

Saving Sharks

Proposing a New Marine Protected Area

In this module, you will use Ocean Tracks to explore the characteristics of marine protected areas (MPAs) in the North Pacific Ocean and discover how they are being used to help conserve ocean species and to improve the overall health of the ocean. In addition, you will examine the issue of human impact on the ocean and its inhabitants. Using this information, you will propose a new MPA aimed at conserving white sharks as you explore the question:

What would be the ideal characteristics of a marine protected area designed to conserve white sharks in the Pacific Ocean?



Pre-Lab Assignment

MARINE PROTECTED AREAS

In 1872 the world's first national park was born. The land that would become Yellowstone National Park had captured the attention of explorers and artists, and Congress decided to keep the area free from private development. The purpose of the National Park system was to protect these natural resources for future generations and allow their unique ecosystems to stay wild forever.

Now, with our increasing exploitation of the ocean through fisheries, aquaculture, and oil extraction, human impact on the ocean is growing. One strategy to manage these impacts is to conserve ocean habitats in the way that National Parks protect terrestrial habitats. Marine Protected Areas (MPAs) are areas of the ocean where some or all human activities are restricted so that these ecosystems can exist undisturbed by humans.

- Visit the MPA section of the Ocean Tracks Library:
<http://oceantacks.org/library/conservation/marine-protected-areas/>
- Click on and read through all the links related to Marine Protected Areas.

Sara Maxwell is a marine biologist who uses satellite technology to track marine animals and learn how they interact with the ocean environment. She uses this information to determine how these animals, human activities, and ocean resources can best be managed.

- Watch a video of Sara Maxwell talking about her research and how animal tracking data can help us better protect marine wildlife:
<http://oceantacks.org/library/scientist-videos/sara-maxwell-how-is-your-research-used-in-conservation/>



Pre-Lab Assignment

PRE-LAB QUESTIONS

Use what you learned from reading in the Ocean Tracks Library and from watching the video to answer the following questions.

1. *What are the three main purposes of marine protected areas?*
2. *What are some of the different levels of protection?*
3. *What are some important characteristics to consider when choosing a site for an MPA?*
4. *Why is it important to consider social dimensions when planning an MPA?*
5. *How is satellite tracking data used when designing MPAs?*



Engage

SHARKS AT RISK

Every year, it is estimated that 100 million sharks are killed by human activities. This equates to approximately 11,000 sharks per hour. Sharks are being harvested for food and cosmetic products through various methods, including shark finning, which involves the removal of the sharks fins so that they can be used for shark fin soup. Sharks are also at risk for other reasons such as bycatch during fishing activities, habitat degradation through pollution, and removal of prey species as a result of overfishing. Sharks are particularly susceptible to these types of human impacts due to their biology. They are slow-growing, late to reproduce, and give birth only to few young, meaning that they are slow to recover from population declines. Currently, one third of all shark species are at risk of extinction.

One of our Ocean Tracks species, the white shark, has been adversely affected by human activities and is currently listed as “vulnerable” on the IUCN (International Union for the Conservation of Nature) Red List of Threatened Species (<http://www.iucnredlist.org/details/3855/0>), meaning that the white shark is likely to become endangered unless steps are taken to improve the conditions necessary for their survival.

As you learned in your Pre-Lab Assignment, Marine Protected Areas can be used to protect ocean species like sharks from human activities. In this module, you will learn how MPAs can help counteract human impacts to help improve the health of the ocean -- and specifically try to help white sharks -- as you answer the research question: ***What would be the ideal characteristics of a marine protected area designed to conserve white sharks in the Pacific Ocean?***

Learning Objectives

- Integrate information from multiple Ocean Tracks data sources to solve a problem related to the conservation of sharks
- Provide reasoning for how data support the specific design strategies employed in the creation of a marine protected area



Engage

Let's start by looking at existing MPAs in the Pacific Ocean to see where they are located and what characteristics they have. Using the Ocean Tracks website, you can explore the location, size, and level of protection of MPAs in the Pacific Ocean.

- Go to <http://oceantacks.org/map>.
- Open the Data and Tools tab. Click the “+” to expand Overlays. Check the box for Show Marine Protected Areas.
- Zoom in and out on Hawaii and the west coast of North America. Notice the legend on the bottom right that describes the level of protection for MPAs.
- Look for patterns in the size, location and level of protection of the MPAs.

CLASS DISCUSSION

As a class, discuss the following questions:

1. *What patterns do you notice between the size of an MPA and the level of restriction in the MPA?*
2. *Where are most of the MPAs located? Why do you think this might be?*
3. *What might be the purpose of a very large MPA? What about a very small MPA? What would the purpose of an MPA close to shore be vs. one further from shore?*
4. *Why would it be not be practical to protect the whole ocean?*



Explore

PART 1: HUMAN IMPACTS IN THE PACIFIC OCEAN

One of the unique features of the Ocean Tracks interface is the inclusion of data related to the impact humans are having on the ocean. These data are visualized as a map that shows the intensity of human impacts in the ocean. The colors on this map reflect the values of a human impacts “index” in each area of the ocean. Marine resource managers can use this map to determine where effort needs to be focused in the ocean to minimize the negative effects of humans on the marine environment. To learn more about these data, read the *Nature* article Spatial and temporal changes in cumulative human impacts on the world’s ocean by Halpern et. al (2015): <http://www.nature.com/ncomms/2015/150714/ncomms8615/full/ncomms8615.html>

In this section, you’ll learn more about some of the ways that humans are affecting the ocean by using the Human Impact overlay available on Ocean Tracks. You will then use this information to help you make decisions about the characteristics of your MPA to protect white sharks.

- Go to <http://oceantracks.org/map>.
- In the **Data & Tools** tab, expand **Overlays**.
- Go to #4: **Explore Human Impact Layers** and select **Cumulative Human Impact** from the dropdown menu (NOTE: Cumulative Human Impacts is a sum of all of the individual types of human impacts in the list combined).



Explore

EXPLORE PART 1 QUESTIONS

1. *Which regions of the world show the highest levels of human impact?*
2. *Which regions of the North Pacific basin show the highest levels of human impact?*
3. *Which regions of the world's ocean experience very little human impact?*
4. *Describe patterns or trends you observe in the data. For example, do you tend to see higher impacts near coastlines or in the open ocean?*
5. *What is surprising to you about these data?*
6. *What questions does this map raise for you?*



Explore

PART 2: HUMAN IMPACTS ON WHITE SHARKS

Now let's explore the level of human impact in the areas frequented by white sharks. The first step is to identify the locations that sharks are visiting using the Ocean Tracks Hotspot tool.

- Under **Tracks**, check the box to **Show All** white shark tracks.
- Expand **Overlays** and check the box for **Show Hot Spot** map. Then, go back to **Tools** and click the **Hide Tracks** button to make hotspots easier to discern.
- Use the **Add Polygon** tool to outline and label the locations of shark hotspots that you have identified. To use the **Polygon Tool**:
 - Click on the **Add Polygon** button in the upper right portion of the screen. Then click on the map where the first point of your polygon should be. Continue to drop points on the map, creating an outline of the shape you are trying to make. To finish the shape, click on the starting point of your polygon.
 - Create additional polygons to highlight additional shark hotspots by repeating the steps described above.
- Use the **Add Marker** tool to label the hotspots you have identified.
- Save a screenshot of your final, annotated map.



Explore

- Make and complete a table like the example on the next slide. Use the Human Impacts overlay to find out how sharks are being affected by human activity in their hotspots.

You can investigate human impacts on the North Pacific even further by looking at individual sources of human impact.

- Select different impacts from the **Impact Type** dropdown menu under **Explore Human Impacts** under **Overlays**. Suggestion: Save screenshots of the visuals you create through your exploration in your notebook to refer back to when you are designing your shark MPA.

EXPLORE PART 2 QUESTIONS

1. *Which types of impact do you think would have the strongest effect on the white sharks? Why?*
2. *In what ways did the data surprise you? What questions do you have about the data?*



Explore

	Location of Hotspot	How many tracks travel through this area?	When are the sharks in this area?	What is the quantitative value of cumulative human impact in this area?	What are the top three specific types of human impact affecting this location?
Hotspot #1	Off the southern coast of Hawaii			Medium to medium-high impact (4.95-12)	
Hotspot #2					
Hotspot #3					



Explore

PART 3: EXISTING MPAs FOR SHARK CONSERVATION

Before you design your own MPA to help protect white sharks, let's look at a couple examples of existing MPAs that are part of a conservation strategy to help sharks.

The Farallon Islands, located in the Gulf of the Farallones off the coast of San Francisco, are closed to the public, but are a safe haven for many different marine species, including white sharks. Let's explore.

- Find the North and Southeast Farallon Islands State Marine Reserves:
 - Under **Overlays**, check the box next labeled “**Show Marine Protected Areas**”
 - Zoom in on the coast of California, near San Francisco.
 - The Farallon Islands are approximately 50 km off shore.
 - Notice how many other MPAs are also in this location.
- Right click the area of the map that contains the North Farallon Islands State Marine Reserve.
- Click “**More About These MPAs**” to open the Protected Seas website. Then click on “North Farallon Islands State Marine Reserve” in the list of Marine Restricted Areas.
- Identify the purpose, allowed activities, and prohibited activities within the MPA. Record this information in a table like the one on slide 13.



Explore

- Using the ruler tool, try to estimate the approximate area of the MPA (the greatest width x the greatest height in km²) and record it in your data table. To use the ruler tool:
 - Click **Show Ruler** to activate the ruler tool.
 - Click on the map to place a 0 km marker.
 - Click & drag the marker to extend the ruler—a 2nd marker shows distance between start & end markers.
 - Click & drag either marker to change the start/end positions of the ruler.
 - Click **Hide Ruler** to remove the ruler from map.
- Show All white shark tracks and check the box labeled **Use Unique Colors** to see how many shark tracks cross through this MPA. Record this value in your table.
- Follow the same steps as above for the Southeast Farallon Islands State Marine Reserve.
- Next, find the Papahanaumokuakea National Marine Monument.
 - Zoom out from the coast of California and pan southwest to locate the Hawaiian Islands.
 - Look for the red restricted area around the northern islands.
- Right click on the MPA and click **More About These MPAs** to go to the Protected Seas website and read about this MPA and record the information in the table on the following page as you did for the Farallon Islands MPAs.



Explore

	North and Southeast Farallon Islands State Marine Reserves	Papahanaumokuakea National Monument
How many other protected areas exist here?	14	
Observations of Size and shape of MPA		
Purpose	To protect a seabird colony, seals, whales and sharks	
Allowed Activities		None
Prohibited Activities	Unlawful to take, damage or possess any marine resource	
When is the MPA in effect? (Constancy)		
Who manages this MPA?		
How many shark tracks pass through this area?		2



Explore

EXPLORE PART 3 QUESTIONS

1. *What do you think is the potential of these MPAs to help white shark population?*
2. *Describe the level of human impact in these habitats. How do you think the MPAs help to address those issues?*
3. *What did you notice about the size of these MPAs? When you have a highly migratory species, how do MPAs still benefit animals like the white shark?*
4. *What might be some of the costs associated with maintaining these MPAs?*
5. *What other restricted areas did you notice in the same regions of these MPAs? How do these work together in an MPA network? How is this beneficial for species?*
6. *In what ways do you think the restrictions in these MPAs have affected people? What might be some of the social and economic consequences of having an MPA in these locations?*



Synthesize

DESIGN A MARINE PROTECTED AREA FOR SHARK CONSERVATION

If conservation were the only factor to consider when designing MPAs, then as MPA designers, we could just pick all of the areas where sharks go to help protect them. However, as you have learned, there are many different factors to weigh when deciding on a conservation strategy. Bring together everything that you have learned in this module to design a conservation strategy based on the creation of a new Marine Protected Area.

Your Synthesize assignment for this module will consist of three major components:

1. **A map of your MPA**, showing the area of the North Pacific you think will make the most effective MPA for protecting white sharks. (See instructions on slide 18.)
2. **A completed table** of key characteristics of your MPA. (See sample table on slide 19.)
3. **A short essay** explaining your rationale for your design choices. (See instructions on slide 20.)

GETTING STARTED

Consider the prompts on the following two slides as you begin to make decisions about the design of your MPA. You don't have to formally answer these questions. Instead, use them to help guide your thinking. You are also encouraged to do some additional research as you think about various aspects of your MPA design. For example, it might be helpful to learn more about the biggest conservation threats facing sharks or how MPAs are monitored.



Synthesize

PROMPTS TO GUIDE YOUR THINKING

Location:

- Look at the shark hotspots that you identified in the Explore section. Which geographic area is the most heavily used by white sharks? What are the sharks doing in these areas? Which habitat locations are most important to the life history of the white shark?
- As you consider location, also think about the management of your proposed MPA. Will the location be close to shore or far from shore? Is it in U.S. waters or international waters? How will that affect the management of the MPA? What are some strategies that could be used to monitor your MPA? Using other MPAs as examples, consider who might manage your MPA.

Size & Shape:

- Consider the size and shape of your proposed MPA. What would be the ideal size that would balance both the needs of the shark as well as the economic impacts of placing restrictions on human activity in the area? Look back at the research you did on other MPAs to help you think about what might be realistic for the size of your MPA.

Constancy:

- Look at when the sharks are in the area of your proposed MPA. Does the MPA need to be in effect year-round or are the sharks only in the area at certain times of the year?



Synthesize

Human Impacts:

- Think back to what you saw in the human impact overlays. Which shark habitat areas are the most impacted by human activity? What are the types of human impact that would have a specific effect on white sharks? How could your MPA address these impacts to protect sharks?
- Also consider the human side of the human impact data. In what ways are shark habitats being used by people? Are these locations important for recreation, jobs, or food? How would having a restricted area here impact people?

Existing Protection:

- What levels of protection already exist in this area? The MPA overlay in Ocean Tracks shows that many locations in the ocean are protected by more than one MPA, offering different levels for protection. If you discover that your proposed MPA overlaps with a pre-existing MPA, how would you expand the size of the MPA or otherwise revise the regulations to further protect the sharks?

Restrictions:

- Which activities will be important to restrict in this area? Again, use your research on other MPAs to see examples of restricted activities and think about what will be necessary to help the sharks. Are there some human activities that don't have much of an impact on sharks that could still be permitted in the area?



Synthesize

Use the guidelines below to build the components of your Synthesize assignment.

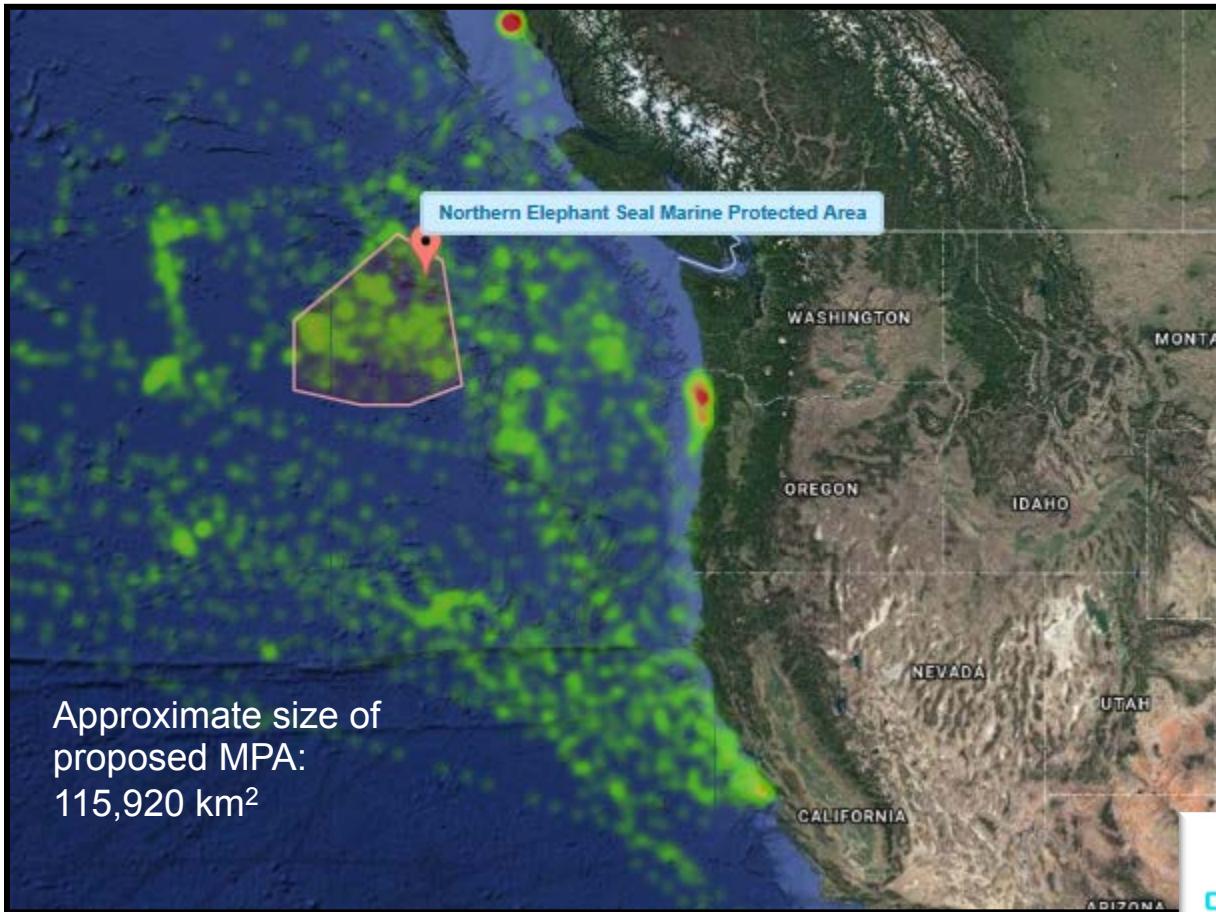
1. CREATE YOUR MAP (and other data visualizations to support your MPA)

- Using Ocean Tracks and the Add Polygon tool, create an outline of your MPA. Use the Add Marker tool to add a label to the map with the name of your proposed MPA. Take a screen shot of this map.
- Using the ruler tool, determine the approximate dimensions of your proposed MPA and calculate the area of the MPA. Annotate your map to include this information.
- To help support your rationale for an MPA in this location, you may also want to generate, save, and annotate other visualizations to show things like: the shark tracks moving through your MPA, the levels of human impact in your MPA, nearby existing MPAs, etc. You should create and annotate these maps to help support your rationale for an MPA in this location.
- Sample annotated visualizations are provided on slides 18 and 19 as examples of the level of detail you should provide in your own map(s).



Synthesize: Example Maps

Figure 1: Example of a labeled map showing a proposed MPA for northern elephant seals in their foraging grounds.



Synthesize: Example Maps

The images below are examples of additional visualizations that could be used to support the proposed elephant seal MPA shown on slide 19.

Figure 2: →

All of the elephant seal tracks available on Ocean Tracks in relation to the proposed MPA. At least 4 seals move through this area.

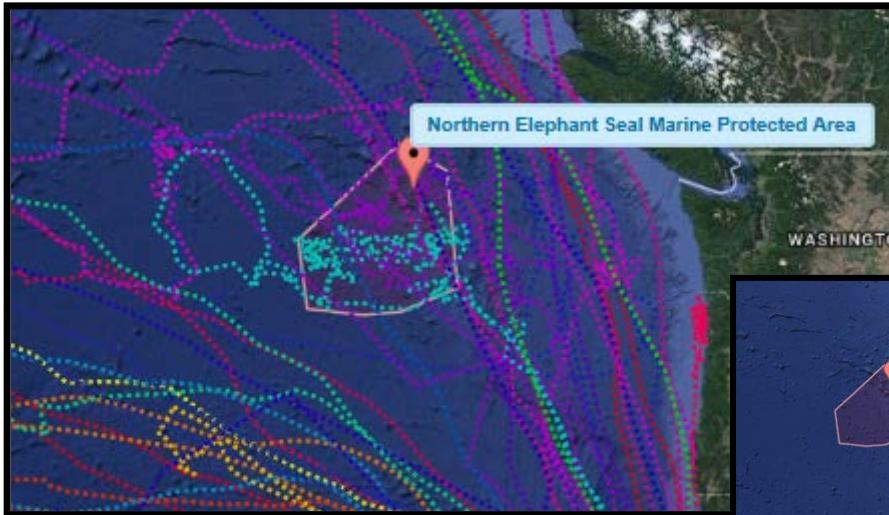


Figure 3: →

Cumulative human impact map showing medium-medium high impact (4.95-12) within the proposed MPA boundaries.

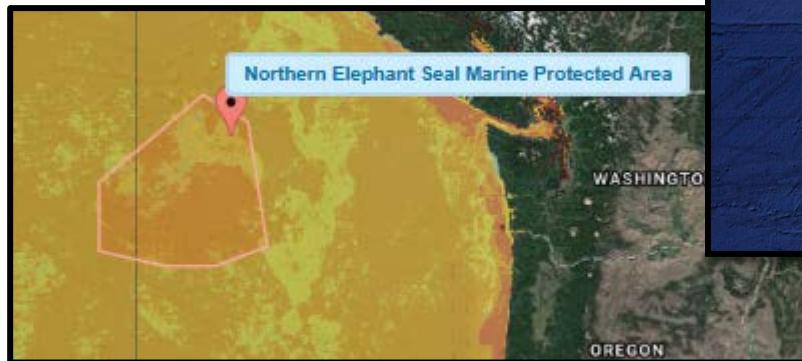
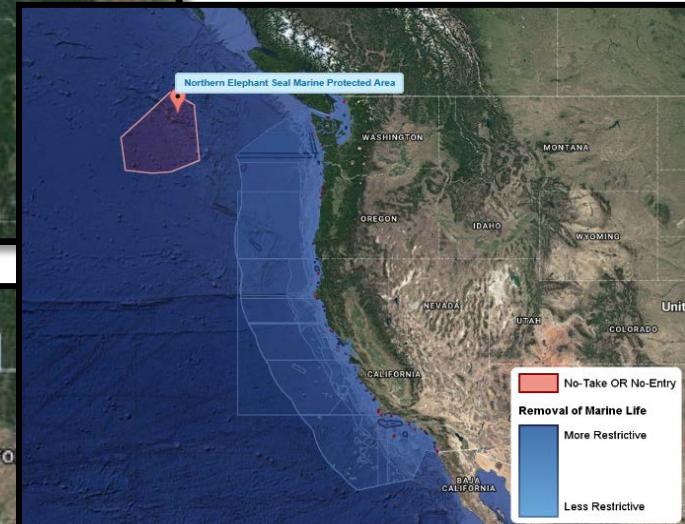


Figure 4:

Proposed MPA, outside the boundaries of existing MPAs along California's coastline.



Synthesize

2. MAKE YOUR TABLE

	Title of your Proposed MPA
How many other protected areas exist here?	
Size of MPA	
Is your MPA in national or international waters?	
Purpose	
Allowed Activities	
Prohibited Activities	
When is the MPA in effect? (Constancy)	
How many white shark tracks pass through this area?	



Synthesize

3. WRITE YOUR RATIONALE (300-500 words)

Now that you have designed what you think is the ideal MPA for conserving white sharks, write a short essay to explain the choices you made in designing your MPA. Explain why the location you chose is the most important area of the North Pacific for protecting sharks and why money should be spent to protect this particular region instead of other locations. Your response should be grounded in the evidence that you have collected throughout the module. Whenever possible, include actual data points, quantitative values (such as statistics from track points, human impact values, information cited from background research, etc.). In your essay:

- Reflect back on the decisions you made as you planned your MPA. Justify the choices you made about the location, size and shape of your MPA.
- Discuss the importance of this habitat to white sharks. Why did you pick this site over other possible locations? Why will this conservation strategy be important in the recovery of white shark populations? How did the human impact data influence your decisions?
- Describe how you were able to balance the conservation needs of the sharks and the economic needs of people. How did these considerations affect the design of your MPA?
- If you discovered that your proposed MPA overlaps with a pre-existing MPA, how you would expand the size of the MPA or revise the regulations to further protect the species/environment there? How could these MPAs work together as a network?
- What are some enforcement strategies you would employ in your MPA? How will you make sure that your proposed restrictions will be followed?

