SeaKeepers Documentary Series
Lesson 2: Trophic Cascades

Grade Level: 8-10   **Estimated Time: 95 min**

Lesson Overview:
Our oceans face many threats today, including climate change and pollution. In order to protect and preserve our oceans, we need to understand these threats and how the oceans respond to them. The International SeaKeepers Society supports marine research and education by connecting scientists with yacht owners, creating research opportunities for scientists to better understand our oceans - and to create plans to protect them.

In this lesson, students will learn about ecosystem dynamics and factors impacting shark populations through case studies. Case studies will contain technical terms, graphs, and results and will transition students into understanding how to read, interpret, and analyze findings from scientific literature. Students will be introduced to ecosystem services and functions, trophic cascades, and the effects of overfishing and shark finning practices.

Lesson Breakdown:
- SeaKeepers Documentary Series: Episode 1 (6 min)
- Trophic Cascade Lecture & Introduction to Scientific Literature (30 min)
- Case Study Activity: 20 min independent, 20 min group discussion, 5 min transition time (45 min)
- Assessment: Discussion (15 min)

Educational Standards Addressed:
- National: MS-LS2-5: Utilizing the material from a case study to develop a general understanding of ecosystem dynamics, focusing on trophic cascades
- Florida: SC.912.L.17.8: Recognize the consequences of the losses of biodiversity due to catastrophic events, climate change, human activity, and the introduction of invasive, non-native species

Anticipated learning objectives:
- Understand human-related factors contributing to global population declines of sharks
- Understand implications of trophic cascades and possible implications of the shark finning industry
- Students will be introduced into how to analyze scientific article(s), complete with graphs and data

This lesson plan was developed by undergraduate students from Shoals Marine Laboratory studying shark biology: Kaitlyn Cisz, Adelaide Dahl, Jamie Ho, Julia Lowe, Lucinda Manlick, Hannah Weinstein

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Preparation & Materials
Students will need background information on food webs, trophic levels, and trophic cascades for this activity. A powerpoint presentation is included for the lesson, but feel free to use whatever materials you prefer to explain these concepts.

Additional Materials/Resources:
• BioInteractive Video: Keystone Species and Trophic Cascades: https://www.youtube.com/watch?list=PLAoFjpcgcSxu7V5vYsKT72-JhMv-jmHC8&v=hRGg5it5FMI
• TEDx Video: Shark Finning: https://www.youtube.com/watch?list=PLAoFjpcgcSxu7V5vYsKT72-JhMv-jmHC8&v=hRGg5it5FMI

Tips:
This lesson is part of a 3-part documentary series by The International SeaKeepers Society. This lesson would fit best surrounded by lessons of similar themes (ocean conservation), including other lessons from this series as well as lessons from other ocean conservational organizations.

Activity instructions for teachers:
1. Divide the class into two groups (or smaller groups, but make sure half the class reads one article and the other half reads the other article) and provide each student with a copy of the article they are to read, along with a worksheet with guiding questions for them to answer. Either hand out the "How to Read a Scientific Paper" infographic, or project it so students can refer to it.
2. Each student should read their article independently, answering their "independent" portion of the worksheet to help them think more critically and highlight the important parts of the article. Provide them with 20 minutes to do this, or assign the article and questions prior to class.
3. Once all group members have read their articles and provided short answers to each question in the independent portion, groups should convene to answer the group questions on their worksheet.
4. The goal of this portion of the lesson is to address the role sharks play in their ecosystem, and the impacts that their removal can have. Discussion may focus towards threats, causes of declines, or preventative measures, which is fine. Listen to the discussions and keep students on track if necessary.
5. Give the students 20 minutes for their discussions, and wrap up by bringing the class back together.
6. For each article, students should then describe (for the other half of the class) what the article was about. This will lead into the final part of the discussion, led by the teacher.
7. The final discussion should focus on these questions: How do humans impact their environment? How can we take better care of our oceans?
8. As an optional follow up to this activity, you may assign an essay to reinforce the ideas learned.

If you'd like to provide feedback on this lesson plan, click here! We'll use your comments to improve existing and future SeaKeepers lessons.

PAPER 1: Global catches, exploitation rates, and rebuilding options for sharks

STUDENT INTRODUCTION

This activity is meant to introduce you to scientific literature while highlighting the practice of shark-finning as an example of how humans impact marine ecosystems. At this point, you should understand why sharks are important in their ecosystem, and how an ecosystem can collapse without sharks present. Now we are going to discuss more about how human actions can result in the removal of apex predators from their ecosystems. While sharks (and other large fish) face many threats today, including climate change and pollution, this dicussion is going to focus on overfishing and shark finning.

Scientific articles can be difficult to read. Review the "How to Read Scientific Papers" infographic provided with this lesson, and remember:

1. Skim, to understand the overall goals of the article and why they are important
2. Re-Read, asking more detailed questions about the purpose of the article and how the study was performed
3. Interpret, look carefully at the figures and try to understand them
4. Summarize, write down the key points of the article if you need to

If time is short, focus on the **introduction** and the **discussion** to find the key points. Refer to figures as they are referenced in the discussion.

PART 1: INDEPENDENT GUIDING QUESTIONS
Answer the following questions about the article independently on a separate piece of paper.

1. Why are some shark species experiencing population declines?

2. What are IUU landings?

3. What does "landed" mean? What does "discarded" mean?

4. Do discarded sharks always survive?

5. What is "bycatch"?

6. What is the range estimated for number of sharks lost in 2000?

When you are done, join the rest of your group and discuss these questions briefly.

Trophic Cascades

PAPER 1: Global catches, exploitation rates, and rebuilding options for sharks

Part 2: Group Discussion Questions
 Answer the following questions about the article as a group.

1. What is the goal of this paper?

2. What conclusions can be made by looking at the estimated exploitation rate?

3. What points does the author use to explain why catch rates have remained relatively stable, despite estimates that shark exploitation rates are so high?

4. How does the author think legislation should be changed? What is the current focus, and how does the author challenge it?

5. What are some unintended effects of placing strongly enforced fishing regulations on a specific are or country?

6. Are all shark species at risk for extinction?

Trophic Cascades

PAPER 2: Extinction risk and conservation of the world's sharks and rays

STUDENT INTRODUCTION

This activity is meant to introduce you to scientific literature while highlighting the practice of shark-finning as an example of how humans impact marine ecosystems. At this point, you should understand why sharks are important in their ecosystem, and how an ecosystem can collapse without sharks present. Now we are going to discuss more about how human actions can result in the removal of apex predators from their ecosystems. While sharks (and other large fish) face many threats today, including climate change and pollution, this dicussion is going to focus on overfishing and shark finning.

Scientific articles can be difficult to read. Review the "How to Read Scientific Papers" infographic provided with this lesson, and remember:

1. Skim, to understand the overall goals of the paper and why they are important
2. Re-Read, asking more detailed questions about the purpose of the paper and how the study was performed
3. Interpret, look carefully at the figures and try to understand them
4. Summarize, write down the key points of the paper if you need to

If time is short, focus on the **introduction** and the **discussion** to find the key points. Refer to figures as they are referenced in the discussion.

PART 1: INDEPENDENT GUIDING QUESTIONS
Answer the following questions about the article independently on a separate piece of paper.

1. According to this article, what are some of the threats to marine ecosystems (not JUST sharks)?

2. What three groups make up "Class Chondrichthyes"?

3. What makes sharks and their relatives a more vulnerable group than other fishes?

4. What is "bycatch"?

5. What are the six categories of the scale used by the International Union for Conservation of Nature (IUCN) to determine extinction risk?

6. If a species is data deficient (DD), can we estimate if population numbers are increasing or decreasing?

When you are done, join the rest of your group and discuss these questions briefly.

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PAPER 2: Extinction risk and conservation of the world's sharks and rays

Part 2: Group Discussion Questions

Answer the following questions about the article as a group.

1. What is the goal of this paper?

2. How many species fall into each IUCN Red List Category? Refer to Table 2.

3. Why does the author suggest species that inhabit shallow waters (and narrow depth ranges) may be more likely to be at risk?

4. Sharks and their relatives are an incredibly diverse group. Why is biodiversity important in an ecosystem? Does it matter if a few species of shark go extinct?

5. Why is lack of global protections an issue for sharks? Specifically, if one country has legal protections for sharks in place but a neighboring country does not, what is the problem?

6. What do you think are some of the difficulties of protecting sharks on a global scale?

ANSWER KEYS

Article 1:

Independent Questions

1. Why are some shark species experiencing population declines? Global growth of fishing, relatively slow rates of growth and reproduction of sharks, and demand for shark fins

2. What are IUU landings? Illegal, unregulated, and unreported

3. What does "landed" mean? What does "discarded" mean? Landed means taken on board and kept, discarded means released back into the ocean

4. Do discarded sharks always survive? Sometimes they do, sometimes they do not. Finned sharks always die, others might still live.

5. What is "bycatch"? Fish or other animals that are caught by accident; not the intended catch.

6. What is the range estimated for number of sharks lost in 2000? 63-273 million

Group Questions

1. What is the goal of this paper? To provide up-to-date information on global shark populations, including estimations of illegal and undocumented fishing.

2. What conclusions can be made by looking at the estimated exploitation rate? The current exploitation rate is unsustainable, meaning we are taking more sharks out than can be replaced by natural processes.

3. What points does the author use to explain why catch rates have remained relatively stable, despite estimates that shark exploitation rates are so high? Fishers move to new sites as sharks are depleted, or target smaller species

4. How does the author think legislation should be changed? What is the current focus, and how does the author challenge it? The current focus of legislation is on anti-finning, where it should be shark sustainability.

5. What are some unintended effects of placing strongly enforced fishing regulations on a specific are or country? Fishers continue fishing, but in different locations - for example, poorer countries that cannot effectively enforce regulations. Also, prices for items like shark fins increase, driving the market further.

6. Are all shark species at risk for extinction? No, 28% of assessed (in this paper anyway!) and non-data deficient species are considered at risk.

Article 2:

Independent Questions

1. According to this article, what are some of the threats to marine ecosystems (not JUST sharks)? The expansion of fisheries and globalized trade

2. What three groups make up "Class Chondrichthyes"? Sharks, rays, and chimaeras

3. What makes sharks and their relatives a more vulnerable group than other fishes? Long lives, late maturity, few offspring

4. What is "bycatch"? Fish or other animals that are caught by accident; not the intended catch.

ANSWER KEYS (CONTINUED)

5. What are the six categories of the scale used by the International Union for Conservation of Nature (IUCN) to determine extinction risk? Critically Endangered, Endangered, Vulnerable, Near Threatened, Least Concern, Data Deficient.

6. If a species is data deficient (DD), can we estimate if population numbers are increasing or decreasing? Not easily! We can sometimes make estimations, but there is no way to know for sure without more research.

Group Questions

1. What is the goal of this paper? To assess all sharks and their relatives and provide statistics about how many sharks are currently at risk of extinction.

2. How many species fall into each IUCN Red List Category? Refer to Table 2. CR: 25; EN: 43; VU: 113; NT: 132; LC: 241; DD: 487

3. Why does the author suggest species that inhabit shallow waters (and narrow depth ranges) may be more likely to be at risk? They are more easily fished.

4. Sharks and their relatives are an incredibly diverse group. Why is biodiversity important in an ecosystem? Does it matter if a few species of shark go extinct? Yes it matters! Removing a single group from an ecosystem can have devastating impacts, even if a species of shark is not an apex predator.

5. Why is lack of global protections an issue for sharks? Specifically, if one country has legal protections for sharks in place but a neighboring country does not, what is the problem? Many sharks move across large geographic regions - if one country protects the species, the shark moves into those waters.

6. What do you think are some of the difficulties of protecting sharks on a global scale? Open ended!