities), and partners will take turns telling each other short responses (one student might say “building on the coast,” the other would follow with “pollution,” and so on.) Going back and forth, the partners will create an oral list.

Suggested lessons: Mangrove student reading, Seagrass student reading.

Bonefish & Tarpon TRUST

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Healthy Habitats = Healthy Fisheries