MARINE MEGAFAUNA FOUNDATION

SCIENTIST SERIES FOR STUDENTS
GRADE 6
Lesson 1 Ray Identification

Lesson Time
45 minutes

Essential Questions
Why is it important to classify organisms? What tools can we use to identify animals?

Materials
Powerpoint of common rays
Copy of dichotomous key
Copy of Name that Ray! worksheet

Objectives - Students Will
Identify notable characteristics of common ray species found in Florida.

Florida State Standards
Science Standard: SC.6.L.15.1
Analyze and describe how and why organisms are classified according to shared characteristics with emphasis on the Linnaean system combined with the concept of Domains.

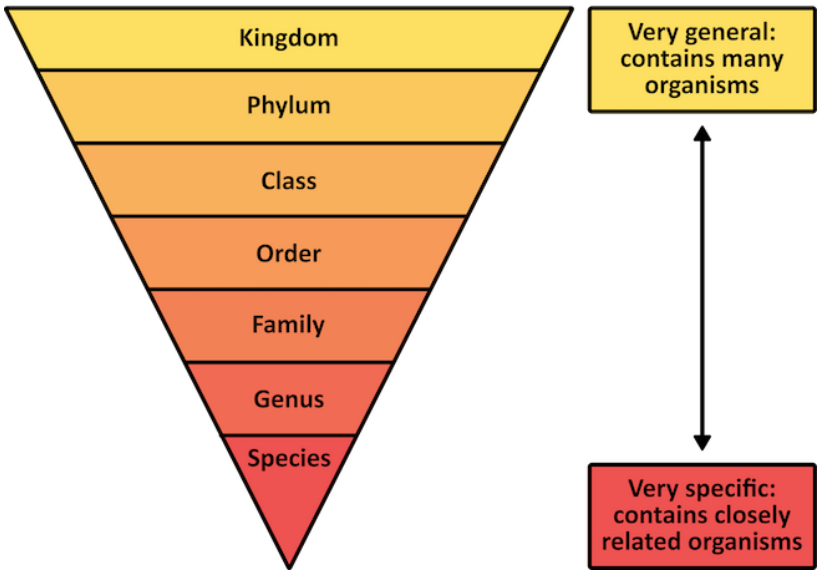
Teacher Background Information
Use this information to help prepare for the lesson.

Classifying living organisms such as plants and animals helps us to better understand the natural world. In observing how living things around us look and behave, we can group them into categories. This allows scientists to see the relationship between organisms and the role they play in our surrounding ecosystems.

Carl Linnaeus, commonly known as the "Father of Taxonomy", is credited with creating the foundation for our modern day classification system. Using this classification system, we begin with broad observations to group organisms into large groups and then narrow them down into smaller groups based on more specific observations.

For example, manta rays are categorized as follows:
Kingdom - *Animalia*, **Phylum -** *Chordata,*
Class - *Chondrichthyes,* **Order -** *Myliobatiformes,*
Family - *Mobulidae,* **Genus -** *Mobula,* **Species -** *birostris*

King Philip Can Only Find Green Socks



https://www.mometrix.com/academy/biological-classification-systems/

MARINE MEGAFAUNA FOUNDATION

SCIENTIST SERIES FOR STUDENTS
GRADE 6
Lesson 1 Ray Identification

Vocabulary:

Buccal Pumping: the act of breathing by sucking water into the mouth and over the gills while stationary

Linnaean Classification: a system used to group together organisms depending on their characteristics

Dichotomous Key: a tool used to identify organisms based on their physical characteristics

Dorsal: the upper or top side of an organism

Filter Feeding: feeding by filtering out plankton or nutrients suspended in the water

Ram Ventilation: the act of breathing by swimming with the mouth open to force water over the gills

Ventral: the under or belly side of an organism

What is a Dichotomous Key?

A **dichotomous key** is a scientific tool used to identify organisms based on their physical characteristics. After an organism has been grouped into its correct Kingdom, Phylum, Class, Order, and Family, you can use a dichotomous key to help you identify the correct Genus and Species. Using this tool is simple, requiring its user only to make correct, detailed observations and then respond to a series of two-sided statements. It is important to always start with the first question in the series which will then guide you to the next question depending on your answer.

How to be a Scientist!

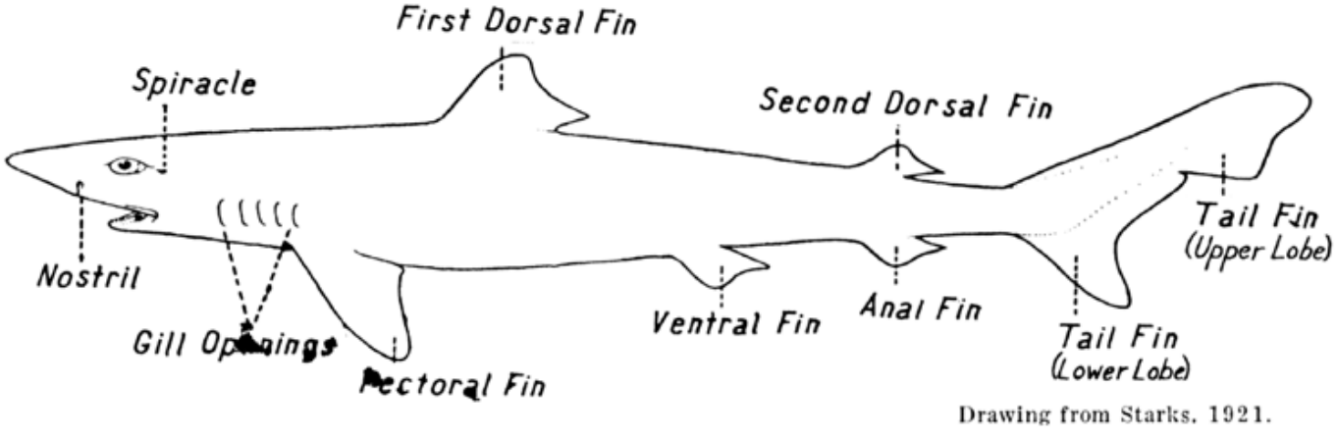
For this activity, students will have to think like a scientist! Science is a process and requires attention to detail. This is especially important for those scientists who work outside in the field observing and collecting data on wildlife. Taking detailed notes on an animal's physical traits, including body shape, distinct coloration, and notable characteristics as well as their behaviors, such as how they swim, where they are feeding, and social interactions can help scientists correctly identify a species. This can be a crucial step, as little is known about many species such as manta rays. Knowing how to correctly identify a species can help with the longterm management and protection of animals who are are at risk of going extinct.

This activity will teach students know how to correctly identify common ray species of South Florida, including the elusive manta ray. Students and community members are encouraged to participate in the Marine Megafauna Foundation's Citizen Science initiative and report manta ray sightings and photos to: **Florida@marinemegafauna.org**

Teacher Preparation:

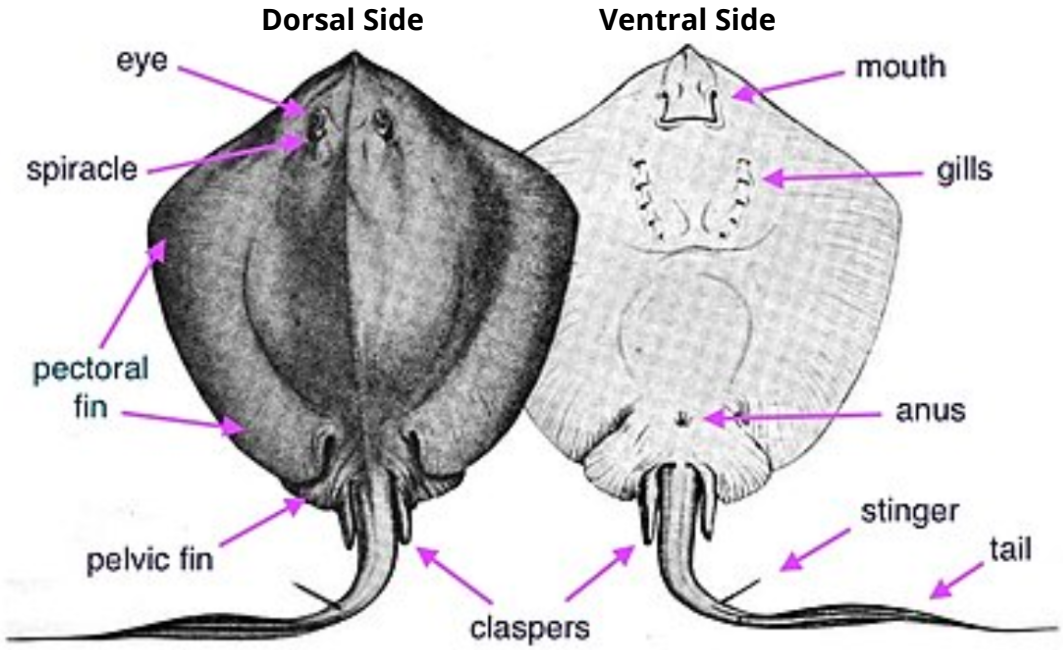
1. Make colored copies of the "Name that Ray!" worksheet
2. Makes copies of the "Dichotomous Key" worksheet
3. If completing as a group activity, load and present the provided **powerpoint**

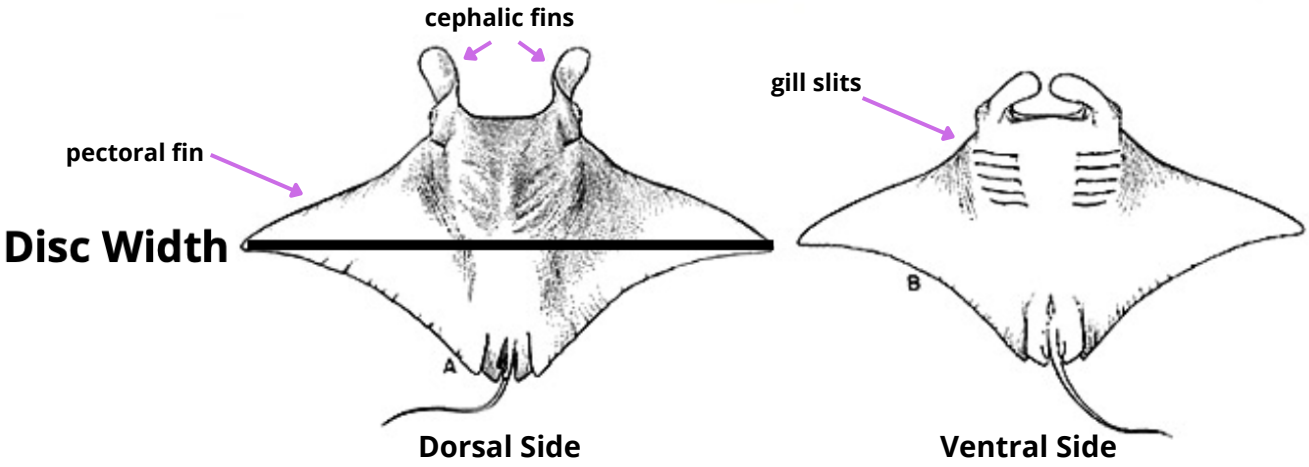
ILLUSTRATIONS OF ANATOMICAL TERMS



Drawing from Starks, 1921.

FIG. 8. Example of a shark.





Sources: http://content.cdlib.org/view?docId=kt938nb3cq;NAAN=13030&doc.view=frames&chunk.id=d0e295&toc.depth=1&toc.id=&brand=calisphere
https://en.wikipedia.org/wiki/Stingray
https://www.floridamuseum.ufl.edu/discover-fish/species-profiles/manta-birostris/

MARINE MEGAFAUNA FOUNDATION

SCIENTIST SERIES FOR STUDENTS
GRADE 6
Lesson 1 Ray Identification

Dichotomous Key

Use the dichotomous key below to identify the ray species presented to you. Upon observing the rays' physical characteristics and answering the provided series of questions, you will be able to identify a variety of ray species commonly found in South Florida.

1a. Ray has a flat disc shaped body.....**go to 2**
1b. Ray has an elongated shark-like body.....**go to 6**

2a. Ray's tail contains a sharp barb.....**go to 3**
2b. Ray's tail lacks a barb.....**go to 7**

3a. Ray is primarily uniform in color and lacks spots or speckles.....**go to 4**
3b. Ray has distinct color pattern and/or speckles on dorsal (top) side of body.....**go to 5**

4a. Ray has a lobed nose.....**Cownose Ray, *Rhinoptera bonasus***
4b. Ray has a "v" shaped nose.....**Southern Stingray, *Hypanus americana***

5a. Ray has a rounded, circular body.....**Yellow Spotted Stingray, *Urobatis jamaicensis***
5b. Ray has a diamond-shaped body with an extended head and beak-like nose
.....**Spotted Eagle Ray, *Aetobatus narinari***

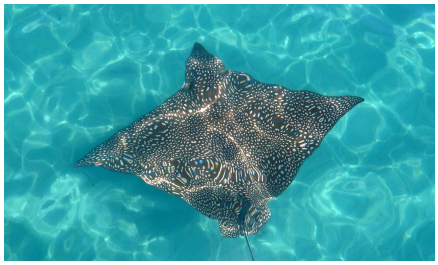
6a. Ray has an elongated and toothed, saw-like nose.....**Smalltooth Sawfish, *Pristis pectinata***
6b. Ray has a flattened, triangle-shaped nose.....**Atlantic Guitarfish, *Pseudobatos lentiginosus***

7a. Ray has cephalic fins (fins coming out of its head).....**go to 8**
7b. Ray does not have cephalic fins.....**Smooth Butterfly Ray, *Gymnura micrura***

8a. Ray has cephalic fins and white patches on "shoulders".....**Giant Manta, *Mobula birostris***
8b. Ray has cephalic fins and is primarily dark grey in color.....**Atlantic Devil Ray, *Mobula hypostoma***

Name that Ray!

Name_____ Date_____

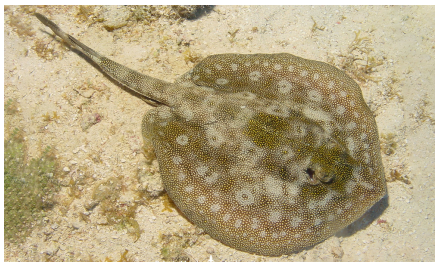


Physical Characteristics

- Flat disc shaped body
- Tail contains sharp barbs
- Distinct speckles on dorsal (top) side of body
- Tail length is proportional to its body width
- Diamond-shaped with extended head and beak-like nose

Common Name: _____

Scientific Name: _____



Physical Characteristics

- Flat disc shaped body
- Tail contains sharp barb
- Distinct speckles on dorsal (top) side of body
- Tail length is proportional to its body width
- Rounded, circular body

Common Name: _____

Scientific Name: _____

Physical Characteristics

- Elongated shark-like body
- Tail does not contain sharp barb
- Uniform in color and lacks spots or speckles
- Elongated and toothed, saw-like nose

Common Name: _____

Scientific Name: _____

Physical Characteristics

- Flat disc shaped body
- Tail does not contain sharp barb
- Tail length is proportional to its body width
- Cephalic fins are present
- Mostly uniform in color with white patches on its "shoulders"

Common Name: _____

Scientific Name: _____

Physical Characteristics

- Elongated shark-like body
- Tail does not contain sharp barb
- Distinct speckles on dorsal (top) side of body
- Flattened, triangle shaped nose

Common Name: _____

Scientific Name: _____

Physical Characteristics

- Flat disc shaped body
- Tail contains sharp barb
- Uniform in color and lacks distinct spots or speckles
- Tail length is proportional to its body width
- "V" shaped nose

Common Name: _____

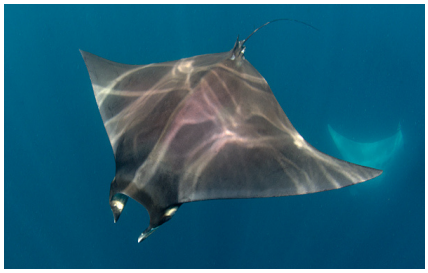
Scientific Name: _____

Physical Characteristics

- Flat disc shaped body
- Tail does not contain sharp barb
- Distinct speckles on dorsal (top) side of body
- Tail length is short relative to its body width

Common Name: _____

Scientific Name: _____



Physical Characteristics

- Flat disc shaped body
- Tail does not contain sharp barb
- Uniform in color and lacks distinct spots or speckles
- Tail length is proportional to its body width
- Cephalic fins are present

Common Name: _____

Scientific Name: _____

Physical Characteristics

- Flat disc shaped body
- Tail contains sharp barb
- Uniform in color and lacks distinct spots or speckles
- Tail length is proportional to its body width
- Lobe-shaped nose

Common Name: _____

Scientific Name: _____

MARINE MEGAFAUNA FOUNDATION

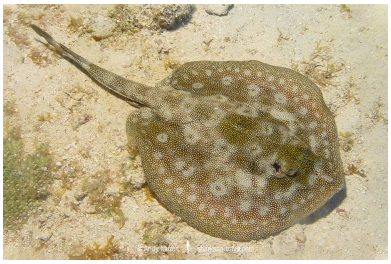
SCIENTIST SERIES FOR STUDENTS
GRADE 6
Lesson 1 Ray Identification

Dichotomous Key
Teacher Answer Sheet

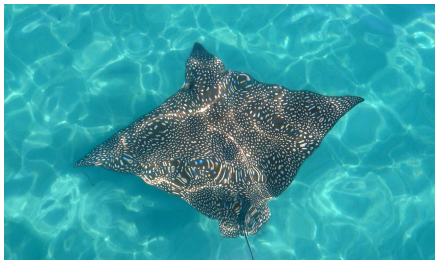
Cownose Ray
Rhinoptera bonasus

Southern Stingray
Hypanus americana

Smooth Butterfly Ray
Gymnura micrura



Yellow Spotted Stingray
Urobatis jamaicensis



Spotted Eagle Ray
Aetobatus narinari

Smalltooth Sawfish
Pristis pectinata

Atlantic Guitarfish
Pseudobatis lentiginosus

Giant Manta Ray
Mobula birostris

Atlantic Devil Ray
Mobula hypostoma

MARINE MEGAFAUNA FOUNDATION

SCIENTIST SERIES FOR STUDENTS
GRADE 6
Lesson 1 Ray Identification

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Scientific Advisory:
Jessica Pate, M.Sc
MMF Florida Project Manager

Grant Provided by:

Disney Conservation Fund

We value your feedback!
Please fill out this Teacher Evaluation form at shorturl.at/aeQW8
As a Thank You, your class will receive a *Manta Ray Adoption Certificate!*

We'd love to see your lessons in action!
Please send an email to florida@marinemegafauna.org and tag us on social media.

@MarineMegafauna

@marinemegafauna

Marine Megafauna Foundation

Additional Resources:

https://www.floridamuseum.ufl.edu/discover-fish/skates-rays/

https://myfwc.com/research/saltwater/sharks-rays/ray-species/

https://www.nps.gov/teachers/classrooms/classification-systems.htm

http://www.onezoom.org/

https://www.treetender.org/

MARINE MEGAFAUNA FOUNDATION

SCIENTIST SERIES FOR STUDENTS
GRADE 6
Lesson 2 Create a New Ray Species

Lesson Time
45 minutes

Essential Question
What makes a ray a ray?

Materials
Copy of Ray Characteristics
Copy of Create a New Ray Species worksheet
Copy of Questions for Thought worksheet

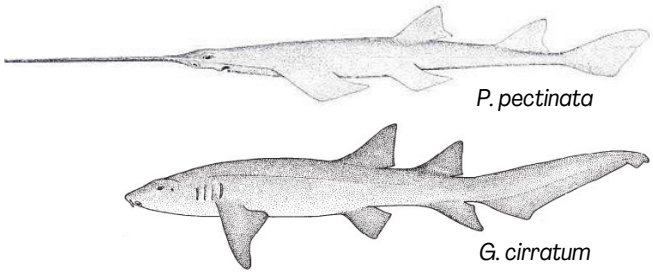
Objectives - Students Will
Identify characteristics of ray species and their adaptations

Florida State Standards
Science Standard: SC.6.L.15.1
Analyze and describe how and why organisms are classified according to shared characteristics with emphasis on the Linnaean system combined with the concept of Domains.

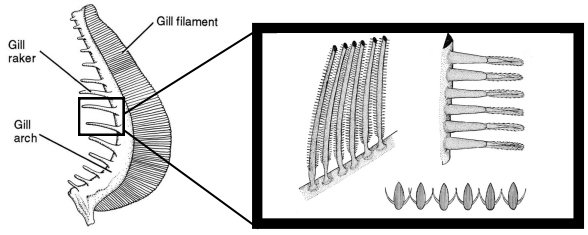
Teacher Background Information
Use this information to help prepare for the lesson.

Rays are closely related to skates and sharks that share many of the same characteristics. As a result they are all classified in the same **Kingdom -** *Animalia,* **Phylum -** *Chordata,* and **Class -** *Chondrichthyes.* The common thread of the class ***Chondrichthyes*** is that all fish in this in this category have skeletons that are primarily made up of cartilage. Cartilage is the same material that makes up our ears and noses, and is much more flexible than skeletons comprised of bones. Scientists commonly refer to this group of fish by their **Subclass -** *Elasmobranch.*

As you can imagine sharks, rays, and skates share other commonalities other than the composition of their skeleton. Take for example, the smalltooth sawfish, *Pristis pectinata*, and the nurse shark, *Ginglymostoma cirratum.* Despite belonging to a different Order, Family, Genus and Species both have a similar tail shape a structure.



Manta rays, *Mobula birostris*, and whale sharks, *Rhincodon typus*, are both large **pelagic** fish that feed on plankton through a process known as **filter feeding**. Both species have specialized structures known as **gill rakers** that help them trap and filter small organisms as water flows into their mouth and over their gills.



Sources: commons.wiki.org
https://wiki.nus.edu.sg/display/TAX/Nebrius+ferrugineus+-+Tawny+Nurse+Shark
https://manoa.hawaii.edu/exploringourfluidearth/media_colorbox/3899/media_original/en

MARINE MEGAFAUNA FOUNDATION

SCIENTIST SERIES FOR STUDENTS *GRADE 6*

Module 2 Create a New Ray Species

Vocabulary:

Adaptation: the means by which an organism becomes best suited for its environment

Benthic: occurring or living on the seafloor

Caudal Fin: the tail fin

Cephalic Fins: specialized fins located near a ray's mouth to aid in feeding

Chondrichthyes: a Class of fish whose skeletons are made of cartilage

Countershading: a type of camouflage where an animal is darker on its dorsal side and lighter on its ventral side

Dorsal: the upper or top side of an organism

Elasmobranch: Subclass of Chondrichthyes that includes sharks, skates, and rays

Gill Rakers: specialized structures within the gill used to trap plankton

Linnaean Classification: a system used to group together organisms depending on their characteristics

Pelagic: occurring or living in the open ocean

Rostrum: a beaklike projection or elongated part of an organisms head

What can Physical Characteristics Tell us about an Animal?

Marine animals are highly specialized for living in the ocean. Other than their ability to breath in water, these animals have **adapted** to their environment in clever and creative ways. Many of the physical characteristics observed in marine species give us a clue as to how they are able to survive in their underwater ecosystem. Some key characteristics that inform of an animal's survival tactics include how an animal swims, how the animal hunts, even means by which they are able to defend themselves against predators.

There are about 630 species of rays, each of which has uniquely adapted to its marine lifestyle. For example **benthic** rays, such as the southern stingray, *Hypoanus americana*, live on the seafloor and have a flat diamond-shaped body. This body shape aids in their protection by allowing them to lay nearly flush with the sand close to their prey and out of sight of predators. Other examples of defensive adaptations can include a venomous barb located on the tail (did you know all stingrays are rays but not all rays are stingrays!), an elongated **rostrum** with tooth-like scales as seen on the smalltooth sawfish, *P. pectinata*, or the ability to produce an electric current to shock their prey as with many electric ray species.

Additional notable traits include where their mouth is placed (underneath their body indicates they are bottom feeders hunting for prey in the sand, or in front of their body which may indicate they are filter feeders), any distinct coloration (tan or beige colored rays are typically found in sandy bottom ecosystems, where as countershading is typical of **pelagic** species), and even the placement of their eyes (eyes located on the side of a ray suggest they may be a pelagic species and need the ability to see on all sides of them, versus rays with eyes on top tend to be bottom dwelling and need to be observant of what is above and around them).

Teacher Preparation:

1. Make copies of the ray characteristics worksheet
2. Makes copies of the "Create a New Ray Species" worksheet
3. Make copies of the "Questions for Thought" worksheet

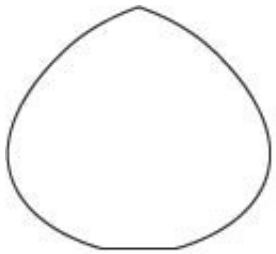
Create a New Ray Species

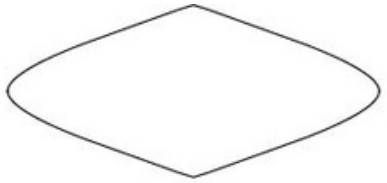
Name_____ Date_____

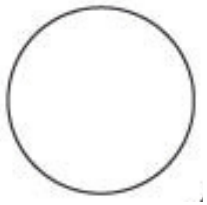
Now it's time to create your own ray species!

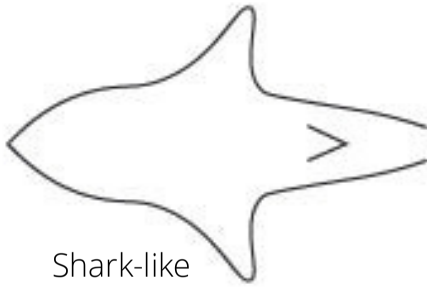
Using the options provided for body shape, head shape, tail shape, mouth placement, and eye placement draw a brand new ray species in the box below.

Body Shape


Spade


Diamond


Circle


Shark-like

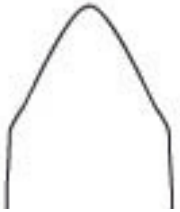
Nose Shape


Saw-like

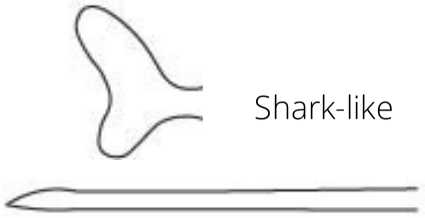

Lobed


Beaked


Cephalic Fins


Shovel

Tail Shape


Shark-like

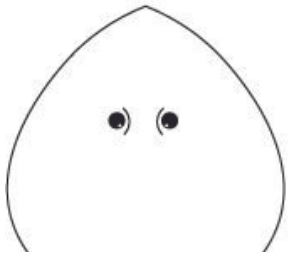
Needle-like

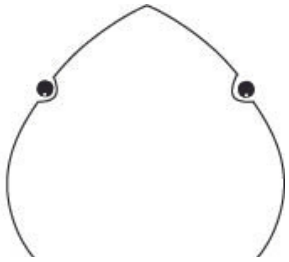
Mouth Placement/Teeth


Underneath


Infront

Eye Placement


On Top


On the Sides

Barb Present - Yes or No

Coloration - Solid color, patterns, spots/speckles, counter shading, identifiable markings

Create a New Ray Species

Name_____ Date_____

Questions for Thought:

1. What is the common name of your new ray species?_____

2. What is the scientific name of your new ray species?_____

3. In what habitat can your ray be found? How do you know?

_____

_____

_____

4. What strategies does your ray use to hunt/feed? How do you know?

_____

_____

_____

5. What does your ray eat? How do you know?

_____

_____

_____

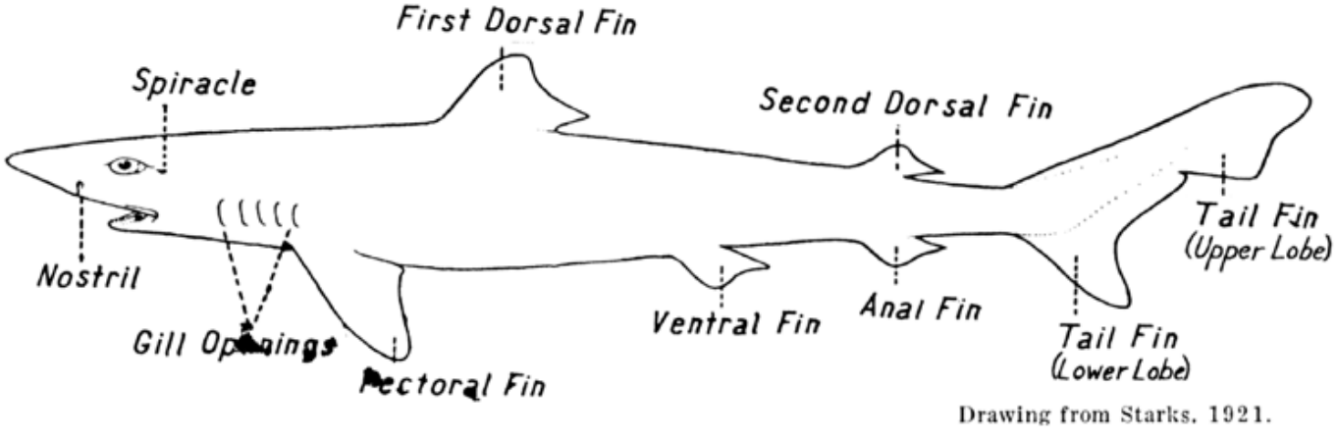
6. What strategies does your ray use for defense? How do you know?

_____

_____

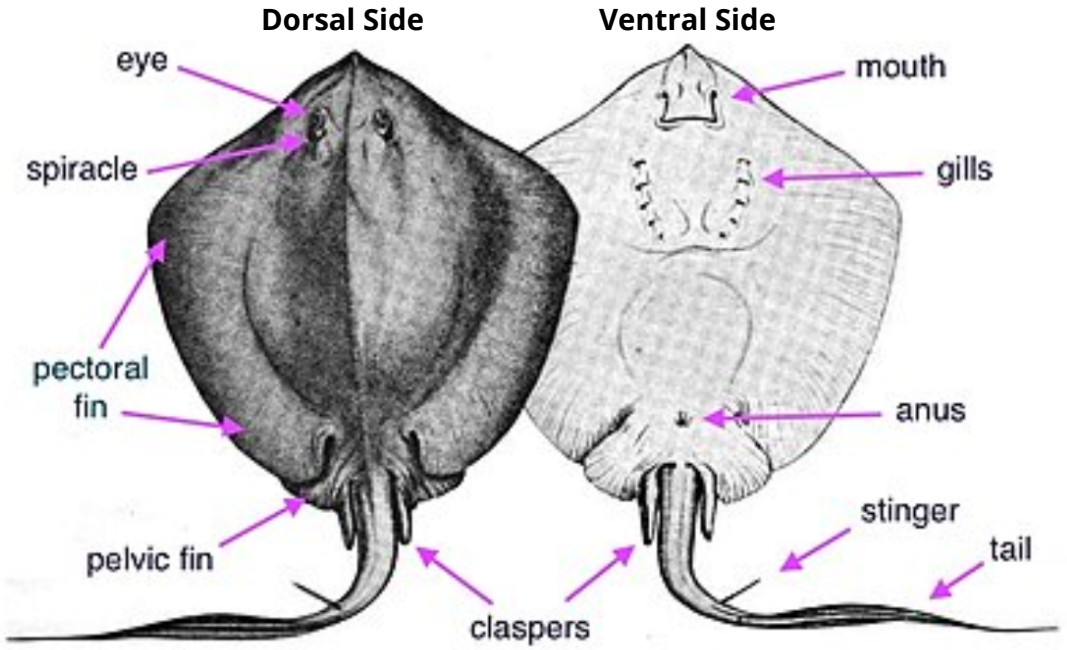
_____

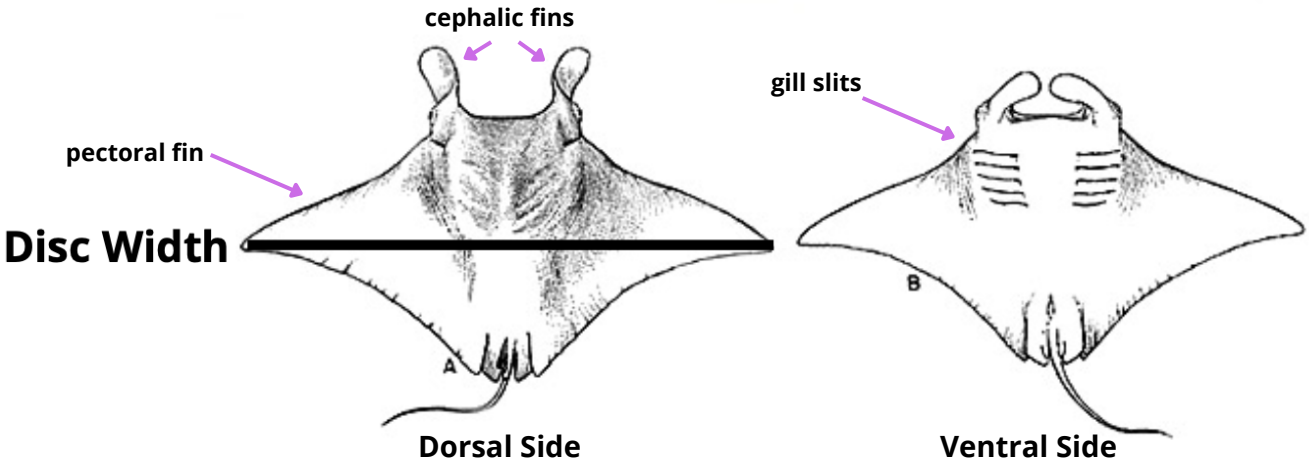
ILLUSTRATIONS OF ANATOMICAL TERMS



Drawing from Starks, 1921.

FIG. 8. Example of a shark.





Sources: http://content.cdlib.org/view?docId=kt938nb3cq;NAAN=13030&doc.view=frames&chunk.id=d0e295&toc.depth=1&toc.id=&brand=calisphere
https://en.wikipedia.org/wiki/Stingray
https://www.floridamuseum.ufl.edu/discover-fish/species-profiles/manta-birostris/

MARINE MEGAFAUNA FOUNDATION

SCIENTIST SERIES FOR STUDENTS
GRADE 6
Lesson 2 Create a New Ray Species

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Scientific Advisory:
Jessica Pate, M.Sc
MMF Florida Project Manager

Grant Provided by:

Disney Conservation Fund

We value your feedback!
Please fill out this Teacher Evaluation form at shorturl.at/aeQW8
As a Thank You, your class will receive a
Manta Ray Adoption Certificate!

We'd love to see your lessons in action!
Please send an email to florida@marinemegafauna.org and tag us on social media.

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@marinemegafauna

Marine Megafauna Foundation

Additional Resources:

https://www.australiangeographic.com.au/news/2022/07/lindblad-expeditions-national-geographic-adds-four-antarctic-departures-for-2022-23-season/

https://www.floridamuseum.ufl.edu/discover-fish/skates-rays/biology/

https://www.floridamuseum.ufl.edu/discover-fish/skates-rays/faq/

MARINE MEGAFAUNA FOUNDATION

SCIENTIST SERIES FOR STUDENTS
GRADE 6
Lesson 3 Manta Ray Matching Game

Lesson Time
30 minutes

Essential Question
How do scientists identify manta ray individuals in the wild?

Materials
Copy of Manta Ray Matching Game
Catalogue of Florida's Manta Rays

Objectives - Students Will
Learn about Jessica Pate and her research on Florida's manta rays.

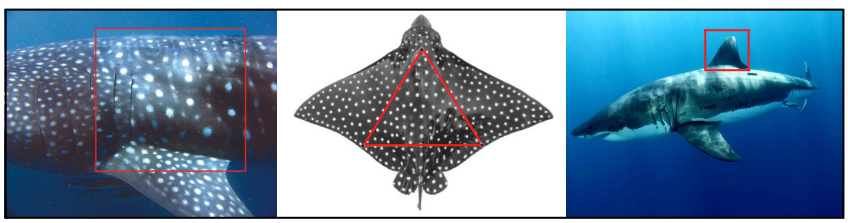
Florida State Standards
Science Standard SC.6.N.2.3:
Recognize that scientists who make contributions to scientific knowledge come from all kinds of backgrounds and possess varied talents, interests, and goals.

Teacher Background Information
Use this information to help prepare for the lesson.

Studying animals in the marine world can be a complicated process. Much of the field research technology is designed for use on land and may not be suitable for the underwater environment. Recent technological advances, including satellite tags (tags that are attached to an animal and transmit data points via satellite) and acoustic tags (tags that collect data when a tagged animal swims past a receiver), allow scientists to understand how animals move throughout the ocean. However, even these tags have their shortcomings, and scientists may be better able to understand a more complete picture of the marine world by observing individual rays in the field.

How are Individual Manta Rays Identified?
Every manta ray has distinct markings on their ventral side/belly that is unique to that individual (similar to a human's fingerprint), and no two manta rays have the same markings. Documenting the number of individual manta rays, along with observations on how they are using the waters they inhabit, helps to inform scientists of the inner workings of a manta ray's life. Ultimately the development of better management practices and identification of high priority areas for the protection of these rays will continue to improve as scientists uncover further details, enhancing our understanding of these and other mysterious megafauna.

Did you know manta rays aren't the only elasmobranch with distinct markings?



Left to right: Whale shark, *rhinocodon typus,* spotted eagle ray, *Aetobatus narinari,* great white shark, *Carcharodon carcharius*

Sources: https://www.nasa.gov/offices/oct/home/tech_life_animals.html
https://hakaimagazine.com/news/fingerprinting-spotted-eagle-ray
https://www.worldwildlife.org/species/great-white-shark

MARINE MEGAFAUNA FOUNDATION

SCIENTIST SERIES FOR STUDENTS
GRADE 6
Lesson 3 Manta Ray Matching Game

JESSICA PATE
Founder and Lead Scientist of the Florida Manta Project, MMF Florida

Degrees:
Bachelor of Science, Env. Science
University of N. Carolina, NC

Master of Science, Biology
Florida Atlantic University, FL

What she does in the field:
Uses drones to observe and document manta rays in South Florida
Photographs rays from boat and records location
Measures and identifies manta ray individuals
Presents research to students and conservation/education groups
Removes fishing hooks from rays

Meet the Scientist!

In 2016 Jessica Pate founded the Florida Manta Project with the Marine Megafauna Foundation. After a chance encounter with a manta ray while performing sea turtle surveys on the beach in South Florida, Jessica realized there was little research or documentation on manta rays off of Florida's coast. In fact, as of 2020 the only other scientific paper mentioning manta rays in Florida was published in 1998. Since her original sighting, Jessica has pioneered the first and only research team dedicated to studying manta rays in Florida. In the last 6 years she has conducted over 300 manta surveys and identified 132 manta ray individuals by their unique spot patterns.

Click **here** to watch a short video of Jessica and hear about her research!

Teacher Preparation:

1. Make copies and cut out cards* of the Manta Ray Matching Game
2. Makes copies of the "Catalogue of Florida Manta Rays"
3. Have students work in pairs or groups to correctly match the spot patterns and identify manta ray individuals
4. Load **"Manta Ray Matching Game Answer Key" powerpoint** for end of activity

***Pro Tip:** Print on card stock and laminate to use cards multiple times!

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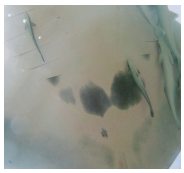
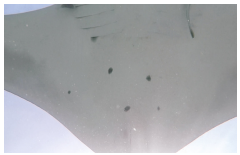
Catalogue of Florida Manta Rays

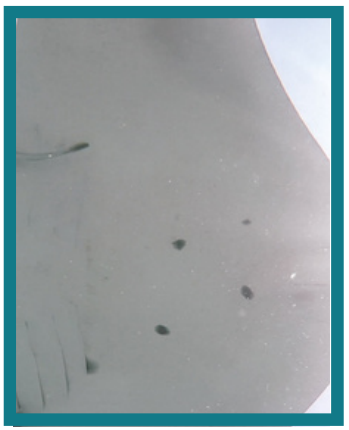
Field Photos	Name and ID #	Sighting Information
 	"Rocco" Manta # 2	• One of the first mantas encountered by manta ray researcher Jessica Pate! • Scars on his back, injury was likely caused by a boat propellor • Missing his tail
 	"Gillie" Manta # 27	• Seen 21 times between 2017-2020! • Had a deep wound on his pectoral fin, likely caused by boat propellor, but fully healed after 1 month • Was satellite tagged in 2019
 	"Hugo" Manta # 59	• Seen 13 times between 2019-2021! • Large male individual (DW ~10 ft) named after Jessica's mom's dog • Very relaxed and allowed researchers to remove a fishing hook from its mouth
 	"Skye" Manta # 64	• Seen 22 times between 2020-2021! • A very friendly manta, likes to flip upside down and swim under people • A 3D model was made after him
 	"Cassiopeia" Manta # 92	• Her belly spots look like the constellation "Cassiopeia" • Was almost run over by jet skis!
 	"Nova" Manta # 93	• First seen in 2020, but we saw her 8 times in less than 1 month in 2021! • Very friendly female individual who is always curious about researchers in the water • Has a short right pectoral fin and many other scars
 	"Valentina" Manta # 108	• Seen 6 times just in 2021! • Named after the heart-shaped spot on her belly • Has a truncated (short) right pectoral fin



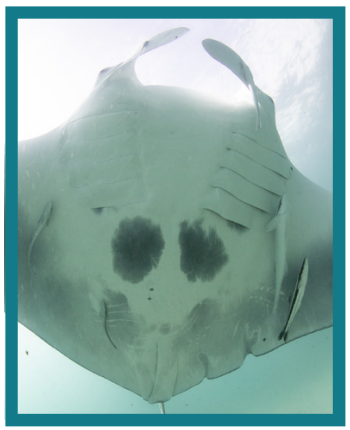













Tip: Be sure to print matching game pages 1 and 2 landscape and flip on short edge

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Grant Provided by:

Disney Conservation Fund

We value your feedback!
Please fill out this Teacher Evaluation form at shorturl.at/aeQW8
As a Thank You, your class will receive a
Manta Ray Adoption Certificate!

We'd love to see your lessons in action!
Please send an email to florida@marinemegafauna.org and tag us on social media.

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Additional Resources:

https://marinemegafauna.org/americas/florida-manta-project

https://www.nps.gov/teachers/classrooms/dichotomou-key.htm#:~:text=A%20dichotomous%20key%20is%20an,users%20to%20the%20correct%20identification