



Lesson Time

75 minutes

Essential Question

What is the importance of science research as it relates to real world scenarios?

Materials

Copy of map worksheet
Copy of provided data set

Objectives - Students Will

Learn to plot data points and develop data driven arguments.

Florida State Standards

Science Standard SC.8.N.1.3:

Use phrases such as "results support" or "fail to support" in science, understanding that science does not offer conclusive 'proof' of a knowledge claim.

Science Standard SC.8.N.1.6:

Understand that scientific investigations involve the collection of relevant empirical evidence, the use of logical reasoning, and the application of imagination in devising hypotheses, predictions, explanations and models to make sense of the collected evidence.

Teacher Background Information

Use this information to help prepare for the lesson.

Jessica Pate, founder and lead scientist of the Florida Manta Project, has been collecting field data on Florida's manta rays since 2016. Prior to this project's inception, very little was known about how manta rays use the warm coastal waters off Florida. Even more shocking, was that very few people even know that manta rays regularly visited these waters! The data collected from Jessica's research indicate that manta rays are not only present in this region but reoccur year after year.

Since 2016, Jessica and her team have observed 132 individual manta rays, and collected more than 440 data points. For each manta ray that is observed the following data points are collected: sex, approximate size, GPS location, any notable markings, such as scars or entanglement in fishing gear, and notable behaviors, such as feeding, mating, or socializing. This research allows scientists to better understand the biology of manta rays and provide data driven logic when it comes to best management decisions and practices.

Click [here](#) to see a short 8 minute video of how Jessica and her team collect this data!





Vocabulary

Anthropogenic: changes to nature and the environment from human activity

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

Inlet: a passageway for boats to the ocean

Marine Protected Area (MPA): a part of ocean that limits or restricts human interactions to conserve the natural ecosystem

Nursery ground: a habitat that enhances the growth (food) and survival (lack of predators) of juveniles

How do Humans Impact Manta Rays?

Approximately 30% of manta ray's that have been documented in Florida's waters exhibited scars from boat strikes and/or were seen entangled in fishing gear. These **anthropogenic** impacts are a few examples of how human-generated actions can harm these animals. In order to understand and help offset the negative effects humans have on manta rays, scientists must recognize and understand which areas are of highest priority for conservation.

Humans can also positively contribute to the success and longevity of our local manta population by making laws and creating **marine protected areas (MPA)**. For example, in 2018 manta rays were listed as "threatened" under the United States Endangered Species Act. Threatened status is defined as a species which is likely to become endangered in the foreseeable future. Listed species receive increased protection and research opportunities. Click [here](#) for a brief overview of MPAs in the United States.

How to be Scientist!

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:

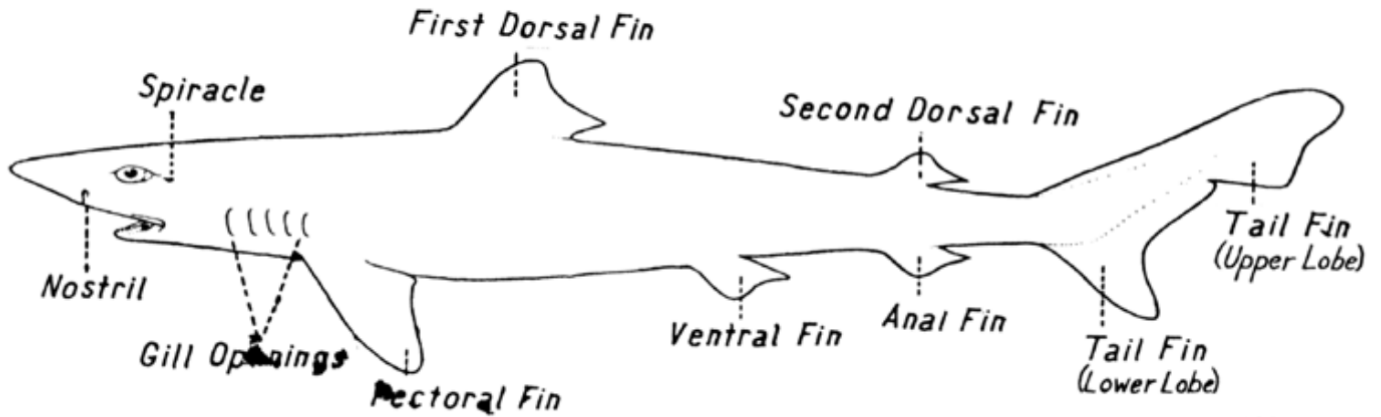
Florida@marinemegafauna.org

Teacher Preparation:

1. Make copies of the Mapping Mantas data set
2. Makes copies of the accompanying map/grid
3. Make copies of the "Questions for Thought"

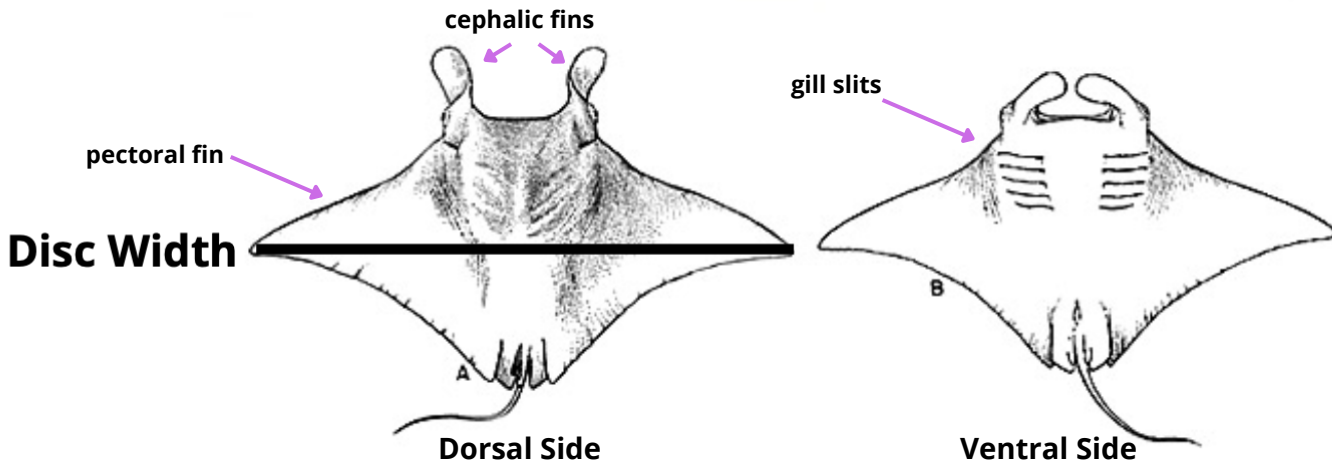
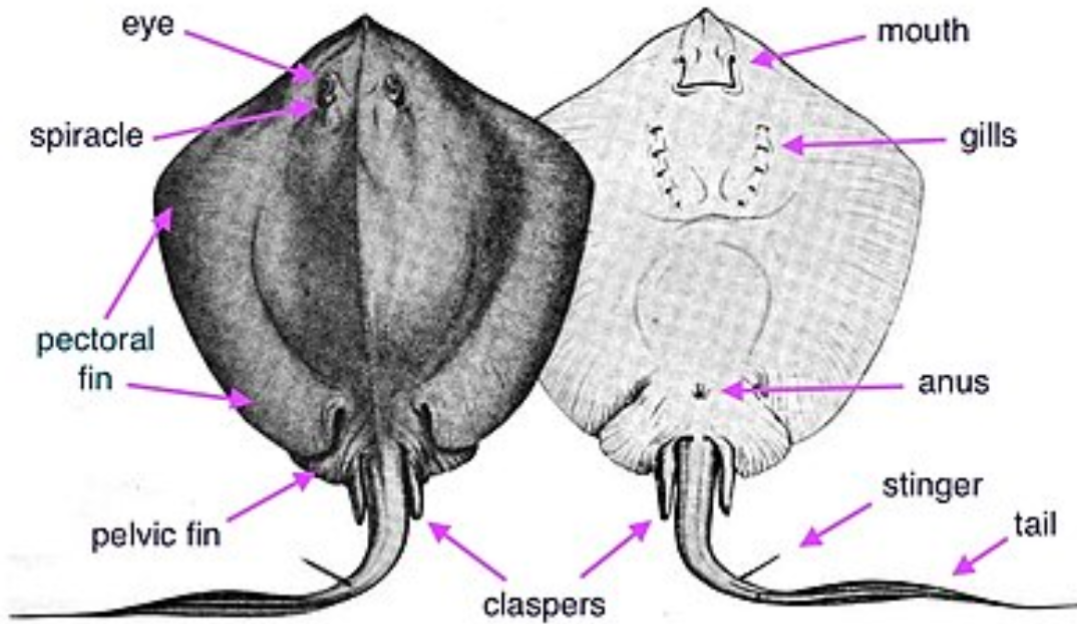


ILLUSTRATIONS OF ANATOMICAL TERMS



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/>

<https://www.floridamuseum.ufl.edu/discover-fish/species-profiles/manta-birostris/>



Procedures:

Pre-Lesson: Assess prior knowledge about Manta Rays and Marine Protected Areas.

Show Introductory Video(s) if needed.

<https://www.youtube.com/watch?v=tC06jYwpmDE> **and** <https://www.youtube.com/watch?v=2gB3zoFxCdS>

Step 1: Engage

Ask: In which part of the world do you expect to see manta rays? Did you know that there are manta rays here in South Florida? How do you think humans are impacting the manta rays we have here? Why do you think it is important that we protect manta rays?

Explain: Most people only expect to find manta rays in places like Hawaii. However, manta rays have been recorded in Florida's water since the early 1900's. Despite early hunters going out to harpoon manta rays, there was very little research regarding the manta rays that occur here. This lapse in knowledge, has led to a general oversight of the negative impacts humans have on our manta ray population. As a result many of the mantas observed here are entangled in fishing gear or have scars or damaged fins from boat propellers. Protecting manta rays is an important part of having healthy oceans.

Step 2: Explore

Partner or Small Group Work

Print out copies of the Mapping Mantas data set, the accompanying grid/map, and "Questions for Thought" worksheet.

Directions: Students will work with a partner or in small groups to plot the data set on the map/grid. Once they have plotted their data set, students will review the "Questions for Thought" and prepare to present their findings to the class.

Step 3: Explain

Partner or Small Group Work

Directions: Now that students are able to visualize their data they will assess which areas on the map should be considered for a Marine Protect Area (MPA). Students will present their arguments to the class and must provide data-drive arguments as to why they chose that specific area.

Note: Each group of students may have a different interpretation of the data set provided.

Step 4: Elaborate

Partner or Small Group Work

Students are encouraged to present both qualitative and quantitative based arguments (i.e. $X\%$ of juveniles utilized X region, or $X\%$ of adult females utilized X region). Graphs may also be helpful for students to present their findings.

Step 5: Evaluate

Students can engage in a class debate and discuss some of the obstacles they might face when designating certain areas as an MPA. Students can also address ways to increase awareness about manta rays in our oceans.



Name and ID #	Data Point	Gender	Disc Width/ Relative Age	Additional Information
"Rocco" Manta #2	C10	Male	5ft Juvenile	<ul style="list-style-type: none">Scar from boat propellor injury on dorsal, missing his tail
"Stevie Nicks" Manta #6	C5	Female	6ft Juvenile	<ul style="list-style-type: none">Was once found with 3 fishing hooks including fishing weights and linesMissing tail, embedded hook in ventral right pectoral fin, and abrasions on right dorsal fin
"Ginger" Manta # 21	C8	Female	8ft Juvenile	<ul style="list-style-type: none">Fishing lure was attached below lower jawScars on upper back likely from boat propellor
"Gillie" Manta #27	D5	Male	12ft Adult	<ul style="list-style-type: none">Multiple fishing line and boat injuries
"Hermoine" Manta #35	B7	Female	11ft Juvenile	<ul style="list-style-type: none">Scar in right shoulder from fishing lineVery relaxed around humans
"Cleo" Manta #41	C9	Female	11ft Juvenile	<ul style="list-style-type: none">"Slice marks" scars on ventral side, propellor scars on dorsal and fishing line scars on pectoral finTagged with a satellite tag by MMF researchersObserved near mangrove fringe
"Hugo" Manta #59	C7	Male	10ft Juvenile	<ul style="list-style-type: none">Observed with fishing hooks and lines which have been removed by MMF researchers
"Skye" Manta #64	F7	Male	8ft Juvenile	<ul style="list-style-type: none">Scar from boat propellor injury on dorsalScars on pectoral fin likely from fishing lineTagged with satellite tag by MMF researchers



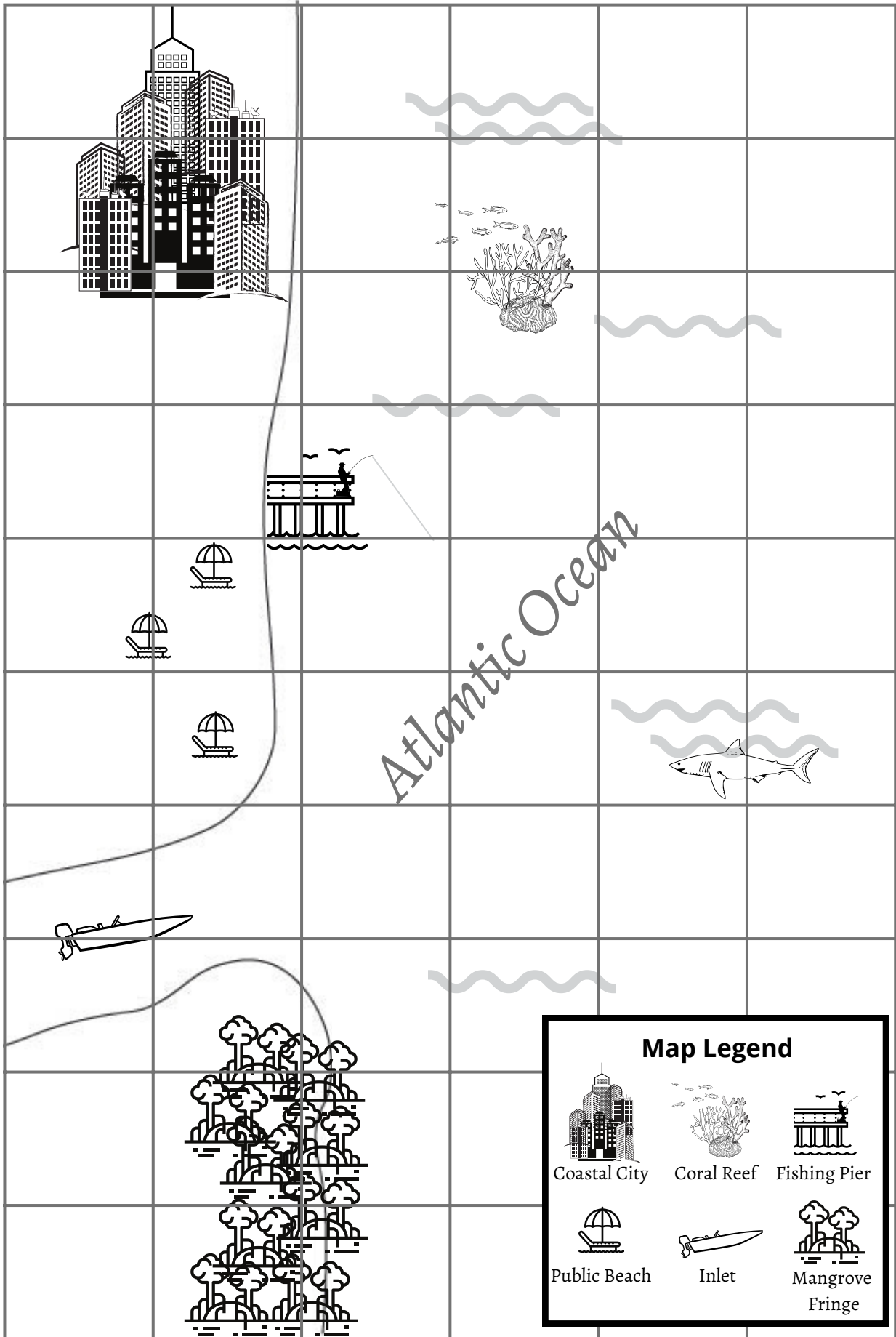
Name and ID #	Data Point	Gender	Disc Width/ Relative Age	Additional Information
"Crawford" Manta #86	D3	Male	9ft Juvenile	<ul style="list-style-type: none">Had fishing line wrapped tightly around pectoral fin and 2 hooks in right side of body
"Nemo" Manta #88	C9	Male	9ft Juvenile	<ul style="list-style-type: none">Missing right cephalic fin most likely from getting entangled in fishing line
"Cassiopeia" Manta #92	C5	Male	7.5ft Juvenile	<ul style="list-style-type: none">Fishing lure with fishing line in right shoulder
"Nova" Manta #93	E2	Female	9.5ft Juvenile	<ul style="list-style-type: none">Shortened right pectoral fin and notches in left pectoral fin likely from fishing line
"Scarface" Manta #96	F6	Male	8.5ft Juvenile	<ul style="list-style-type: none">Scars on right side of face from boat injury
"Cienna" Manta #100	E4	Female	7.5ft Juvenile	<ul style="list-style-type: none">Scars on left side of dorsumTagged with satellite tag and collected genetic sample by MMF researchers
"Valentina" Manta #108	C7	Female	9ft Juvenile	<ul style="list-style-type: none">Shortened right pectoral finObserved feeding near inlet
"Pongo" Manta #114	C6	Male	8ft Juvenile	<ul style="list-style-type: none">Observed feeding near public beach
"Steve" Manta #116	D2	Male	7.5ft Juvenile	<ul style="list-style-type: none">Was found with a remora fish wrapped inside its cephalic fin




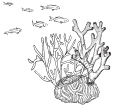




Name and ID #	Data Point	Gender	Disc Width/ Relative Age	Additional Information
"Jacob" Manta #123	F2	Male	7.5ft Juvenile	<ul style="list-style-type: none">• Scars on right shoulder from fishing lure• Fishing lure in right gill slits and pectoral fin
"Bonnie" Manta #131	E6	Female	13ft Adult	<ul style="list-style-type: none">• Observed demonstrating courtship/mating behavior with "Clyde" Manta #132
"Clyde" Manta #132	E6	Male	12ft Adult	<ul style="list-style-type: none">• Observed demonstrating courtship/mating behavior with "Bonnie" Manta #131
"George" Manta #CLF7	C1	Male	12ft Adult	<ul style="list-style-type: none">• Feeding at the surface• Missing left cephalic fin
"Sue" Manta #CLF5	C3	Female	13ft Adult	<ul style="list-style-type: none">• Feeding at the surface• Observed 2 days in a row in March 2022
"El Dora" Manta #CFL9	D3	Female	15ft Adult	<ul style="list-style-type: none">• Feeding at the surface• Very curious about divers in the water

A B C D E F

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Map Legend

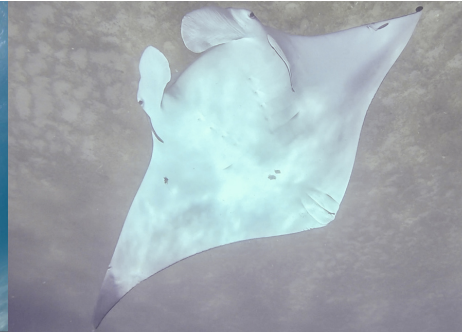
		
Coastal City	Coral Reef	Fishing Pier
		
Public Beach	Inlet	Mangrove Fringe



Meet the Mantas



"Rocco"
Manta #2



"Stevie Nicks"
Manta #6



"Ginger"
Manta #21



"Gillie"
Manta #27



"Hermoine"
Manta #35



"Cleo"
Manta #41



"Hugo"
Manta #59



"Skye"
Manta #64



"Crawford"
Manta #86



Meet the Mantas



"Nemo"
Manta #88



"Cassiopeia"
Manta #92



"Nova"
Manta #93



"Scarface"
Manta #96



"Cienna"
Manta #100



"Valentina"
Manta #108



"Pongo"
Manta #114



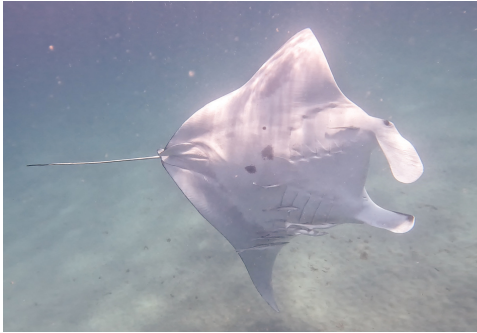
"Steve"
Manta #116



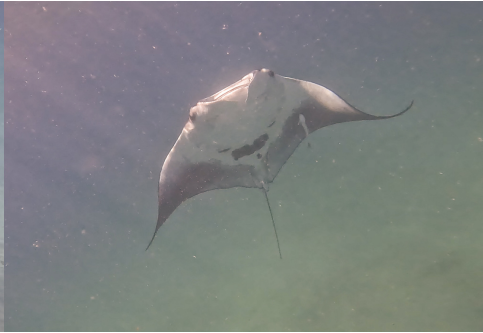
"Jacob"
Manta #123



Meet the Mantas



"Bonnie"
Manta #131



"Clyde"
Manta #132



"Sue"
Manta #CFL5



"George"
Manta #CFL7



"El Dora"
Manta #CFL9



Mapping Mantas

Questions for Thought

Class Presentation Guidelines:

Now that you have plotted the manta ray sightings on the map, you will present your findings to the class. Develop a data driven argument for areas of high priority for conservation. Arguments may vary across classmates as each student may have their own interpretation of the provided data set. Be sure to address the following questions in preparation for your presentation:

1. What information helped you decided which areas need the most protection?

- Areas with the most sightings of manta rays?
- Areas with the most juveniles?
- Areas with the most adults?
- Areas used for feeding?
- Areas used to avoid predation?
- Areas used for mating?

2. Which anthropogenic impacts influenced your decision?

- Boat strikes in and around inlets.
- Entanglement in fishing gear from the pier.
- Pollution and runoff from the city.
- Pollution and human contact in the shallow waters off the public beach.

3. What will make a successful Marine Protected Area?

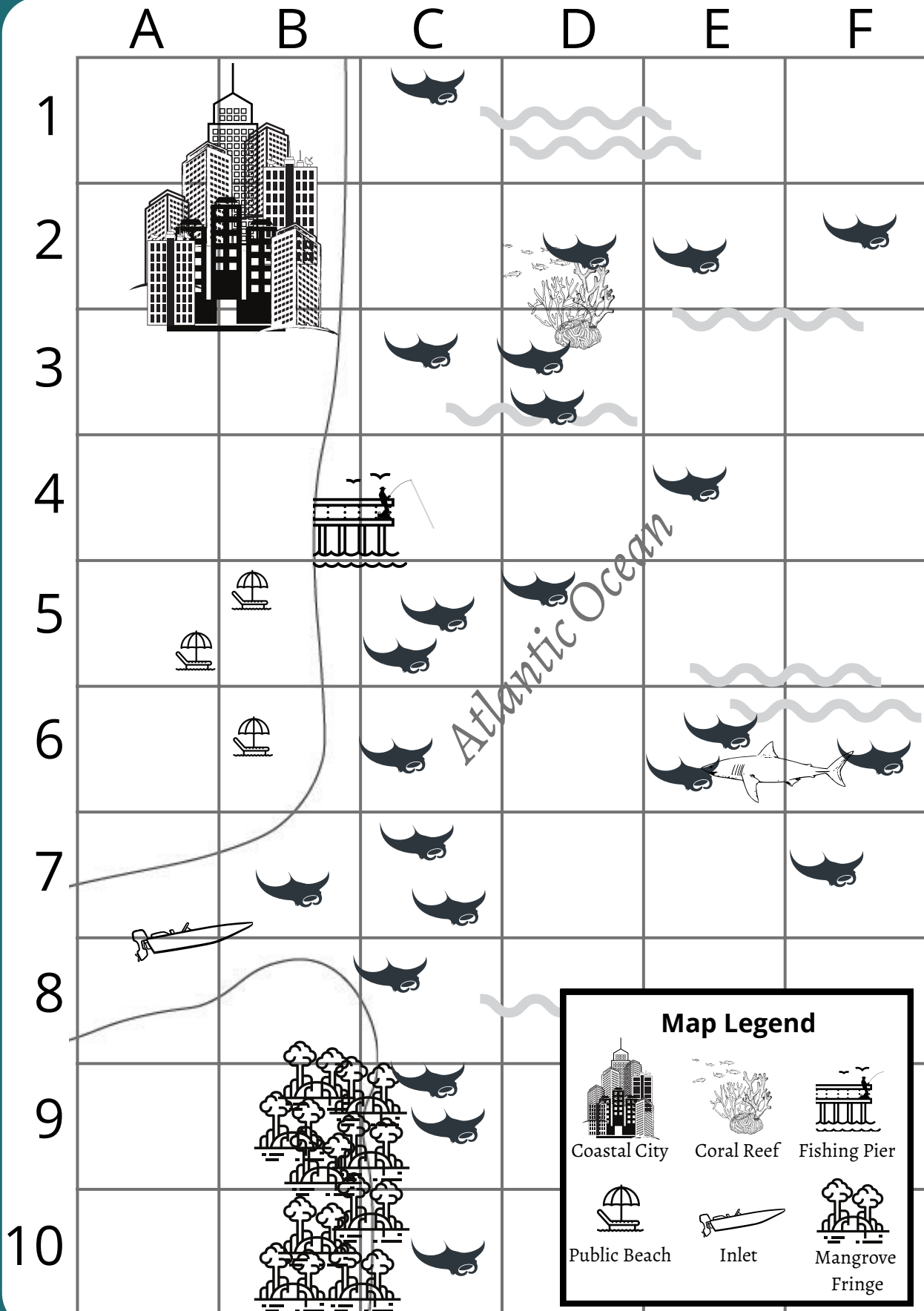
- Based on your research of other marine protected areas, what is an appropriate size and location for your MPA?
- How will both local community members and manta rays benefit from your MPA?
- Can you cite other "success stories" where MPA's have helped in the conservation of a species?

4. How can you, as an individual, help to protect manta rays?

- Community education and involvement?
- At home education?
- Self-improvement?



Teacher Answer Sheet



Map Legend

Coastal City	Coral Reef	Fishing Pier
Public Beach	Inlet	Mangrove Fringe



Mapping Mantas - Questions for Thought

Teacher Reference Guide

Note to teachers: Each "Question for Thought" will have multiple right answers. Students may have different interpretations of the same data and may present a variety of arguments as to which area is of highest priority.

1. What information helped you decide which areas need the most protection?

- Areas with the most sightings of manta rays?

Areas with a lot of manta rays may be the most common argument presented by your students. Such areas may also provide a specific natural resource that is beneficial for not only manta rays but the entire ecosystem. Examples of such natural resources include coral reefs, seagrass beds, mangrove shorelines, oyster beds, etc.

- Areas with the most juveniles?

Protecting the juvenile population can be a critical step in preserving a species. Younger manta rays will ultimately grow into adulthood and eventually reproduce.

- Areas with the most adults?

Adult manta rays have already reached reproductive maturity and only birth one baby every 2 to 5 years. Areas with high concentrations of adults will increase the odds that a manta will find a mate. Students may also suggest that some of the observed adult females may be pregnant resulting in a higher priority for protection.

- Areas used for feeding?

Manta rays are filter feeders meaning they push ocean water over specialized structures in their gills allowing them to filter out and eat plankton in the water column. Because they cannot be selective about what they filter, mantas are especially susceptible to consuming microscopic pieces of plastic and trash.

- Areas used to avoid predation?

Juvenile manta rays use shallow water for protection. Although born quite large with ~5ft disc with manta rays may use the mangrove fringe, coral reefs, and sea grass beds for protection.

- Areas used for mating?

Some marine animals travel to specific places to mate. Although they may only use these areas seasonally and only a few sightings occur in these areas, students may argue that the survival of manta rays depends on these areas.



Mapping Mantas - Questions for Thought

Teacher Reference Guide

2. Which anthropogenic impacts influenced your decision?

- Boat strikes in and around inlets.

Many of the manta rays observed in South Florida have propeller scars from moving boats. Although there may only be a few manta rays observed within and around inlets, areas with a high concentration of boat traffic may be selected for conservation.

- Entanglement in fishing gear from the pier.

Similar to the previous argument, many of the manta rays observed in South Florida have fishing lures in their gills and pectoral fins, and/or are entangled in fishing line. Drone footage has captured manta rays swimming near fishing piers, where mantas may swim into fishing lines left out to catch other fish.

- Pollution and runoff from the city.

Many of the major cities in South Florida are located right on the coast. Stormwater runoff and city pollution are major factors when it comes to the health of the ocean and all things living in it. Our coastal cities also tend to produce a lot of waste which ends up in the ocean if not disposed of properly.

- Pollution and human contact in the shallow waters off the public beach.

South Florida's beaches get thousands of visitors per day. Residents and visitors alike take advantage of our beautiful beaches but may fail to realize that the shorelines must be shared with marine life including manta rays. Frequent encounters with marine species including manta rays may alter their natural behavior. Furthermore, many beach goers accidentally leave behind trash which makes its way into the ocean.





Mapping Mantas - Questions for Thought

Teacher Reference Guide

3. What will make a successful Marine Protected Area?

- Based on your research of other marine protected areas, what is an appropriate size and location for your MPA?

There is no one right answer for this question. Students must research existing MPAs and use that information to designate an area on the map. The MPA should be within reason and use data driven arguments to justify their decision. There are very many MPAs nationally and globally that students can reference.

- How will both local community members and manta rays benefit from your MPA?

Healthy oceans are vital for our planet's success. Protecting the ocean and the plants and animals that live in directly benefits us. Healthy oceans support commercial and recreational fishing, increase tourism through diving and snorkeling, etc. Manta rays will benefit because MPAs will minimize anthropogenic impacts.

- Can you cite other "success stories" where MPA's have helped in the conservation of a species?

There are many examples of this. A great resource can be found here: <https://californiampas.org/about-mpas/success-stories>

4. How can you, as an individual, help to protect manta rays?

- Community education and involvement?

Many South Florida residents and visitors do not know that manta rays frequent our waters. There are many answers to this including: increasing awareness through signage along public beaches and fishing piers, providing contacts on who to call if a manta ray is entangled, citizen science initiatives to help people spot and identify manta rays, free workshops on how to distinguish between manta rays and other common ray species, increasing the number of fishing gear disposal boxes near and around popular fishing spots, community beach clean ups, etc.

- At home education?

Students can take home what they have learned in the classroom and educate parents and other family members. Students may teach manta basics and educate family members who are fisherman or boaters.

- Self-improvement?

Students may choose to decrease or eliminate plastic waste in their everyday lives. Students may choose to pursue a career in marine science and study manta rays in the future. Students may volunteer with a local non-profit helping to protect the marine environment.





MARINE MEGAFUNA FOUNDATION

SCIENTIST SERIES FOR STUDENTS GRADE 8

Lesson 1 Mapping Mantas

Author:

Stacy Assael, M.Sc

Scientific Advisory:

Jessica Pate, M.Sc
MMF Florida Project Manager

Grant Provided by:




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 actions!

Please send an email to
florida@marinemegafauna.org
and tag us on social media.

 @MarineMegafauna

 @marinemegafauna

 Marine Megafauna Foundation

Additional Resources

<https://californiampas.org/about-mpas/success-stories>

[https://flowergarden.noaa.gov/science/mantaresearch.h
tml](https://flowergarden.noaa.gov/science/mantaresearch.html)

[https://oceantoday.noaa.gov/marineprotectedareas/wel
come.html](https://oceantoday.noaa.gov/marineprotectedareas/welcome.html)



Lesson 2 Manta Rays & My Community

Lesson Time

30 minutes

Essential Question

How can individual action promote positive change in their community?

Materials

Student presentation information from **Lesson 1** Mapping Mantas
Copy of "How to Write a Letter for Change"
Copy of Letter Template

Objectives - Students Will

Use critical thinking to develop creative solutions to help protect manta rays

Florida State Standards

Science Standard SC.8.N.4.1

Explain that science is one of the processes that can be used to inform decision making at the community, state, national, and international levels.

Teacher Background Information

Use this information to help prepare for the lesson.

Manta rays are prone to impacts from humans and are frequently observed with injuries from boat strikes, entangled in fishing gear including monofilament and lures, and feeding in areas with high concentrations of microplastics. These impacts are especially common in Florida as majority of the residents and visitors are located within close proximity to the coastline and associated waterways. This is further compounded with the fact that much of Florida's recreational and tourism activities take place on or near the ocean. However, the majority of people do not associate Florida with manta rays and are surprised to learn that mantas frequent our waters! Mending this disconnect and raising awareness is a key component in helping to protect this species.

To best protect threatened species, it is crucial to include scientific evidence in conservation initiatives. Now that students are "in the know" about manta rays in Florida they can use their newly acquired knowledge and promote positive change to help protect this species. Impactful change can happen on a small local scale in ways such as reaching out to restaurants to limit or eliminate wasteful plastic products or a larger national scale by encouraging public officials to pass laws that limit fishing gear or enact seasonal closures.

Teacher Preparation:

1. Review **Lesson 1** Mapping Manta Rays and key take aways
2. Make copies of "How to Write a Letter for Change"
3. Make copies of the "Manta Rays & My Community" Letter Template





How to Write a Letter for Change

Use the information you learned from **Lesson 1** Mapping Manta Rays to write a Letter for Change. A Letter for Change is one step that you can take to promote positive action within your country, state, or community. These letters can be useful tools in letting our leaders know about topics that are important to you, such as Florida's manta rays, and the changes you would like to see in the future. Your letter should be about ways to help manta rays and include the following information:

Step 1: Decide who you are writing to.

Be sure to properly address recipient of your letter, and include the correct mailing address in the top left corner of your letter.

Step 2: Clearly state who you are, and your reason for writing this letter.

Do not forget to include your return address on the top left corner of the page. It is also important to clearly state your name in the beginning of the letter. Including your school name lets the recipient know that you are a student.

Step 3: Make sure the person you are writing to can help with the change that you would like to see.

Different agencies and organizations make/modify the rules and regulations of specific areas. For example, you may want to write to a State Park Ranger to change the regulations on a fishing pier. If you would like to see more boat regulations in the inlets, you can write to your Mayor or Coast Guard. You can even write a letter to an ocean front dining establishment asking them to limit their plastic products.

Step 4: Use data driven evidence to explain why your chosen topic is important.

It is important to include facts in your letter. You are encouraged to provide a brief background on your topic, and include data or statistics to help support your argument. For example, "Approximately 30% of manta ray's documented in Florida's waters exhibited scars from boat strikes and/or were seen entangled in fishing gear."

Step 5: Provide realistic solutions and explain how they will be helpful.

Including some possible solutions lets your recipient know that you have put thought and effort into your letter. Make sure that the solutions you suggest are realistic and explain how they can be beneficial once they are achieved. Some of your solutions may take years to accomplish but it is important to recognize that even a small step in the right direction can yield long term results.



**MARINE
MEGAFUNA
FOUNDATION**

To:

From:

(Date)

Dear _____,

My name is _____ **and I am a student at** _____

_____. **I am writing to you because** _____

Did you know that _____

This is important to me and my community because _____

Some actions that you can take to help are _____

These actions will be beneficial because _____

Thank you for helping us work towards a better future. I look forward seeing these changes in action.

Sincerely,

(Your Name)

(Residing County)





Letter for Change Example

This letter was written by Jessica Pate to the Federal Government to encourage the protection of Florida's waters.



September 4th, 2018

Dr. Walter Cruickshank
Director, Bureau of Ocean Energy Management
U.S. Department of the Interior
1849 C Street, N.W. Washington, DC 20240

Ryan Zinke
Secretary of the Interior
U.S. Department of the Interior
1849 C Street, N.W. Washington, DC 20240

The Marine Megafauna Foundation (MMF) writes to voice our opposition to seismic airgun testing and urges you to halt the proposed testing in the Atlantic Ocean.

MMF uses research, conservation and education to ensure healthy oceans for present and future generations. Our organization consists of leading experts on our two focal species, whale sharks and manta rays. Our research has revealed that southern Florida is a critical developmental habitat for manta rays. Migratory paths for these rays could include seismic testing areas. Manta rays were recently listed on the Endangered Species Act due to the severity of their global threats, and this important population could be negatively affected by the proposed seismic testing.

Seismic testing produces intense blasts of compressed air that can be heard for hundreds of miles in the ocean. These blasts have been shown to reduce catch rates of commercially important fish, alter fishes' use of habitat, and elicit escape response in sea turtles. Marine mammals are of particular concern, as whales and dolphins rely on sound for communication, mating, feeding, and reproduction. The North Atlantic Right Whale, one of the most endangered whales on the planet, has been under severe pressures from fishing line entanglement and underwater noise impacts. Adding the additional stress of seismic testing in their habitat could jeopardize the survival of the entire species.

To ensure a healthy oceans for our future, we ask that you halt the permits for seismic testing for oil and gas in the Atlantic Ocean.

Sincerely,

Marine Megafauna Foundation



MARINE MEGAFUNA FOUNDATION

SCIENTIST SERIES FOR STUDENTS GRADE 8

Lesson 2 Manta Rays & My Community

Author:

Stacy Assael, M.Sc

Scientific Advisory:

Jessica Pate, M.Sc
MMF Florida Project Manager

Grant Provided by:




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 actions!

Please send an email to
florida@marinemegafauna.org
and tag us on social media.

 @MarineMegafauna

 @marinemegafauna

 Marine Megafauna Foundation

Additional Resources

<https://www.fisheries.noaa.gov/species/giant-manta-ray>

<https://www.scubadiving.com/successful-marine-protected-areas-mpas-analysis>