MARINE MEGAFAUNA FOUNDATION

SCIENTIST SERIES FOR STUDENTS
GRADE 7
Lesson 1 Mapping Microplastics

Lesson Time
45 minutes

Essential Question
What are microplastics and where do they accumulate in our oceans?

Materials
Colored copy of the Choropleth Map Activity Instructions sheet
Copy of the Mapping Microplastics worksheet(s)
Crayons or colored pencils

Objectives - Students Will
Plot and visualize data using a choropleth map

Florida State Standards
Science Standard SC.7.N.1.3
Distinguish between an experiment (which must involve the identification and control of variables) and other forms of scientific investigation and explain that not all scientific knowledge is derived from experimentation.

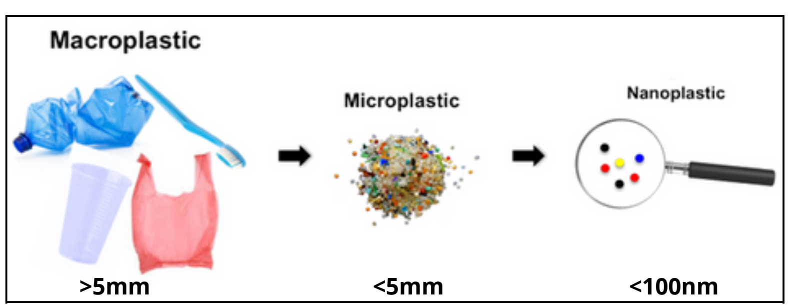
Social Studies Standard
SS.7.G.5.1 Use a choropleth or other map to geographically represent current information about issues of conservation or ecology in the local community.

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

The invention of plastic has changed the course of humanity. Its lightweight and portable properties have led to its use in nearly every product we see today. Although we have greatly benefited from the convenience and ease of plastic items, their longterm impact on the environment is catastrophic. Once a plastic item is created it will NEVER go away and every plastic product that was ever produced is still in existence today.

Each year about 8 million tons of plastic end up in our oceans, most of which originated on land. Some of the primary sources of marine debris include storm-water runoff from coastal cities, litter from beaches and parks, illegal dumping, or overflow from sewers. There are also ocean based sources of marine debris such as industrial fishing, open-water fish farming (a form of aquaculture), and other recreational marine activities.

Much of this trash and pollution in our oceans often does not reflect its original form. While many **macroplastics** such as plastic bags, plastic water bottles, straws, plastic packaging, etc. may appear to disintegrate entirely, they are only being broken down into smaller and smaller microscopic pieces. As macroplastics decrease in size, they become more easily transported and distributed by wind and ocean current. These smaller pieces are known as **microplastics**, and the even smaller pieces are referred to as **nanoplastics**.



https://www.envmedia.org/article/plastic-foods/

MARINE MEGAFAUNA FOUNDATION

SCIENTIST SERIES FOR STUDENTS GRADE 7

Lesson 1 Mapping Microplastics

Vocabulary

Anthropogenic: changes to nature and the environment from human activity

Choropleth Map: a map that uses shades of colors to visualize data and share information

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

Gyre: rotating current of water

Krill: small, shrimp-like crustacean

Macroplastic: plastic items larger than 5mm

Microplastic: plastic items smaller than 5 mm

Nanoplastic: plastic items smaller than 100 mm

Parts per Million (ppm): how many parts of a molecule are in one million parts of the whole

Pelagic: occurring or living in the open ocean

Phytoplankton: microscopic plantlike organisms that live in sea water

Plankton: organisms that are unable to swim against a current

Water Column: a vertical section of water from the seafloor to the surface

Zooplankton: microscopic animals that live in sea water

What is a choropleth map?

A choropleth map is a scientific tool that uses shades of colors to help us visualize data. These maps allow both scientists and the general public to better understand and share information. For this activity, students will use an imaginary data set to depict the concentration and distribution of microplastics in the ocean. Darker colors represent areas with high concentrations of microplastics and lighter colors represent areas with low concentrations of microplastics.

One way to measure how much debris is in the ocean is by calculating its **parts per million (ppm).** The ppm of marine debris in the ocean can be calculated by measuring how many grams of **microplastics** are in 1,000,000 grams of water. As larger plastic items break down, more and more pieces of microplastic accumulates in the **water column**. Recent studies suggest that there are a million times more microplastics in our oceans than previously estimated. If the use of plastics and plastic byproducts is not limited, we can only expect to see that number to increase over time. Students will learn more about how microplastics impact manta rays in ***Lesson 2*** Manta Rays & Microplastics.

Teacher Preparation:

1. Make colored copies of the Choropleth Map Activity Instructions sheet
2. Make copies of the "Mapping Microplastics" worksheet(s)*
3. Provide students with colored pencils, crayons or markers.

*Teachers may opt to print choropleth maps (a) and (b) for larger classes

Procedures:

Pre-Lesson: Assess prior knowledge about microplastics. Show Introductory Video if needed.
https://www.youtube.com/watch?v=_6xlNyWPpB8

Step 1: Engage
Ask: What are examples of things we use everyday that are made up of plastic? What happens to those items when we are finished with them? What is the impact of plastics on the environment?

Explain: Majority of the items we use everyday are either made up of plastic or come packaged in plastic. Although many people purchase these items with good intentions and follow the proper means of disposal, a large percentage of plastic waste still ends up in our oceans. Overtime, these items slowly breakdown into smaller and smaller pieces and many of the animals in the ocean end up either entangled or consuming the micro and nanoplastic byproducts.

Step 2: Explore
Independent or Partner Work
Print out copies of the "Choropleth Map Activity Instructions" sheet and the "Mapping Microplastics" worksheet.

Directions: Students will work individually or with a partner to color their choropleth map using the legend provided. Colors may vary depending on available supplies, but the darkest color or darkest shade of a color should be used to represent the highest concentration. Students should understand that the distribution of marine debris on the "Mapping Microplastics" worksheet illustrates a theoretical data set of water samples taken in the field. Students will also use this data to understand the difference between an experiment and other forms of scientific investigation. In working through this activity, students should recognize that they are acting as scientists, despite the fact there is not an experiment or variables.

Step 3: Explain
Independent or Partner Work
Directions: Now that students can visualize this data they should be able to consider why some parts of the ocean may have higher concentrations of marine debris compared to others. Students may research the 5 major gyre systems (North Atlantic, South Atlantic, North Pacific, South. Pacific, and Indian Ocean) to understand this relationship.

Step 4: Elaborate
Independent or Partner Work
Students will understand that microplastics originate both on land and at sea from both large scale and individual actions. While the intention is not to harm marine life, many of the animals in the ocean are negatively impacted from marine debris. Students may suggest possible solutions to clean-up and/or eliminate marine debris in our oceans.

Step 5: Evaluate
Students may reflect on ways they can decrease or eliminate plastic consumption in their lives and community. It is important to note that students should focus on progress and not perfection in order to make realistic goals.

Choropleth Map Activity Instructions

Scientists measure the concentration of microplastics in the ocean by collecting water samples at specific locations. To ensure an accurate comparison across each sample site, scientists must collect a predetermined volume of water at a predetermined depth. The following "Mapping Microplastics" worksheet represents a theoretical data set collected by a scientist at sea. Each cell represents a sample site in the Atlantic Ocean, and the number within each cell is the concentration of microplastics measured within that water sample. Students will use scientific investigation to understand how microplastics are distributed in our oceans and consider possible explanations for their distribution.

Now it's time to create a choropleth map! For this activity, the darkest color will represent the highest concentration of microplastics, and the lightest color will represent the lowest concentration of microplastics. See the below example and use the blank legend on the following page to create your own.

Choropleth Map Legend

10,000 to 8,001 ppm

8,000 to 6,001 ppm

6,000 to 4,001 ppm

4,000 to 2,001 ppm

2,000 to 0 ppm

Note that students do not have to match the exact colors displayed in the legend. The color(s) used are not important and may vary depending on available supplies. Students may use different shades of the same color, or different shades of the same color family.

Mapping Microplastics

Name________________________________ Date________________

Choropleth Map

Select 5 different colors, or 5 shades of the same color for your choropleth map legend. Using the colors you selected, fill in the squares on the Mapping Microplastics worksheet with the appropriate color for its corresponding value.

Choropleth Map Legend

	10,000 to 8,001 ppm
	8,000 to 6,001 ppm
	6,000 to 4,001 ppm
	4,000 to 2,001 ppm
	2,000 to 0 ppm

Mapping Microplastics (a)

Name________________________________ Date________________

	A	B	C	D	E	F	G	H	I	J	K	L
1	76 ppm	134 ppm	361 ppm	473 ppm	222 ppm	428 ppm	344 ppm	389 ppm	563 ppm	382 ppm	529 ppm	287 ppm
2	155 ppm	265 ppm	900 ppm	1500 ppm	831 ppm	1,301 ppm	759 ppm	644 ppm	920 ppm	1,029 ppm	623 ppm	461 ppm
3	2,001 ppm	2,352 ppm	2,267 ppm	2,519 ppm	2,264 ppm	2,001 ppm	2,691 ppm	2,087 ppm	3,083 ppm	2,519 ppm	2,012 ppm	2,142 ppm
4	3,835 ppm	3,030 ppm	4,000 ppm	3,976 ppm	3,783 ppm	3,629 ppm	3,133 ppm	2,973 ppm	3,204 ppm	3,086 ppm	3,208 ppm	2,739 ppm
5	2,519 ppm	3,001 ppm	5,872 ppm	5,143 ppm	4,015 ppm	5,973 ppm	5,038 ppm	4,459 ppm	5,294 ppm	4,932 ppm	5,204 ppm	3,473 ppm
6	2,723 ppm	3,402 ppm	5,609 ppm	7,933 ppm	7,023 ppm	7,933 ppm	6,001 ppm	6,639 ppm	7,845 ppm	7,004 ppm	4,001 ppm	3,898 ppm
7	2,529 ppm	2,197 ppm	5,083 ppm	7,520 ppm	6,034 ppm	8,500 ppm	9,328 ppm	8,001 ppm	10,000 ppm	7,933 ppm	5,753 ppm	3,052 ppm
8	3,063 ppm	2,086 ppm	4,935 ppm	7,284 ppm	6,947 ppm	9,011 ppm	10,000 ppm	9,201 ppm	8,012 ppm	7,457 ppm	5,839 ppm	3,597 ppm
9	2,382 ppm	2,056 ppm	5,999 ppm	8,000 ppm	7,026 ppm	9,550 ppm	8,739 ppm	10,000 ppm	8,001 ppm	6,464 ppm	6,000 ppm	3,999 ppm
10	2,819 ppm	2,345 ppm	5,073 ppm	7,457 ppm	6,028 ppm	8,302 ppm	8,080 ppm	8,761 ppm	9,283 ppm	7,653 ppm	5,999 ppm	3,752 ppm
11	3,164 ppm	4,000 ppm	5,430 ppm	6,937 ppm	7,027 ppm	7,838 ppm	6,764 ppm	7,845 ppm	6,853 ppm	6,835 ppm	5,968 ppm	3,515 ppm
12	3,538 ppm	3,999 ppm	4,987 ppm	7,520 ppm	6,528 ppm	8,000 ppm	7,934 ppm	6,542 ppm	7,103 ppm	7,963 ppm	6,000 ppm	3,904 ppm
13	3,811 ppm	4,000 ppm	6,000 ppm	4,729 ppm	4,927 ppm	5,973 ppm	4,999 ppm	4,869 ppm	5,672 ppm	5,587 ppm	5,996 ppm	4,000 ppm
14	3,100 ppm	2,619 ppm	3,958 ppm	2,089 ppm	2,369 ppm	3,165 ppm	3,765 ppm	3,197 ppm	2,520 ppm	3,826 ppm	2,863 ppm	3,098 ppm
15	2,000 ppm	1,573 ppm	1,693 ppm	1,399 ppm	979 ppm	1,054 ppm	2,000 ppm	1,539 ppm	886 ppm	913 ppm	1,209 ppm	991 ppm

Atlantic Ocean

Mapping Microplastics (b)

Name________________________________ Date________________

	A	B	C	D	E	F	G	H	I	J	K	L
1	5,076 ppm	5,134 ppm	5,361 ppm	4,473 ppm	4222 ppm	5,428 ppm	4,344 ppm	4,389 ppm	2,563 ppm	3,382 ppm	2,529 ppm	3,287 ppm
2	7,155 ppm	7,265 ppm	6,900 ppm	6,500 ppm	6,831 ppm	7,301 ppm	4,759 ppm	5,644 ppm	2,920 ppm	2,029 ppm	3.623 ppm	3,461 ppm
3	6,001 ppm	9,352 ppm	8,267 ppm	9,519 ppm	8,264 ppm	7,001 ppm	5,691 ppm	4,087 ppm	3,083 ppm	2,519 ppm	2,012 ppm	2,142 ppm
4	6,835 ppm	9,030 ppm	10,000 ppm	9,976 ppm	8,783 ppm	7,629 ppm	4,133 ppm	4,973 ppm	3,204 ppm	3,086 ppm	3,208 ppm	2,739 ppm
5	7,519 ppm	8,001 ppm	9,872 ppm	8,143 ppm	8,015 ppm	6,973 ppm	5,038 ppm	4,459 ppm	5,294 ppm	4,932 ppm	5,204 ppm	3,473 ppm
6	8,000 ppm	8,402 ppm	9,609 ppm	9,933 ppm	8,023 ppm	7,933 ppm	6,001 ppm	6,639 ppm	7,845 ppm	7,004 ppm	4,001 ppm	3,898 ppm
7	7,529 ppm	6,197 ppm	7,083 ppm	7,520 ppm	6,034 ppm	8,500 ppm	9,328 ppm	8,001 ppm	10,000 ppm	7,933 ppm	5,753 ppm	3,052 ppm
8	5,063 ppm	5,086 ppm	4,935 ppm	7,284 ppm	6,947 ppm	9,011 ppm	10,000 ppm	9,201 ppm	8,012 ppm	7,457 ppm	5,839 ppm	3,597 ppm
9	5,382 ppm	4,056 ppm	5,999 ppm	8,000 ppm	7,026 ppm	9,550 ppm	8,739 ppm	10,000 ppm	8,001 ppm	6,464 ppm	6,000 ppm	3,999 ppm
10	2,819 ppm	2,345 ppm	5,073 ppm	7,457 ppm	6,028 ppm	8,302 ppm	8,080 ppm	8,761 ppm	9,283 ppm	7,653 ppm	5,999 ppm	3,752 ppm
11	3,164 ppm	4,000 ppm	5,430 ppm	6,937 ppm	7,027 ppm	7,838 ppm	6,764 ppm	7,845 ppm	6,853 ppm	6,835 ppm	5,968 ppm	3,515 ppm
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14	3,100 ppm	2,619 ppm	3,958 ppm	2,089 ppm	2,369 ppm	3,165 ppm	3,765 ppm	3,197 ppm	2,520 ppm	3,826 ppm	2,863 ppm	3,098 ppm
15	2,000 ppm	1,573 ppm	1,693 ppm	1,399 ppm	979 ppm	1,054 ppm	2,000 ppm	1,539 ppm	886 ppm	913 ppm	1,209 ppm	991 ppm

Atlantic Ocean

Mapping Microplastics

Name____________________________________ Date___________________

Questions for Thought:

1. What are some common examples of marine debris?

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2. By what means does plastic pollution end up in our oceans?

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3. Why would you expect marine debris and microplastics to accumulate in some areas and not others? Explain.

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4. Which animals would you expect to be most impacted by marine debris? Explain.

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Mapping Microplastics
Teacher Answer Key

<u>Questions for Thought:</u>

1. What are some common examples of marine debris?

Some common examples of marine debris include any plastic products such as water bottles, straws, cutlery, toys, containers, etc. Other marine debris can include fishing nets, ropes, anchors, buckets, fishing hooks and lines

2. By what means does plastic pollution end up in our oceans?

Plastic pollution can easily end up in our oceans by way of wind and storm water runoff. Even cities that are not located near the ocean accidentally contribute to marine pollution through our rivers, which ultimately end up in the ocean. Many people do not litter on purpose and accidentally drop trash on the ground or forget to take all their belongings when they leave the beach.

3. Why would you expect marine debris and microplastics to accumulate in some areas and not others? Explain.

There are areas in the ocean where several currents come together forming a gyre. Each of these systems act almost like a giant washing machine, moving water in a circular motion. Trash from all over the world travels along their nearest current and occurs in high concentration in these areas. Other areas include places with a high density of people (more people=more trash), or places that lack modern technology to properly dispose or breakdown trash.

4. Which animals would you expect to be most impacted by marine debris? Explain.

This is an extensive list and can include almost any marine animal including fish, birds, and mammals. Some common examples are sea turtles that confuse plastic bags for jelly fish, their main food source, and die of starvation, sharks like the great white which must swim to breathe can get tangled in abandoned fishing gear, and marine birds that accidentally consume plastic as they hunt for fish.

Teacher Answer Key (a)

	A	B	C	D	E	F	G	H	I	J	K	L
1	76 ppm	134 ppm	361 ppm	473 ppm	222 ppm	428 ppm	344 ppm	389 ppm	563 ppm	382 ppm	529 ppm	287 ppm
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15	2,000 ppm	1,573 ppm	1,693 ppm	1,399 ppm	979 ppm	1,054 ppm	2,000 ppm	1,539 ppm	886 ppm	913 ppm	1,209 ppm	991 ppm

Atlantic Ocean

Teacher Answer Key (b)

	A	B	C	D	E	F	G	H	I	J	K	L
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Atlantic Ocean

Author:
Stacy Assael, M.Sc

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

@MarineMegafauna

@marinemegafauna

Marine Megafauna Foundation

Additional Resources

https://debrisfreeoceans.org/plastics

https://marinedebris.noaa.gov/

https://marinemegafauna.org/indonesia-projects/microplastics-megafauna

https://education.nationalgeographic.org/resource/ocean-currents

https://www.youtube.com/watch?v=55cb0tbODY4

MARINE MEGAFAUNA FOUNDATION

SCIENTIST SERIES
FOR STUDENTS
GRADE 7
Lesson 2 Manta Rays & Microplastics

Lesson Time
45 minutes

Essential Questions
How do microplastics impact manta rays? What can you do to help?

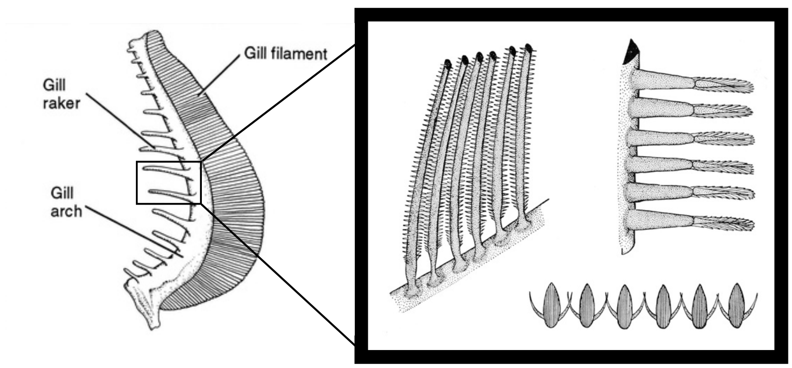
Materials
Colored choropleth map(s) from previous activity
Copy of provided data set
Markers or stickers
Copy of "Manta Rays & Microplastics" worksheet

Objectives - Students Will
Learn to plot data points to understand how humans impact the marine environment

Florida State Standards
Science Standard SC.7.N.1.1 Define a problem from the seventh grade curriculum, use appropriate reference materials to support scientific understanding, plan and carry out scientific investigation of various types, such as systematic observations or experiments, identify variables, collect and organize data, interpret data in charts, tables, and graphics, analyze information, make predictions, and defend conclusions.

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

Manta rays feed on plankton such as krill and copepods through a process known as **filter feeding**. In order to consume these microscopic organisms, manta rays swim with their mouths open, allowing water to flow into their mouth and out over their gills. Within the gills are specialized structures known as **gill rakers** which trap the plankton.



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

This way in which they feed makes them extremely susceptible to marine debris and microplastics in the ocean. For example, areas where there are high densities of food, may also be areas where mircoplastics accumulate. Due to the fact that the manta ray's food is similar in size to the marine microplastic, it is estimated that **manta rays consume approximately 63 pieces of plastic every hour!** Non-profit organizations such as the [Marine Megafauna Foundation](#) (MMF) are dedicated to conserving large marine animals such as the manta ray and better understanding the impacts of ingesting microplastics.

Vocabulary

Anthropogenic: changes to nature and the environment from human activity

Endangered Species: a species at risk of going extinct

Endangered Species Act: law that makes it illegal to sell, buy, or kill specific animals and plants that are categorized as ***threatened*** or ***endangered***

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

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

Krill: small, shrimp-like crustacean

Plankton: organisms that are unable to swim against a current

Threatened Species: a species likely to become endangered in the near future

Meet the Scientist!

Dr. Elizta "Ellie" Germanov is a senior scientist for the MMF's Indonesia Manta Project. Her current research is focused on how marine plastic pollution impacts filter feeders such as manta rays and whale sharks. Indonesia is an area of high priority for manta ray conservation as it is located in one of the most biologically diverse areas on the planet. Unfortunately, this region also has one of the highest concentrations of plastic pollution in the world.

Ellie's research is an important component in making evidence-based management strategies. Although manta rays are protected in American waters under the United States **Endangered Species Act**, their conservation status may shift once they enter international waters. It is important to make global conservation efforts to help better protect this ocean giant.

Click **here** to learn more about Ellie and her research!

Teacher Preparation:

1. Make copies of the "Manta Rays & Microplastics Dataset(s)*"
2. Make copies of the "Manta Rays & Microplastics" worksheet
3. Colored maps from ***Lesson 1*** Mapping Microplastics
4. Make copies of the "Ways to Help the Rays!" worksheet

*Teachers may opt to print data sets (a) and (b) for larger classes

Manta Rays & Microplastics

Name_______________________________ Date________________

For this activity students will need their colored choropleth maps from ***Lesson 1*** Mapping Microplastics. Using the provided Manta Rays & Microplastics Data Set, plot the manta rays in the appropriate cells. Once complete, use your finalized map to answer the following

Questions for Thought:

1. Why do you think the manta rays are feeding in areas with high concentrations of microplastics? Explain.

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2. How will feeding in areas with high concentrations of marine debris impact manta rays? Explain.

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3. How do the impacts of microplastics on marine life affect humans? Explain.

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4. Describe a creative way to remove the marine debris and microplastics in our oceans.

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Manta Rays & Microplastics Data Set (a)*

Name and ID #	Data Point	Sex	Observed Behavior
"Rocco" Manta #2	L4	Male	Swimming
"Stevie Nicks" Manta #6	E7	Female	Feeding
"Ginger" Manta # 21	F8	Female	Feeding
"Gillie" Manta #27	G8	Male	Feeding
"Hermoine" Manta #35	I7	Female	Feeding
"Cleo" Manta #41	G9	Female	Feeding
"Hugo" Manta #59	I9	Male	Feeding
"Skye" Manta #64	D11	Male	Feeding
"Crawford" Manta #86	J13	Male	Swimming
"Nemo" Manta #88	I15	Male	Socializing

**Note: The manta rays represented in this data set are real mantas that were observed by MMF's Florida Manta Project team.*

Manta Rays & Microplastics Data Set (b)*

Name and ID #	Data Point	Sex	Observed Behavior
"Cassiopeia" Manta #92	A1	Male	Swimming
"Nova" #93	D3	Female	Feeding
"Scarface" #96	C4	Male	Feeding
"Cienna" Manta #100	C5	Female	Feeding
"Valentina" #108	D5	Female	Feeding
"Bonnie" Manta #131	I7	Female	Feeding
"Clyde" Manta #132	I9	Male	Socializing
"Sue" Manta #CLF5	G9	Female	Feeding
"George" Manta #CLF7	J10	Male	Socializing
"El Dora" Manta #CLF9	H12	Female	Feeding

**Note: The manta rays represented in this data set are real mantas that were observed by MMF's Florida Manta Project team.*

Manta Rays & Microplastics

Name___________________________________ Date__________________

Tell us Some Ways YOU can Help the Manta Rays!

Now that you have a better understanding of how microplastics and marine debris impact manta rays, explain some ways that you can help on both an individual and community scale. Use the space below to explain and/or draw your solution(s).

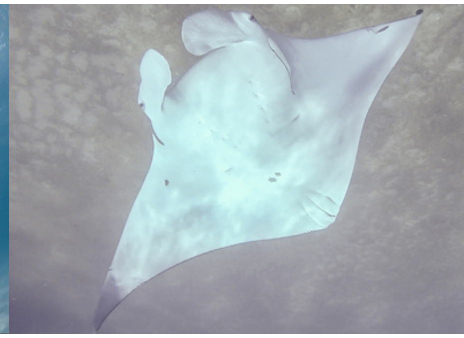
MARINE MEGAFAUNA FOUNDATION

SCIENTIST SERIES FOR STUDENTS GRADE 7

Lesson 2 Manta Rays & Microplastics

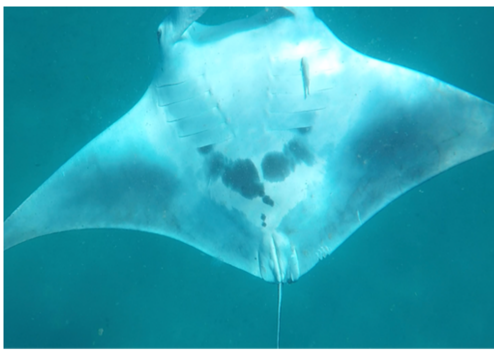
Meet the Mantas (a)

"Rocco"
Manta #2

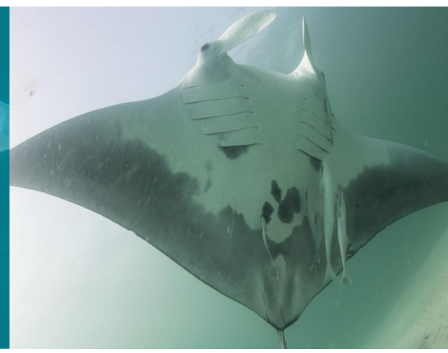


"Stevie Nicks"
Manta #6

"Ginger"
Manta #21



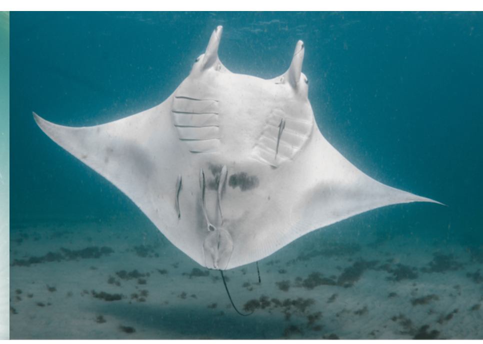
"Gillie"
Manta #27



"Hermoine"
Manta #35

"Cleo"
Manta #41

"Hugo"
Manta #59



"Skye"
Manta #64

"Crawford"
Manta #86

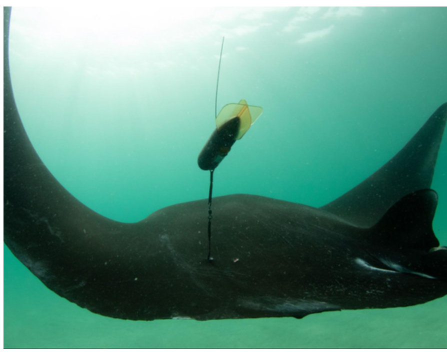
"Nemo"
Manta #88

Meet the Mantas (b)

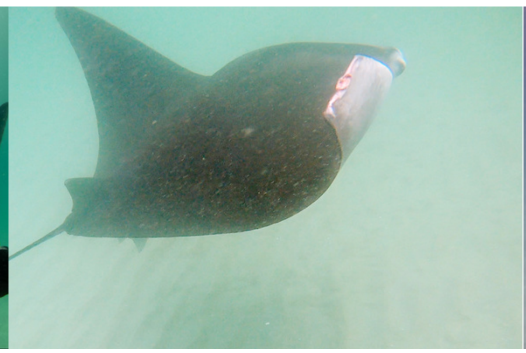
"Cassiopeia"
Manta #92

"Nova"
Manta #93

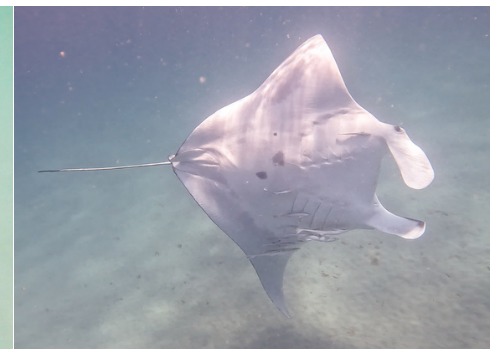
"Scarface"
Manta #96



"Cienna"
Manta #100



"Valentina"
Manta #108



"Bonnie"
Manta #131

"Clyde"
Manta #132

"Sue"
Manta #CFL5

"George"
Manta #CFL7

"El Dora"
Manta #CFL9

Teacher Answer Key (a)

	A	B	C	D	E	F	G	H	I	J	K	L
1	76 ppm	134 ppm	361 ppm	473 ppm	222 ppm	428 ppm	344 ppm	389 ppm	563 ppm	382 ppm	529 ppm	287 ppm
2	155 ppm	265 ppm	900 ppm	1500 ppm	831 ppm	1,301 ppm	759 ppm	644 ppm	920 ppm	1,029 ppm	623 ppm	461 ppm
3	2,001 ppm	2,352 ppm	2,267 ppm	2,519 ppm	2,264 ppm	2,001 ppm	2,691 ppm	2,087 ppm	3,083 ppm	2,519 ppm	2,012 ppm	2,142 ppm
4	3,835 ppm	3,030 ppm	4,000 ppm	3,976 ppm	3,783 ppm	3,629 ppm	3,133 ppm	2,973 ppm	3,204 ppm	3,086 ppm	3,208 ppm	2,739 ppm
5	2,519 ppm	3,001 ppm	5,872 ppm	5,143 ppm	4,015 ppm	5,973 ppm	5,038 ppm	4,459 ppm	5,294 ppm	4,932 ppm	5,204 ppm	3,473 ppm
6	2,723 ppm	3,402 ppm	5,609 ppm	7,933 ppm	7,023 ppm	7,933 ppm	6,001 ppm	6,639 ppm	7,845 ppm	7,004 ppm	4,001 ppm	3,898 ppm
7	2,529 ppm	2,197 ppm	5,083 ppm	7,520 ppm	6,034 ppm	8,500 ppm	9,328 ppm	8,001 ppm	10,000 ppm	7,933 ppm	5,753 ppm	3,052 ppm
8	3,063 ppm	2,086 ppm	4,935 ppm	7,284 ppm	6,947 ppm	9,011 ppm	10,000 ppm	9,201 ppm	8,012 ppm	7,457 ppm	5,839 ppm	3,597 ppm
9	2,382 ppm	2,056 ppm	5,999 ppm	8,000 ppm	7,026 ppm	9,550 ppm	8,739 ppm	10,000 ppm	8,001 ppm	6,464 ppm	6,000 ppm	3,999 ppm
10	2,819 ppm	2,345 ppm	5,073 ppm	7,457 ppm	6,028 ppm	8,302 ppm	8,080 ppm	8,761 ppm	9,283 ppm	7,653 ppm	5,999 ppm	3,752 ppm
11	3,164 ppm	4,000 ppm	5,430 ppm	6,937 ppm	7,027 ppm	7,838 ppm	6,764 ppm	7,845 ppm	6,853 ppm	6,835 ppm	5,968 ppm	3,515 ppm
12	3,538 ppm	3,999 ppm	4,987 ppm	7,520 ppm	6,528 ppm	8,000 ppm	7,934 ppm	6,542 ppm	7,103 ppm	7,963 ppm	6,000 ppm	3,904 ppm
13	3,811 ppm	4,000 ppm	6,000 ppm	4,729 ppm	4,927 ppm	5,973 ppm	4,999 ppm	4,869 ppm	5,672 ppm	5,587 ppm	5,996 ppm	4,000, ppm
14	3,100 ppm	2,619 ppm	3,958 ppm	2,089 ppm	2,369 ppm	3,165 ppm	3,765 ppm	3,197 ppm	2,520 ppm	3,826 ppm	2,863 ppm	3,098 ppm
15	2,000 ppm	1,573 ppm	1,693 ppm	1,399 ppm	979 ppm	1,054 ppm	2,000 ppm	1,539 ppm	886 ppm	913 ppm	1,209 ppm	991 ppm

Atlantic Ocean

Teacher Answer Key (b)

	A	B	C	D	E	F	G	H	I	J	K	L
1	5,076 ppm	5,134 ppm	5,361 ppm	4,473 ppm	4222 ppm	5,428 ppm	4,344 ppm	4,389 ppm	2,563 ppm	3,382 ppm	2,529 ppm	3,287 ppm
2	7,155 ppm	7,265 ppm	6,900 ppm	6,500 ppm	6,831 ppm	7,301 ppm	4,759 ppm	5,644 ppm	2,920 ppm	2,029 ppm	3.623 ppm	3,461 ppm
3	6,001 ppm	9,352 ppm	8,267 ppm	9,519 ppm	8,264 ppm	7,001 ppm	5,691 ppm	4,087 ppm	3,083 ppm	2,519 ppm	2,012 ppm	2,142 ppm
4	6,835 ppm	9,030 ppm	10,000 ppm	9,976 ppm	8,783 ppm	7,629 ppm	4,133 ppm	4,973 ppm	3,204 ppm	3,086 ppm	3,208 ppm	2,739 ppm
5	7,519 ppm	8,001 ppm	9,872 ppm	8,143 ppm	8,015 ppm	6,973 ppm	5,038 ppm	4,459 ppm	5,294 ppm	4,932 ppm	5,204 ppm	3,473 ppm
6	8,000 ppm	8,402 ppm	9,609 ppm	9,933 ppm	8,023 ppm	7,933 ppm	6,001 ppm	6,639 ppm	7,845 ppm	7,004 ppm	4,001 ppm	3,898 ppm
7	7,529 ppm	6,197 ppm	7,083 ppm	7,520 ppm	6,034 ppm	8,500 ppm	9,328 ppm	8,001 ppm	10,000 ppm	7,933 ppm	5,753 ppm	3,052 ppm
8	5,063 ppm	5,086 ppm	4,935 ppm	7,284 ppm	6,947 ppm	9,011 ppm	10,000 ppm	9,201 ppm	8,012 ppm	7,457 ppm	5,839 ppm	3,597 ppm
9	5,382 ppm	4,056 ppm	5,999 ppm	8,000 ppm	7,026 ppm	9,550 ppm	8,739 ppm	10,000 ppm	8,001 ppm	6,464 ppm	6,000 ppm	3,999 ppm
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Atlantic Ocean

Manta Rays & Microplastics
Teacher Answer Key

<u>Questions for Thought:</u>

1. Why do you think the manta rays are feeding in areas with high concentrations of microplastics? Explain.

Manta rays primarily feeding on zooplankton such as krill and copepods. These microscopic organisms float in the water column and their movements are influenced by environmental factors such as wind patterns and ocean currents. Microplastics in the ocean are also transported by these factors creating areas with not only a high concentration of food but also a high concentration of marine debris.

2. How will feeding in areas with high concentrations of marine debris impact manta rays? Explain.

Manta rays are filter feeders meaning they filter microscopic organisms out of the water column using specialized structures in their gills known as gill rakers. Due to the fact that their primary food sources and microplastics are about the same size, manta rays end up consuming a lot of plastic. This may cause manta rays to feel full even though they have not eaten much food. Another impact is that those plastics that are consumed may be leaching toxins into their body, blocking the absorption of nutrients into their digestive track. In addition to impacts from consuming plastic, manta rays risk entanglement in discarded fishing gear including monofilament, lures, nets, and ropes as they swim through areas with high concentrations of marine debris.

3. How does the impacts of microplastics on marine life affect humans? Explain.

There are many ways in which the impacts of microplastics on marine life affects humans. Students may suggest some of the following answers: that fish and other marine life are dying and thus impacting the livelyhood of fisherman, healthy oceans are necessary for a healthy planet, or that microplastics have been found in much of the seafood that humans consume and may cause health problems.

4. Describe a creative way to remove the marine debris and microplastics in our oceans.

There have been many attempts at creative solutions to clean the marine debris and micro-plastics out of our oceans. Several non-profits host underwater cleanups, where participants are on SCUBA and remove old fishing gear and ropes from the ocean bottom. Other organizations host regular beach cleanups to remove trash that has washed up on shore. There are even more controversial methods such as inventions that model the filter feeding techniques of the manta ray and work to filter floating marine debris and microplastics out of the water column. Although these inventions may successfully cleanup the ocean of debris they may also be removing plankton and other microorganisms necessary for a healthy ocean.

*Two helpful articles can be found here: **<u>Vox.com</u>** and the **<u>guardian.com</u>***

Author:
Stacy Assael, M.Sc

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

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

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Marine Megafauna Foundation

Additional Resources

https://marinemegafauna.org/indonesia-projects

https://marinemegafauna.org/indonesia-projects/microplastics-megafauna

https://theoceancleanup.com/