Exploring Ocean Frontiers

Ocean Frontiers:
The Dawn of a New Era in Ocean Stewardship

Grades 7-12 / Secondary Lessons

Acknowledgements

Film

Karen Anspacher-Meyer	Executive Director, Green Fire Productions
Ralf Meyer	Creative Director, Green Fire Productions

Curriculum Authors

Jennifer Buffett	B.A., B.Ed, Masters of Science Communications
Sarah Lockman	B.Kin, B.Ed, Masters in Cultural Studies and Critical Theory

Resource Reviewers

Karen Anspacher-Meyer	Executive Director, Green Fire Productions
Eva Barnett	Outreach Manager, Green Fire Productions
Kimberly Williams	B.S. Master of Science in Coastal Oceanography, NYS Certified Science Teacher, Grades 5-12

Project Developers

Karen Anspacher-Meyer	Executive Director, Green Fire Productions
Eva Barnett	Outreach Manager, Green Fire Productions

Project Manager

Eva Barnett	Outreach Manager, Green Fire Productions

Graphic Design

Monika Sosnowska	MSE Marketing (www.msemarketing.net)

Cover Images

Humpback whale calf - Florian Graner; All other images - Green Fire Productions

green fire
PRODUCTIONS

ocean-frontiers.org
greatbearsea.net
greenfireproductions.org

Table of Contents

Introduction

The **Exploring Ocean Frontiers Secondary Educator Resources** are based on the *Ocean Frontiers* film series by Green Fire Productions, and can be used to engage students on an inquiry-based educational journey in ocean stewardship. The inspiring *Ocean Frontiers* films portray how unlikely allies – government, industry, science and conservation – are working together to find solutions that benefit ocean ecosystems and economies.

Students can learn about this new wave of ocean stewardship through these secondary lesson sets that build on real-world science and help make science more relevant. The lessons feature engaging classroom activities that include inspiring film clips, research data, local knowledge, place-based stories, role-playing, background information and more — providing educators curriculum-linked tools to incorporate ocean management and conservation perspectives into a variety of classroom settings. Themes include: collaborative science, ocean planning, stakeholder engagement, ocean data portals, marine biodiversity and ocean stewardship. All secondary lessons are connected to the Next Generation Science Standards and Ocean Literacy Principles.

The films, secondary lesson sets and post-secondary discussion guides are available at no cost:
https://ocean-frontiers.org/educator-resources

Ocean Frontiers Film Series

As the blue planet's burgeoning populace faces an uncertain future, never before have the world's oceans been called upon to serve so many, while suffering so much. To address this, people around the world are engaged in collaborative ocean planning. In North America, the U.S. and Canada have created ocean plans to help guide management and conservation of our oceans. State, federal and tribal governments are working together with scientists and a wide array of marine stakeholders including maritime commerce, fishing and recreation, plus the growing industries of offshore wind energy and aquaculture. Green Fire Productions has traveled North America from coast to coast, capturing the inspiring stories of people working together to sustain our seas and our ocean economies. The three *Ocean Frontiers* films focus on ocean planning in the U.S. and *The Great Bear Sea* portrays ocean planning in British Columbia, Canada.

Green Fire Productions, a non-governmental organization, produces documentaries on sustainability and conservation of natural resources. Founded in 1989 by Karen Anspacher-Meyer and Ralf Meyer, Green Fire films are used in classrooms worldwide and screened in community events, for government officials and on public television.

Ocean Planning

Our ocean use is growing rapidly, with massive new ships, soaring demand for offshore sand mining and proposed wind energy development offshore. Our busy waters are also home to endangered whales and sea turtles, and support vital fishing and recreation industries. It's more important than ever that we plan ahead for responsible ocean growth. In the face of both increasing development pressures and increasing interest in the conservation of nature, ocean planning has been identified by scientists, policy makers and stakeholders around the globe as a practical approach to manage both conflicts and compatibilities in the marine environment. It is a comprehensive, ecosystem-based planning process built on sound science to analyze and plan for current and anticipated uses of the ocean. Pioneered in Western Europe, ocean planning is underway in more than 60 countries, including the United States and Canada. For more background information on ocean planning, see Appendix.

Resource Overview

Ocean Frontiers: The Dawn of a New Era in Ocean Stewardship

The first *Ocean Frontiers* film tells four ocean planning success stories from seaports and watersheds across the country — from the busy shipping lanes of Boston Harbor to a small fishing community in the Pacific Northwest; from America's coral reefs in the Florida Keys to the nation's premier seafood nursery in the Mississippi Delta. Lessons include:

- **Uncovering GIS Data: Saving Whales at Stellwagen Bank**
  Map interpretation; using GIS data to reduce ship strikes on whales.
- **Stakeholder Engagement: Playing and Working in the Florida Keys**
  Marine zoning and stewardship roles in coral reef conservation.
- **Rivers Connect: Iowa Farmers & the Gulf of Mexico**
  An inland perspective on reducing human impacts on the ocean.
- **Sustainable Fishing in Port Orford, Oregon: Collaboration in Action**
  Local knowledge, marine protected areas and collaborative research to preserve natural and cultural resources.

View film | Download film | Download Spanish version

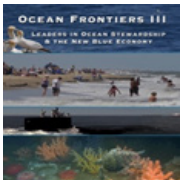
Ocean Frontiers II: A New England Story for Sustaining the Sea

Ocean Frontiers II looks closely at Rhode Island's ocean planning work, the use of science and data to make better decisions and the subsequent siting of an offshore wind farm. The story focuses on how the offshore wind energy company worked with conservationists, fishermen and the Narragansett Indian Tribe to reduce conflicts and potential impacts. Lessons include:

- **Ocean Stakeholders: Every Voice Matters**
  Stakeholder engagement and collaborative decision-making.
- **Keeping Track Of It All: Using Data Portals for Ocean Planning**
  Understanding human activity in the ocean to reduce impacts on marine life.
- **Multi-Species Management: We're All In This Together**
  Food webs; keystone species; systems thinking; writing to Congress.
- **Collaborative Research: Block Island Wind Farm**
  Interpreting data; collaborative research and local knowledge to understand potential wind farm impacts to fishermen.

View film | Download film

Ocean Frontiers III: Leaders in Ocean Stewardship & the New Blue Economy

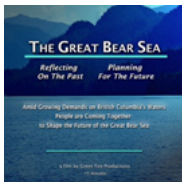


The most recent film in the series, *Ocean Frontiers III*, provides the best overview of U.S. ocean planning in the series. The film focuses on U.S. regional ocean planning efforts and how a broad array of people are using science and data to reduce conflicts and protect marine ecosystems.
Lessons include:

- **What is Ocean Planning: Charting the Ocean's Future**
  Stakeholder role-playing game; working together to resolve conflicts.
- **Ocean Data Portals: The Key to Smart Decisions**
  Exploring interactive mapping tools; scavenger hunt and map making.
- **Marine Biodiversity, Conservation & Healthy Oceans: Deep Sea Corals**
  How human uses of the ocean intersect with marine life; compatible uses; mapping.
- **Get Involved: Student Advocacy & Citizen Science**
  Writing to Congress; engaging in citizen science.

View film | Download film

The Great Bear Sea: Reflecting on the Past—Planning for the Future



The Great Bear Sea portrays marine planning in British Columbia. The film focuses on the collaboration between Indigenous communities and the Province of British Columbia to create marine plans to both protect their home and build sustainable coastal economies. 'Exploring the Great Bear Sea' curriculum resources include elementary, secondary and post-secondary resources that are available for free download online at www.greatbearsea.net. Themes include traditional and local knowledge, collaborative science, marine planning, biodiversity, sustainable resource management and marine stewardship. All resources are connected to the revised British Columbia curriculum.

View film | Download film | Download Spanish version

Tips for Educators

The lesson plans, film clips and resources provide a framework for educators to teach key elements of ocean planning and ocean stewardship. All lessons are inquiry-based and activities can be customized to suit the needs of your environment or learners. Lessons can be taught individually or as units of study with the full four-lesson sets. When utilizing individual lessons, students will benefit from watching the associated full-length film in advance. At points it may be helpful to pre-teach new concepts or learning strategies. These have been noted, where appropriate, with guidance provided.

The resources have been divided into sections to guide the classroom teacher. For each lesson teachers will find essential questions, required materials, learning objectives, step-by-step instructions for suggested activities, extensions and additional resources, as well as learning materials (handouts, worksheets, etc.) to complete the lessons. A background information section is included for each lesson, highlighting additional content for educators. Prior to teaching these lessons, it is highly recommended that educators watch the associated film.

Post-secondary discussion guides are also available for each film and may be adapted by secondary teachers for their learning environment.

Resource Development & Contributors

We believe that teaching students about current marine policy decisions and the science-based, solutions-oriented approach of ocean planning is critical for them to become informed ocean stewards. Green Fire Productions created these resources to inform and motivate the next generation of ocean leaders.

Curriculum Authors

Curriculum developers, Jennifer Buffett (B.A., B.Ed, Masters of Science Communications) and Sarah Lockman (B.Kin, B.Ed., Masters in Cultural Studies and Critical Theory) have worked in formal and informal educational settings, including elementary, secondary, post-secondary classrooms and non-profit organizations in British Columbia and Ontario, Canada. They specialize in innovative approaches to hands-on, inquiry and place-based learning, and work with students, teachers and organizations to develop relevant, engaging learning resources and environments. Contact them at: learninginplace@gmail.com.

Contributors

There are materials included in this lesson set that were provided by individuals or organizations for use in this resource. Please note these resources are not available for use or publication outside of the classroom without permission. Thank you to the following contributors for sharing these resources:

Lesson 1: Stellwagen Bank GIS Map PDF – Stellwagen Bank National Marine Sanctuary

Lesson 3: Fishtracker Data Handout – Fishtracker Project, Tom Calvanese

Next Generation Science Standards & Ocean Literacy Table

Next Generation Science Standards	Lesson 1	Lesson 2	Lesson 3	Lesson 4
Middle School				
MS-LS2-1. Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.	✓			✓
MS-LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.	✓			✓
MS-LS2-5. Evaluate competing design solutions for maintaining biodiversity and ecosystem services.	✓		✓	✓
MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.		✓	✓	✓
MS-ESS3-4. Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.			✓	✓
High School				
HS-LS2-6. Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.	✓	✓		✓
HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.	✓	✓	✓	✓
HS-LS2-8. Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.	✓			
HS-LS4-6. Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity	✓			
HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems	✓	✓	✓	✓
HS-ESS3-6. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.	✓			
HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.		✓		
Ocean Literacy Principles	**Lesson 1**	**Lesson 2**	**Lesson 3**	**Lesson 4**
Essential Principle #1: The Earth has one big ocean with many features.	✓	✓	✓	
Essential Principle #5: The ocean supports a great diversity of life & ecosystems.	✓	✓		✓
Essential Principle #6: The ocean and humans are inextricably linked.	✓	✓	✓	✓

Uncovering GIS Data:
Saving Whales at Stellwagen Bank

Essential Questions

- What is GIS? How is GIS being used to help inform decision-making in ocean planning?
- How is scientific research helping to protect whales from ship strikes?

Materials & Resources

- Computer, projector and screen
- Film clip
  - *Ocean Frontiers: Saving Whales at Stellwagen Bank* (18 minutes) http://bit.ly/OF1-Stellwagen
- Stellwagen Bank GIS Map PDF[1]
- Legend and Layer Descriptions Handout (PDF)
- Stellwagen Bank Observations and Research Notes Worksheet (or writable PDF)
- Stellwagen Bank Observations and Research Notes Worksheet (Teacher Copy)

NOTE: The Stellwagen Bank GIS Map PDF **must be opened with Adobe Acrobat Reader** in order for the layers to work. Download free Adobe Acrobat Reader.

[1] Provided by Stellwagen Bank National Marine Sanctuary

Objectives

Students will:

1. Explore a GIS map that uses research collected from Stellwagen Bank National Marine Sanctuary.
2. Analyze and interpret data regarding shipping lanes in Massachusetts Bay and Stellwagen Bank National Marine Sanctuary.
3. Construct explanations and engage in argument from evidence regarding selection of a new shipping lane route.

Subjects

- Science – Environmental, Marine, Oceanography
- Technology

Duration 140+ minutes

Note: *Ocean Frontiers I* can be downloaded at http://bit.ly/OF1-DL

Overview

In this lesson, students will explore the Geographic Information System (GIS) approach that was used to study whale populations in Stellwagen Bank National Marine Sanctuary. Students will watch *Ocean Frontiers: Saving Whales at Stellwagen Bank* to learn more about the shipping lanes in Boston Harbor and the impact ships were having on whale populations. Using data represented in an interactive GIS map and examining the placement of the old shipping lanes, students will analyze the whale sightings, baleen whale density, bathymetry and sediment, and conduct further research to predict the placement of the new shipping lanes.

> "There were also areas in the sanctuary that were less used by whales. So we decided it would be a good idea – very smart – to try to move the shipping lanes from areas that whales used a lot to areas that the whales used with much less frequency."
>
> *Dave Wiley – Stellwagen Bank National Marine Sanctuary*

Activities

Activity 1 – Introduction to Massachusetts Bay and Stellwagen Bank National Marine Sanctuary (45 minutes)

1. Facilitate a discussion about current knowledge of marine sanctuaries. Some possible prompting questions may include (see Background Information):
   a. What is a marine sanctuary?
   b. What is the purpose of sanctuaries related to the environment?
   c. Are there any marine or terrestrial sanctuaries in your area?
   d. What would be the purpose of a marine sanctuary?
   e. Think about particular species that might be found or migrate through marine sanctuaries in the US, what threats would be present for the species?
2. Ensure all of the layers except GIS Layers, Border and Bathymetry are turned off, and then project the Stellwagen Bank GIS Map PDF on the screen and ask students if they can identify the area. See Background Information to learn more about using the layers within the map.
3. Inform the students that this area is Massachusetts Bay. Introduce Stellwagen Bank National Marine Sanctuary to the students by turning on the SBNMS Polygon.
4. Watch *Ocean Frontiers: Saving Whales at Stellwagen Bank*. As the students watch the film, they should take notes using the prompting questions above as a guide.
5. After watching the film, review the prompting questions and discuss additional information presented in the film.

Activity 2 – Introduction to GIS (45 minutes)

1. Introduce the concept of geographic information systems (GIS) – see Background Information for additional GIS information and resources:

   "A geographic information system (GIS) is a framework for gathering, managing, and analyzing data. Rooted in the science of geography, GIS integrates many types of data. It analyzes spatial location and organizes layers of information into visualizations using maps and 3D scenes. With this unique capability, GIS reveals deeper insights into data, such as patterns, relationships, and situations – helping users make smarter decisions."

   - Defined online by ESRI, a company who sells GIS software

2. In pairs, have students brainstorm how they think GIS might be used in marine sanctuaries. Share as a class and explain that at Stellwagen Bank National Marine Sanctuary GIS was used to track baleen whale populations within the sanctuary and specifically within the shipping lanes in Boston Harbor, and helped with the eventual change in shipping lanes.

3. Ensure all of the layers except GIS Layers, Border and Bathymetry are turned off, and then project the Stellwagen Bank GIS Map PDF on the screen. Introduce the legend and definitions of the layers using the Legend and Layer Descriptions Handout, either projecting it on the screen or using a printed copy. Each layer on the map represents many points of data that were collected about that particular layer's content. Turn on each layer as it is discussed.

   a. SBNMS Polygon
   b. Bathymetry (Note: This layer is already on.)
   c. Survey Tracklines
   d. Standardized Survey Sightings
   e. Sediment (Note: To see the sediment, turn off Survey Tracklines and Standardized Survey Sightings layers.)
   f. Baleen Whale Density (Note: To see the baleen whale density, turn off sediment and bathymetry layers.)

   IMPORTANT NOTE: The New Shipping Lane layer should not be turned on and identified until the students have completed their research and made predictions.

4. Show the students the placement of the Old Shipping Lane by turning this layer on and discuss observations. At this point you will have the following layers on: GIS Layers, Border, SBNMS Polygon and Old Shipping Lane; the Baleen Whale Density will also be visible.

Activity 3 – Research (45 minutes, plus additional research and sharing predictions)

1. Divide the class into small groups. Use the Stellwagen Bank Observations and Research Notes Worksheet either as a writable PDF or a printed copy and have the students observe the GIS images, conduct further research and predict the placement of the New Shipping Lane. Some possible research ideas could include:

   a. Standardized Survey Sightings and Survey Tracklines
   b. Baleen Whale Density

c. Bathymetry
d. Sediment
e. Other

2. Have each group share where they think the placement of the New Shipping Lane should be and why. Allow other groups the opportunity to ask questions about the predictions.

3. Review the Old Shipping Lane placement and reveal the placement of the New Shipping Lane using the Stellwagen Bank GIS Map PDF by turning the New Shipping Lane layer on. At this point you will have the following layers on: GIS Layers, Border, SBNMS Polygon, Old Shipping Lane and New Shipping Lane; the Baleen Whale Density will also be visible.

    a. Discuss the placement of the new shipping lane and why that location was selected as the best option. Was it where students expected it to be?

Activity 4 – Wrap Up/Closure Questions (5 minutes)

1. Discuss why continuing to monitor the ship strikes in the shipping lanes is an important step for the future.

2. Allow students time to discuss as a class or journal answers to the Essential Questions to check for student understanding and correct any misconceptions.

Extension

1. Introduce the "Whale Alert" app (see Background Information and Additional Resources) and allow the students to explore whale sightings in real-time. Compare and contrast the different species that are found along the east and the west coasts. Research more about the whale species and their movement.

2. Research shipping lanes in other harbors in the United States and/or globally to learn more about their shipping lane placements and ship strikes

Background Information

Stellwagen Bank National Marine Sanctuary

Stellwagen Bank National Marine Sanctuary contains an underwater plateau located at the mouth of Massachusetts Bay. It is an 842 square mile marine protected area that stretches from three miles southeast of Cape Ann to three miles north of Cape Cod and is about 25 miles east of Boston. A National Marine Sanctuary is a type of marine protected area in federal waters that preserves the marine environment. Marine sanctuaries are underwater parks that are protected and the area supports monitoring programs that meet the needs of the specific sanctuary. For more information on marine sanctuaries, see the NOAA National Marine Sanctuaries website and fact sheet.

There are many marine mammals found in Stellwagen Bank National Marine Sanctuary.

Seventeen species have been seen in the sanctuary at some point in time; however, there are regular visitors which include the following species: humpback whales, fin whales, minke whales, northern right whales, Atlantic white-sided dolphins, harbor porpoises, pilot whales and harbor seals. The North Atlantic right whales are endangered. For example, in 2017, 17 out of a population of barely 460 of the North Atlantic right whales were lost.

Stellwagen Bank National Marine Sanctuary is open to all forms of vessels with regulations and both commercial and recreational fishing are allowed with restrictions. The shipping lanes to Boston Harbor pass through Stellwagen Bank National Marine Sanctuary. Increased vessel traffic had led to more noise pollution and ship strikes. Moving the shipping lanes to a new location within the sanctuary was an important step in reducing whale and ship collisions.

What is GIS?

Geographic Information Systems (GIS) is a system that brings together technology, data, people and processes to help plan. People use GIS to make maps that analyze, communicate information and solve problems. In this lesson plan data was collected on whale sightings and analyzed to help plan new shipping lanes to decrease the collisions between whales and ship strikes.

As noted by ESRI (GIS software company): https://www.esri.com/en-us/what-is-gis/overview

"A geographic information system (GIS) is a framework for gathering, managing, and analyzing data. Rooted in the science of geography, GIS integrates many types of data. It analyzes spatial location and organizes layers of information into visualizations using maps and 3D scenes. With this unique capability, GIS reveals deeper insights into data, such as patterns, relationships, and situations – helping users make smarter decisions."

How to use the Stellwagen Bank GIS Map PDF

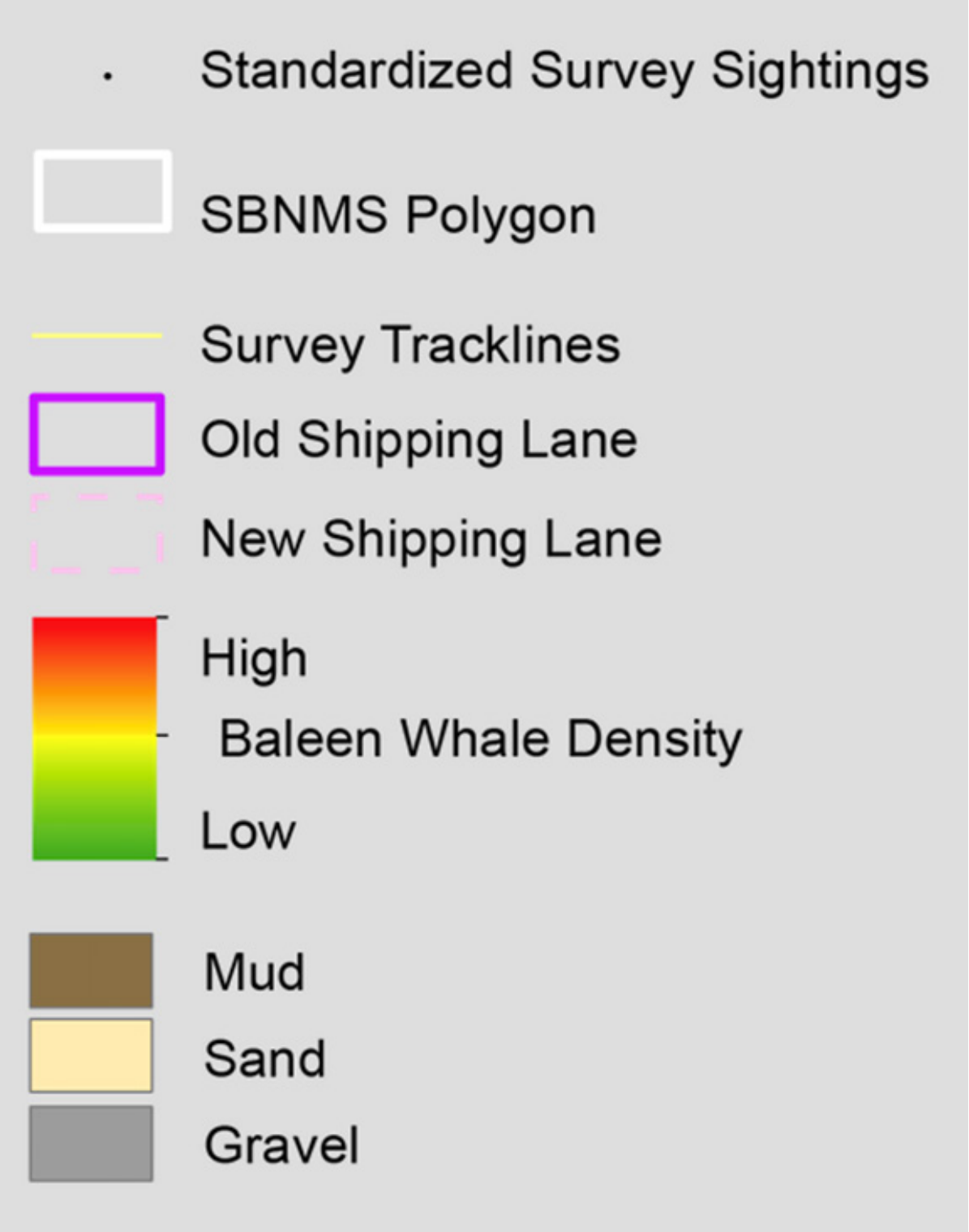
Stellwagen Bank National Marine Sanctuary provided the interactive Stellwagen Bank GIS Map PDF. To use the map, it must be opened using Adobe Acrobat. Ensure you have opened up the layers, found on the left hand side of the page. Under the paperclip icon there is a stack of papers icon. Click this icon. This opens up the layers – GIS Layers Folder and Baleen Whale Density. An "eye" in the box means the layer has been turned on. Click on the arrow between the eye and the GIS Layers folder. You will then see the following drop down list: GIS Layers, Border, SBNMS Polygon, Standardized Survey Sightings, Survey Tracklines, New Shipping Lane, Old Shipping Lane, Sediment and Bathymetry. The Baleen Whale Density layer is a locked reference layer and cannot be manipulated. Within the lesson you will see references to turning on and off the layers. To turn on a layer, click on the box beside the layer and an eye appears, and to turn off a layer click on the eye and the box will be all white.

Additional Resources

- Stellwagen Bank National Marine Sanctuary
- National Marine Sanctuaries
- ESRI website - What is GIS?
- Article on California Shipping Lanes Moved in Attempt to Avoid Killing Whales
- Shipping Lanes in Greater Farallones National Marine Sanctuary
- Whale Alert

Legend and Layer Descriptions Handout

Legend



Layer Descriptions

SBNMS Polygon

Stellwagen Bank National Marine Sanctuary designated boundary was passed by Congress in 1992. The sanctuary consists of an area entirely within federal waters, measuring 842 square miles (638 square nautical miles) and lying off the coast of Massachusetts.

Bathymetry

Graphic representation illustrating water depth measurement information used to produce depth-contoured charts. Water depths over and around the bank range from 65 feet (light blue) on the southwest corner to depths of about 600 feet (dark blue) in deep passages to the north-east. Massachusetts Basin on the western side of the sanctuary levels off at about 300 feet in depth, while the top of the bank averages about 100 to 120 feet.

Standardized Survey Sightings

During July 1994–August 1995 and July 2001–June 2002 a study was undertaken by the sanctuary to quantify and map patterns of human and wildlife use of the sanctuary. This survey provided equal effort in all parts of the sanctuary. Each month data was collected along 10 standardized shipboard survey tracklines (strip transects of 400 m width) that crossed the sanctuary at 5 km (2.5 nm) intervals providing complete coverage of the sanctuary. 9,414 locations were recorded totaling 14,850 sightings.

Survey Tracklines

Ten standardized shipboard survey tracklines (strip transects of 400 m width) that crossed the sanctuary at 5 km (2.5 nm) intervals providing complete coverage of the sanctuary.

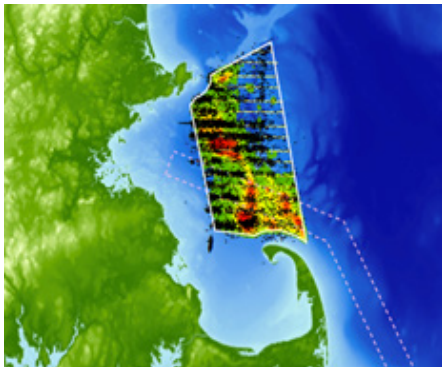
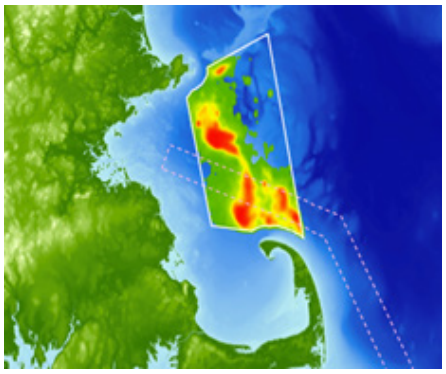
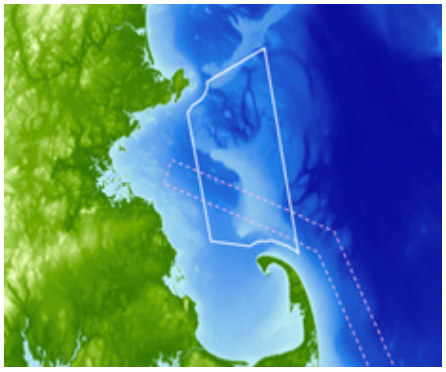
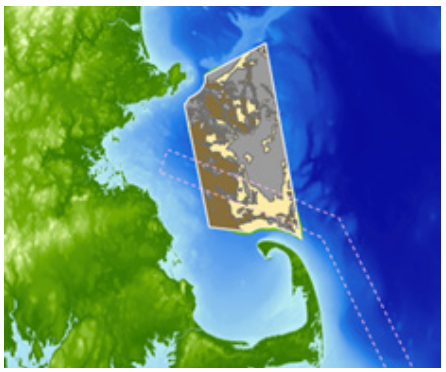
Baleen Whale Distribution

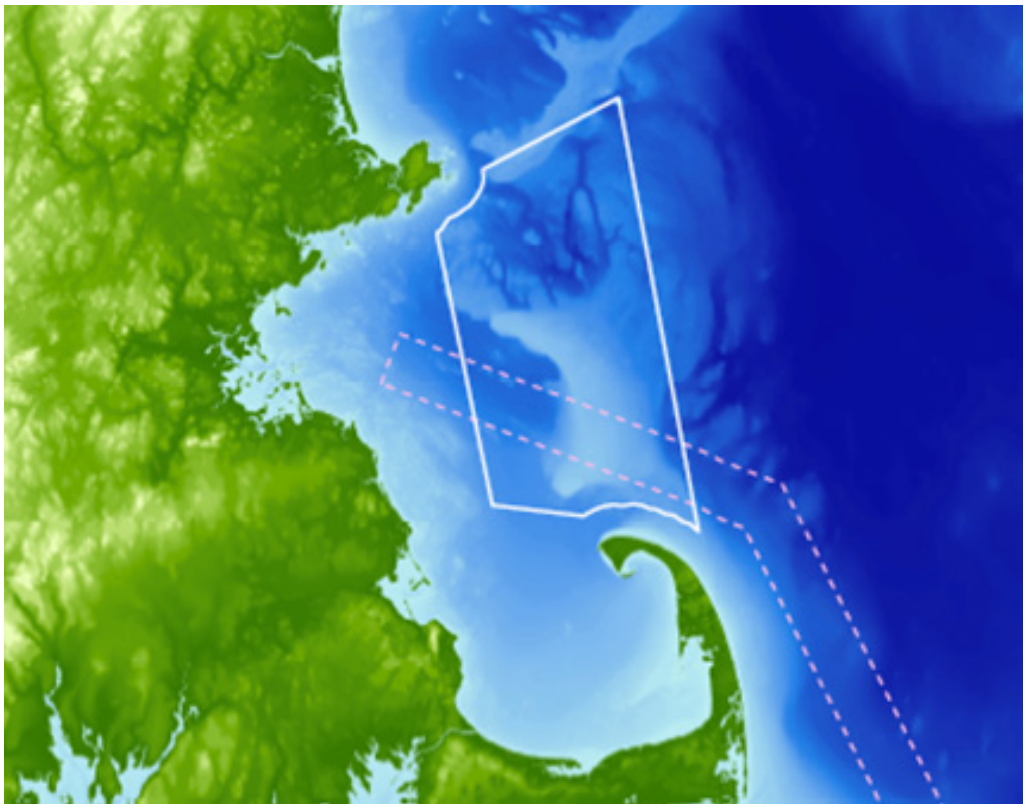
Direct knowledge of the relative occurrence and spatial/temporal distribution of cetaceans in the Stellwagen Bank sanctuary was derived from two sources: non-standardized data collected aboard whale watching vessels and standardized surveys conducted by the sanctuary. Whale watch sightings data were provided by the Provincetown Center for Coastal Studies and the Whale Center of New England. Whale watching trips targeted high use areas where companies expected to see the largest number of whales, particularly humpbacks. The database is robust in that it consists of multiple daily trips occurring from April through October, has been continuous over 25 years (1979–2004), and consists of over 255,000 sightings of animals. However, effort is not equally distributed throughout the sanctuary. Kriged density plots of baleen whale derived sightings were produced using a 5,000 m search radius and symbolized on a stretched histogram with red being areas of high density and green areas of low density.

The descriptions are from the Stellwagen Bank National Marine Sanctuary Management Plan.

Name:_____

Stellwagen Bank Observations and Research Notes Worksheet

Standardized Survey Sightings and Survey Tracklines		
Baleen Whale Density		
Bathymetry		
Sediment		

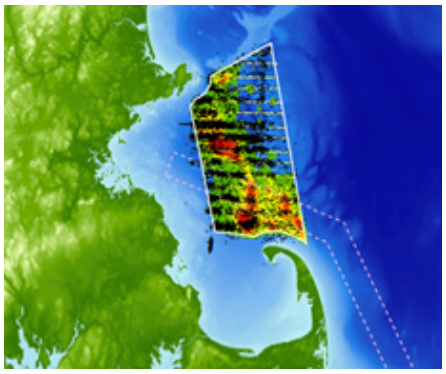
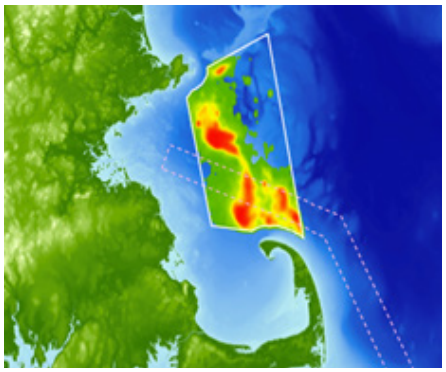
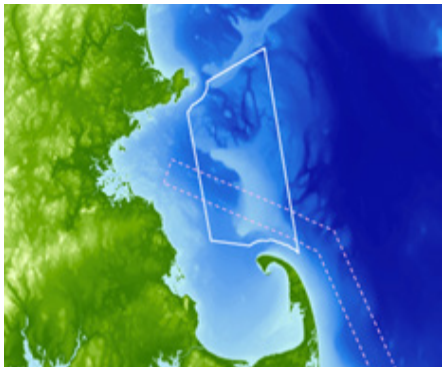
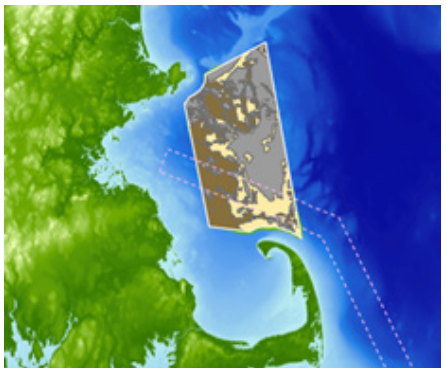
Other	
Prediction of New Shipping Lane	

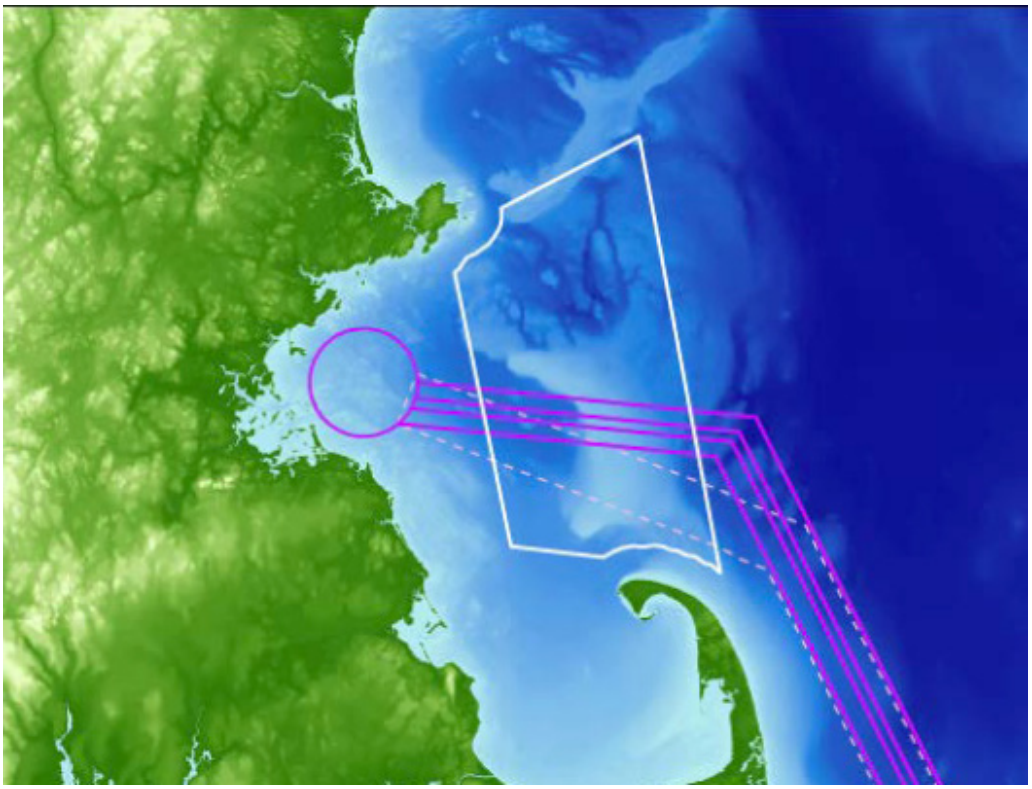
Note: Old shipping lanes are referenced on this handout.

The images were contributed from Stellwagen Bank National Marine Sanctuary.

Name:_____

Stellwagen Bank Observations and Research Notes Worksheet (Teacher Copy)

Standardized Survey Sightings and Survey Tracklines		*Example of possible student response:* There are more tracklines in the western part of the sanctuary, with the most activity in the southwest and central/north. The shipping lane and tracklines overlap, but the shipping lane mostly misses the heaviest trackline areas.
Baleen Whale Density		*Example of possible student response:* The greatest concentrations of whales are in the northwest, south and southeast parts of the sanctuary. The shipping lane goes through an area with a great deal of whale activity.
Bathymetry		*Example of possible student response:* The shallower water is in the central and southeastern parts of the sanctuary, with some shallow areas in the northeast that have deeper water channels running through them. It's deepest in the west and southwest. The shipping lane goes through both deeper and shallower water.
Sediment		*Example of possible student response:* The sediment layer is muddy in the west, sandy in the southeast, with gravel mostly in the east and north. The shipping lane goes through areas with mostly mud and sand bottoms.

Other	*Student responses will vary.* *The actual new shipping lane is pictured below in purple. Student predictions of where the new shipping lane should go will vary.*
Prediction of New Shipping Lane	

Note: Old shipping lanes are referenced on this handout.

The images were contributed from Stellwagen Bank National Marine Sanctuary.

Stakeholder Engagement: Playing and Working in the Florida Keys

Essential Questions

- How were stakeholders included in ocean management in the Florida Keys? Who are the stakeholders?
- What might be some conflicting ocean uses and some compatible uses?
- What stewardship roles can stakeholders be involved with to protect coral reef health as well as resources in the Florida Keys?

Materials & Resources

- Computer, projector and screen
- Film clip
  - *Ocean Frontiers: An Ocean Blueprint for the Florida Keys* (11 minutes) http://bit.ly/OF1-FloridaKeys
- Ocean Stakeholders in the Florida Keys Worksheet
- Ecotourism in the Florida Keys Worksheet

Objectives

Students will:

1. Examine why it is important to help protect the resources in a marine ecosystem by engaging in the role of a stakeholder.
2. Identify and investigate the current types and locations of marine zoning in the Florida Keys.
3. Explore stewardship roles that ocean stakeholders can participate in locally, regionally or globally to conserve resources.

Subjects

- Science – Ecology, Environmental
- Art
- English Language Arts
- Social Studies
- Technology

Duration 110+ minutes

Note: *Ocean Frontiers I* can be downloaded at http://bit.ly/OF1-DL

Overview

In this lesson, students will explore ocean stakeholders (ocean users and businesses) in the Florida Keys that play an important role in the economy. Using a tourism and recreation lens, students will research marine zones and explore how ocean stakeholders can have conflicting and compatible uses in the marine ecosystem. Students will watch *Ocean Frontiers: An Ocean Blueprint for the Florida Keys* and learn that ocean stakeholders can help protect resources while playing an important role in the economy. Students will create an ecotourism business and develop a public service announcement that takes into account how businesses can play a role locally, regionally and globally to help protect resources of the Florida Keys.

> "We have seen a turn in this community. We've seen people realize that we're not going to put them out of business. Our job is to keep them in business. Our job is to make sure that there are fish and other resources here for the future."
>
> *Billy Causey – Office of National Marine Sanctuaries, National Oceanic and Atmospheric Administration (NOAA)*

Activities

Activity 1 – A Vacation in the Florida Keys (45 minutes plus research time)

1. Have students imagine that they are heading to the Florida Keys on a vacation. As a large group brainstorm and list the different ocean activities that the students would like to participate in while on vacation.
2. Watch *Ocean Frontiers: An Ocean Blueprint for the Florida Keys*.
3. After the clip, provide a few minutes for the students to make notes. Have the students discuss their notes with a partner, then share as a class. Consider the following discussion points:
   a. How are the ocean stakeholders helping to protect resources in the Florida Keys?
   b. What might be some conflicting/compatible ocean uses among the ocean stakeholders?
   c. What were some of the actions taken to protect resources in the Florida Keys?
4. Divide the class into small groups and have each group take on the role of a different ocean stakeholder through the lens of recreation or tourism in the Florida Keys.
   Note: You can select the ocean stakeholders from the brainstorm or from the film, for example, sightseers, divers, sailors, fishers, etc. Groups can be assigned an ocean stakeholder role by pulling from a hat or selecting on their own.
5. Provide each student with a copy of Ocean Stakeholders in the Florida Keys Worksheet and review together as a class. Have each group research how the marine zones help their business.

Activity 2 – Ocean Users and Actions to Protect the Florida Keys (60 minutes plus sharing public service announcements)

1. Share the following quote:

   "And this is what I get up every day to go to work to do, is to say, what can I do locally, what can I do regionally and how can I influence what is happening on a global scale?" Billy Causey – Office of National Marine Sanctuaries, National Oceanic and Atmospheric Administration (NOAA)

2. Discuss the quote and how consumers can look for businesses that help the environment. Think of or research examples of businesses that do this in your community.

3. Continue working in the same groups from Activity 1 and using the same ocean stakeholders, have the students use it as a base to create an ecotourism business and a public service announcement (print ad, poster, radio ad, TV commercial, etc.) that promotes marine conservation. The business must address Billy Causey's three questions: (1) What can I do locally to conserve resources? (2) What can I do regionally to conserve resources? (3) How can I influence what is happening globally to conserve resources? Provide the students with the Ecotourism in the Florida Keys Worksheet and allow time for them to create the public service announcement for their ecotourism business in the Florida Keys.

   Note: The public service announcements could be started in class and finished for homework if more time is needed.

4. Share public service announcements as a class.

Activity 3 – Wrap Up/Closure Questions (5 minutes)

1. Ask students how the needs of future generations might affect the decisions being made about our oceans today.
2. Allow the students time to discuss as a class or journal answers to the Essential Questions to check for student understanding and correct any misconceptions.

Extension

1. Efforts are now being made to eliminate water pollution in the Florida Keys. Research water pollution in the Florida Keys. Have students submit a reflective response of their ideas on how to eliminate water pollution using stakeholder collaboration as a model.
2. Reflect on your own community: What is a pressing environmental concern in your local region? Provide some examples of ways it could be addressed through stakeholder collaboration or a stewardship role.
3. Engage in a class stewardship activity at a local water source in your community and discuss how stewardship at the local level has impacts at the global level.

Background Information

Florida Keys National Marine Sanctuary

North America's only living coral barrier reef, known as the Great Florida Reef, is located approximately six miles seaward of the Florida Keys. The reef tract starts near Miami and extends southwest to the Dry Tortugas, about sixty-seven miles west of Key West. It is the third largest coral barrier reef system in the world. Coral reefs are an important ecosystem in the oceans as they support and provide homes for many plants and animals.

Protecting these coral reefs is the Florida Keys National Marine Sanctuary, America's most popular marine destination—bringing in $1.2 billion every year via tourism. The sanctuary is also America's showcase of marine conservation zoning, one of the early efforts in ocean planning. With a dizzying array of people making a living and playing in the Keys, the marine zones provide an effective way to reduce conflicts between ocean users and protect the reefs, the fisheries and ocean-dependent jobs.

The management of the Sanctuary is overseen by a Sanctuary Advisory Council, which is made up of more than 30 organizations and industries, including sport and commercial fishing, tourism, diving, research, restoration and conservation. The Sanctuary provides refuge, recreation and livelihoods through a collaborative plan developed by all concerned.

Additional Resources

- Florida Keys National Marine Sanctuary
- How to Create the Perfect Public Service Announcement

Name:_____

Ocean Stakeholders in the Florida Keys Worksheet

1. What is your assigned ocean stakeholder? Notes on the assigned ocean stakeholder.

2. How does your role as an ocean stakeholder impact the coral reef ecosystem?

3. Notes on how marine zones help your role as an ocean stakeholder.

Name:_____

Ecotourism in the Florida Keys Worksheet

Your business will promote ecotourism in the Florida Keys. It will protect the coral reefs and promote marine conservation. Tourists visiting the Florida Keys will choose your company because of your commitment to helping protect the coral reef's ecosystem.

Business Name:

Type of public service announcement:

Ways to incorporate Billy Causey's 3 questions:

1. What can our business do locally to conserve resources for future generations?

2. What can our business do regionally to conserve resources for future generations?

3. How can our business influence what is happening globally to conserve resources for future generations?

4. What other businesses could your business collaborate with to help conserve resources?

Rivers Connect:
Iowa Farmers & the Gulf of Mexico

Essential Questions

- How are farms and agriculture connected to the ocean?
- What are some other human activities that impact our oceans?
- What are some ways to help decrease negative impacts of human activities on our oceans?
- What constitutes a Dead Zone? How is it formed? What are the impacts?

Materials & Resources

- Computer, projector and screen
- Film clip
  - *Ocean Frontiers: Iowa Farmers & Gulf of Mexico* (15 minutes) http://bit.ly/OF1-Iowa
- Mississippi Watershed Map 1[1] http://bit.ly/MissWatershedMap
- Iowa Farmers & Gulf of Mexico Guided Viewing Worksheet
- The Rivers of the Mississippi Watershed (animated map)[2] https://svs.gsfc.nasa.gov/4493
- Human Impacts on Oceans Group Activity Worksheet

[1] Credit: Wikimedia Commons, John Platek

[2] Credit: NASA's Scientific Visualization Studio

Objectives

Students will:

1. Analyze the path of water between Iowa and the Gulf of Mexico, exploring the concepts of "effluents" and "hypoxic (or dead) zones".
2. Examine the connections between agriculture and ocean conservation, using the example of how agricultural actions in Iowa impact the Mississippi River and the Gulf of Mexico.
3. Obtain and evaluate impacts of other large-scale human activities on ocean health and well-being, and communicate ideas for minimizing negative impacts.

Subjects

- Science – Ecology, Environmental
- Art / Media / Technology
- Geography
- Social Studies

Duration 130+ minutes

Note: *Ocean Frontiers I* can be downloaded at http://bit.ly/OF1-DL

Overview

In this lesson students will explore ways in which human activities have impacts on our oceans, regardless of one's proximity to the ocean. Using the example of the flow of water from Iowa to the Gulf of Mexico, students will consider how farms and agriculture are connected to the ocean, including the concepts of "effluents" and "dead zones", as well as examples of positive agricultural practices in place to help minimize negative human impacts. Students will inquire into other ways that humans influence the ocean and propose ideas for reducing negative impacts on ocean health.

> "We need a healthy marine environment and we need resilient coastlines. Increasing water quality, decreasing nutrient introduction, increasing and restoring and improving habitat function—all of those things build toward a healthy marine environment. And they don't need to come at the cost of economic development."
>
> *Bill Walker – Gulf of Mexico Alliance*

Activities

Activity 1 – Farming and Oceans: Earth's Interconnectedness (30 minutes)

1. Share the following quote with students, and in pairs, have them discuss what they think the quote means:

   "Even the upper end of the river believes in the ocean." William Stafford – American poet

2. As a class, discuss how rivers and oceans are connected, reinforcing that all water sources inland, as well as how we use those water sources, are connected to the ocean and impact ocean well-being.

3. Now share the following quote:

   "Some people say, 'Well, what does Iowa have to do with the Gulf of Mexico or the ocean anyway?' And we say, 'well, about 200 million gallons every minute'."
   Jerry Enzler – National Mississippi River Museum and Aquarium

4. Project the Mississippi Watershed Map 1 on a screen, showing the path of the Mississippi River, pointing out Iowa and the Gulf of Mexico, and reflect on the quote. Prompt students to consider what Iowa's primary industry is (agriculture and food production). Have students brainstorm how farming and the ocean are connected. Share as a large group, creating a list of ideas on the board. Some possible prompting questions may include:

   a. How might farming practices impact the land? How might this, in turn, have impacts on local water sources?

   b. What materials or products are used in farming? How might these materials "run off" into local water sources?

Activity 2 – Iowa & the Gulf of Mexico (45 minutes)

1. Provide each student with a copy of the Iowa Farmers & Gulf of Mexico Guided Viewing Worksheet and review together as a class.

2. Watch *Ocean Frontiers: Iowa Farmers & Gulf of Mexico*. As the students watch the film clip, have them record their answers to the questions on the worksheet, as well as any other notes of interest.

3. After the clip, provide a few minutes for the students to complete the worksheet and make notes on their own. Then, in small groups, have students discuss the questions together. Provide students with additional time for researching answers to questions if needed. See Background Information as a reference.

4. As a class, discuss the clip together. Review the concepts of farming or agricultural runoff, or "effluents" like nitrogen and phosphorus, and how these effluents can contribute to "Hypoxic Zones" (or Dead Zones) in the ocean. Have students share their responses to the meaning of wetlands as "organic filters" as well as some of the other action-based solutions that farmers in Iowa are taking to reduce their impact on the Gulf of Mexico.

Activity 3 – Human Impacts on the Ocean (45 minutes, plus additional research and sharing findings)

1. Project The Rivers of the Mississippi Watershed (animated map) on a screen and have students watch the demonstration of the magnitude of rivers that flow into the Mississippi, and then into the Gulf of Mexico.

2. Reiterate the concept of "watersheds" (all of the land that drains into the same location or body of water), and how what we do on the land impacts both local and global water sources.

3. Divide the class into 4 - 6 groups. Have each group research a different location in the Mississippi Watershed, identifying a major human activity and/or industry in that area, how that activity impacts ocean well-being, as well as strategies and ideas for decreasing that impact. Note: Groups can select a location from reviewing one of the maps, or by providing some options and having groups select from a hat, such as Minneapolis, Minnesota; St. Louis, Missouri; Memphis, Tennessee; Baton Rouge, Louisiana; New Orleans, Louisiana, etc.

4. Provide the students with the Human Impacts on Oceans Group Activity Worksheet and allow time for them to create a presentation (poster, slideshow, video, etc.) to share their findings.

5. Have groups share their presentations as a class.

Activity 4 – Wrap Up/Closure Questions (10 minutes)

1. Discuss how stewardship at the local level has impacts at the global level. Have students consider an action they can take in their everyday lives to decrease impact on the local watershed. Have students commit to one action they can take in the next week.

2. Allow the students time to discuss as a class or journal answers to the Essential Questions to check for student understanding and correct any misconceptions.

Extension

1. Explore the Gulf of Mexico Alliance (5 states that border the Gulf of Mexico) and the role of alliances and collaborations in producing collective impacts on ocean health and well-being.
2. Compare and contrast the impacts of different types of farming and farming practices on local and global water sources. For example, organic vs conventional; plant vs animal, etc.
3. Research programs in your area where industry is changing practices to reduce impacts on the local watershed.

Background Information

Mississippi Watershed and Gulf of Mexico

With its many tributaries, the Mississippi's massive watershed stretches from the Rocky Mountains in the west to the Appalachian Mountains in the east. It covers all or part of 31 U.S. states and reaches into two Canadian provinces. It's the fourth longest river in the world, behind the Amazon, Nile, and Yangtze Rivers.

The Gulf of Mexico is the ninth largest water body in the world and teems with sea life, from killer whales to unexplored deep-sea corals living hundreds of feet below the surface. Its coastal region contains half the coastal wetlands in the United States and is home to abundant wildlife resources, including colonial waterfowl rookeries, sea turtles, oysters and fisheries. These resources are supported by rich natural habitats, including bays, estuaries, tidal flats, barrier islands, hard and soft wood forests and mangrove swamps. The Gulf region's ecological communities are essential to sustaining nationally-vital economic and recreational industries.

The Mississippi River begins below Lake Itasca in northern Minnesota and flows approximately 2,350 miles to the Gulf of Mexico. On this journey, the Mississippi River captures runoff from 41% of the land area of the continental United States, making it the largest watershed in North America. Human activities have greatly altered the Mississippi River and its watershed. As a result, the river delivers substantial amounts of sediment, nutrients and chemical pollutants to the Gulf of Mexico.

Gulf of Mexico Alliance & Iowa Farmers

The once fertile Gulf has begun to falter – its wetlands vanishing by the minute, its waters often rendered dead from too many contaminants flowing from upstream. Realizing that one state alone cannot solve all of the Gulf's problems, the Governors of the five Gulf States formed the Gulf of Mexico Alliance and work with partners in the Mississippi River basin, including Iowa.

Iowa farmers are now changing their agricultural practices to reduce their impact on the Gulf of Mexico. Their efforts include reducing the amount of fertilizer they use, constructing wetlands

to filter water before it heads downstream and planting strips of native tallgrass prairie to prevent runoff. At the time of the film, Iowa's goal was to reduce their nitrogen runoff by 45%.

Key Definitions

A **dead zone**, which occurs in oceans and Great Lakes, is an area usually in the bottom waters where there's not enough oxygen to sustain life. This occurrence of low oxygen, known as hypoxia, is generally caused by algae stimulated by lots of agricultural nutrients – such as nitrogen and phosphorus – in surface waters. When nutrients enter the water, they create an algal bloom. When the algae sink, bacteria start decomposing them, which uses up the available oxygen.

During calm, non-windy days of summer, it is common for the water column to become stratified. This inhibits atmospheric oxygen from reaching the deeper waters. As the bacteria use up oxygen, it's not being replenished, so oxygen concentrations can decrease even as low as two milligrams of oxygen per liter of water, which is bad for fish. Below that, fish that are able to will leave that area. Other organisms that can't leave the area may die if oxygen levels don't return quickly.

A **watershed** is all of the land that drains into the same location or body of water. The Mississippi watershed drains into the Gulf of Mexico.

Effluents are liquid wastes that drain into watersheds, including rivers and oceans. Common agricultural effluents are nitrogen and phosphorus.

Sources include National Geographic and Gulf of Mexico Alliance.

Additional Resources

- Video: What is a Watershed?
- Gulf of Mexico Alliance
- Mississippi River, Gulf of Mexico Hypoxia Task Force
- Iowa Department of Agriculture and Land Stewardship, Water Resources Dept.
- Iowa Conservation Reserve Enhancement Program

Name:_____

Iowa Farmers & Gulf of Mexico Guided Viewing Worksheet

1. What is an ocean “dead zone", also known as a “hypoxic zone"?

2. List some ways in which agricultural practices in Iowa might contribute to ocean dead zones in the Gulf of Mexico.

3. List some ways in which farmers and others in Iowa might work together to decrease agricultural impacts on oceans.

4. The film describes wetlands as “organic filters." Describe what you think this means. How can wetlands contribute to healthier oceans and ecosystems?

Human Impacts on Oceans Group Activity Worksheet

Group members:

Location researched:

1. Provide a description of the human activity and/or industry researched:

2. Describe any effluents that are caused by the human activity and/or industry:

3. Describe how the human activity/industry might contribute to ecosystem pollution and/or to ocean dead zones:

4. Is there anything currently underway to help lessen the environmental impact of this human activity/industry? Provide real-life examples of current conservation efforts.

5. Develop an action plan for steps that could be taken in the future to help decrease environmental impact of this human activity/industry.

Sustainable Fishing in Port Orford, Oregon: Collaboration in Action

Essential Questions

- What does sustainable fishing mean and what does it look like in practice?
- How are marine reserves and marine protected areas used to protect natural and cultural resources for generations to come?
- What is collaborative research and how can it contribute to ocean stewardship?

Materials & Resources

- Computer, projector and screen
- Film clip
  - *Ocean Frontiers: Port Orford Fisherman Protect Ocean & Way of Life* (15 minutes) http://bit.ly/OF1-PortOrford
- Port Orford Guided Viewing Worksheet
- Redfish Rocks Map 1[1] http://bit.ly/RRMap1
- Redfish Rocks Map 2[1] http://bit.ly/RRMap2
- Fishtracker Data Handout[2]
- Fishtracker Data Research Questions Handout
- Fishtracker Data Research Questions Handout (Teacher Copy)
- Fishtracker Map 2 http://bit.ly/Fishtracker

[1] Credit: Oregon Marine Reserves, Oregon Department of Fish and Wildlife

[2] Credit: Fishtracker Project, Tom Calvanese

Objectives

Students will:

1. Explore and understand concepts of sustainable fishing, marine reserves and marine protected areas, ocean stewardship, collaborative research and rockfish ecology.
2. Identify ways in which different types of knowledge and collaborative research can contribute to ocean stewardship.
3. Analyze and interpret baseline data regarding marine reserves and rockfish behavior.

Subjects

- Science – Ecology, Environmental, Marine
- Mathematics
- Social Studies

Duration 145 minutes

Note: *Ocean Frontiers I* can be downloaded at http://bit.ly/OF1-DL

Overview

In this lesson, students will explore the concept of sustainable fishing and how ocean stewardship can help preserve both natural and cultural resources for generations to come. They will examine the importance of taking into account multiple factors – social, ecological, economic – when decision-making around sustainable fishing practices, as well as the stakeholders who might be both involved and impacted by this decision-making. After watching *Ocean Frontiers: Port Orford Fisherman Protect Ocean & Way of Life*, students will analyze data tracking the home ranges and movement behaviors of the fishes of Redfish Rocks – the site of Oregon's first Marine Reserve and Marine Protected Area.

> "We really need the focus to be on the ocean now. It hasn't been in the past and it's really important. We see clearly that jobs can go with conservation; that we can continue to fish. Let's extract fish from the ocean and do it right, and have a conservation ethic around how we fish—and still have our jobs and our income for our families."
>
> *Leesa Cobb – Port Orford Ocean Resource Team*

Activities

Activity 1 – Sustainable Fishing: What Does It Look Like? (30 minutes)

1. Write the term "sustainability" on the board. Divide the class into small groups and have them come up with a working definition of the term. Share as a class, capturing words and ideas on the board.

2. Now, have students consider the concept of sustainability as it relates to fishing. What does sustainable fishing look like and why would fishing sustainably be important? Have students think about the following scenario:

   > Fish stocks in a coastal area are going down for a variety of reasons, including overfishing, destructive fishing methods, tour boat traffic, marine traffic from industry like imports and exports, land-based developments like new oceanfront condos and the effects of global climate change. In order to increase fish stocks and keep these stocks growing for the future, an ocean plan needs to be developed for the region. But many people would be impacted by the plan and everyone would need to agree to it.

3. In their small groups, have students consider this scenario and address the following questions:

   a. Create a list of all of the people and/or groups who might be impacted by a sustainable fishing plan.
   b. What might be the social, ecological and economic impacts of a sustainable fishing plan?
   c. What questions might we need to ask those impacted in the region?

4. As students are working, write down the three categories (social, ecological and economic) on the board. Have students share their ideas under the categories and discuss as a class.

Activity 2 – Sustainable Fishing Practices in Port Orford, Oregon (60 minutes)

1. Introduce Port Orford, Oregon, a small fishing community on the southern Oregon coast that relies on a rich ocean ecosystem for their livelihoods.
2. Provide each student with a copy of the Port Orford Guided Viewing Worksheet and review together as a class. Review the term stakeholder, noting that some people or groups may have varying interests (social, economic, ecological or a combination).
3. Watch *Ocean Frontiers: Port Orford Fisherman Protect Ocean & Way of Life*. As students watch the film clip, have them record their answers to the questions on the worksheet, as well as any other notes of interest regarding sustainable fishing.
4. After the clip, provide a few minutes for the students to complete their answers and make notes on their own. Then, in small groups, have students discuss the questions together.
5. As a class, discuss the film clip together. Review the concepts of Marine Reserves and Marine Protected Areas, noting these as two methods for engaging in ocean conservation, and have students share some of the research activities taking place in the Redfish Rocks Marine Reserve. See Background Information.
6. Project the Redfish Rocks Map 1 and Redfish Rocks Map 2 on the screen, distinguishing between the different areas (marine reserve versus marine protected area).
7. Introduce students to the concept of collaborative research (valuing different types of knowledge in the scientific process). Consider the following additional discussion questions:
    a. When making decisions about conservation efforts, why is it important to be collaborative?
    b. What is local knowledge and traditional knowledge, and why are these important? Think about the fishers noted in the film and the knowledge they have about the region – behaviors of species in the region, fishing seasons and locations, etc. Think about Native Americans and the knowledge that has been passed on about the land and sea from generation to generation.
    c. How might traditional and local knowledge inform scientific research processes and data gathering? Why is this type of collaborative research important?
    d. What are some of the cultural resources that could be protected through ocean conservation?

Activity 3 – Fishtracker Data (45 minutes)

1. Divide the class into small groups and provide each student with a copy of the Fishtracker Data Handout and the Fishtracker Data Research Questions Handout. Keep the two Redfish Rocks Maps accessible for students to reference. Note: If groups have access to the internet, have them also review the Fishtracker Map.
2. Inform students that this sample of data is provided from the Fishtracker Project, a

collaborative effort with commercial fishermen in Port Orford to learn more about the home ranges and movement behaviors of fishes of Redfish Rocks. This representative data sample looks specifically at three types of rockfish. Review the data columns, noting the following:

   a. Residency index: the percentage of time a fish was detected in the reserve.
   b. Home range: the area of each fishes' regular activities.

3. Have students analyze the data and come up with some questions from the data.
4. Have different groups work on a selection (or all) of the questions from the Fishtracker Data Research Questions Handout.
5. Share findings from the data as a class. Discuss how research like this might be used to help inform future ocean stewardship. For example:
   a. What do you think the long term effect of the protected area might be?
   b. How do you think this might affect the local commercial fishers?
   c. What other research or data do you think would improve our understanding of this system?

Activity 4 – Wrap Up/Closure Questions (10 minutes)

1. In addition to Marine Reserves and Marine Protected Areas, discuss some other methods for engaging in ocean conservation, stewardship and planning for the future. What are actions that can be taken at the individual level, regional level and/or global level?
2. Allow the students time to discuss as a class or journal answers to the Essential Questions to check for student understanding and correct any misconceptions.

Extension

1. Identify a local conservation issue and propose a collaborative approach to learning more about the problem and coming up with potential next steps.
2. Explore the rockfish in more depth, including identifying different types of rockfish, habitats, adaptations and behaviors, importance of protecting female fish, etc.
3. Research the concept of ecosystem-based resource management. See the National Oceanic and Atmospheric Administration (NOAA) website for more information: www.st.nmfs.noaa.gov/ecosystems/ebfm.

Background Information

Port Orford, Oregon

Port Orford is a small fishing community on the southern Oregon coast that relies on a rich ocean ecosystem for their livelihoods. To put them on a path toward sustainability, they designated the Port Orford Community Stewardship Area to both protect the ocean and their economy. The Stewardship Area encompasses 1,300 square miles, which includes their traditional fishing grounds and the upland watersheds that feed into them.

The Port Orford Ocean Resource Team, or POORT, was run by commercial fishermen dedicated to maintaining access to natural resources by people who fish selectively, while promoting sustainable fisheries and protecting marine biological diversity. This is also known as the triple bottom line operating principle: ecology, equity and economics.

The Port Orford community, with guidance from POORT, developed a communal vision to sustain their fisheries and their ecosystem as one. In order to have a sustainable fishery and economy, they initiated local science research to inform their fishery management, Redfish Rocks Marine Reserve and Marine Protected Area, and protected upstream forests to save their salmon and steelhead — a farsighted perspective that considers both their links to the land and the future of their children.

Fishtracker Project

Tom Calvanese launched the Fishtracker project in partnership with local commercial fishermen in order to learn more about the home ranges and movement behaviors of fishes of Redfish Rocks. This work was part of his Master's degree research at Oregon State University. The team used acoustic telemetry to study the movement behavior of commercially valuable rockfish that live at Redfish Rocks, the site of Oregon's first Marine Reserve and Marine Protected Area. This work was designed to contribute to understanding the ecology of the area and is being used to inform the adaptive management of the reserve.

There are more than 70 species of rockfish living in the northeast Pacific Ocean. Rockfish are long lived; the verified maximum ages of the three study species are:

- China Rockfish (*S. nebulosus*): 79 years
- Quillback Rockfish (*S. maliger)*: 95 years
- Copper Rockfish (*S. caurinus*): 50 years

Rockfish females give birth to live young (internal fertilization of eggs, mothers provide some nutrition to developing embryos, young are extruded as larvae, i.e. matrotrophic viviparity). The larvae are planktonic (drifting on ocean currents) for approximately 90 days prior to settling as juveniles.

Marine Reserves & Marine Protected Areas

Marine Reserves and Marine Protected Areas are important tools for protecting ecosystems from overuse and exploitation. They restrict human activity for conservation purposes, typically to protect natural, historic and cultural resources. They allow for fish and marine life restoration, increasing both size and number of species and protecting species in critical stages of the life cycle. They can also act as a baseline for research purposes, to assess

management processes in nearby areas.

Marine Reserves are areas that prohibit fishing/harvesting. They can act as a safe haven for marine life so stocks can be replenished. Plants, invertebrates and fish can spread into surrounding water, which is open to fishing. A marine reserve is a specific type of Marine Protected Area.

Marine Protected Areas are areas that are less restrictive than marine reserves. They may allow crabbing, salmon trolling, sport fishing and other activities.

Additional Resources

- Port of Port Orford
- Redfish Rocks Marine Reserve and Marine Protected Area
- Oregon Department of Fish and Wildlife Marine Reserves Program - Rules, Maps and Coordinates
- Fishtracker Research in Redfish Rocks Marine Reserve

Videos:

- Fisherman of the Port Orford Ocean Research Team
- Aerial Footage of Redfish Rocks, with Island Rock (Footage provided by Oregon State Productions)
- Underwater video of Redfish Rocks (ODFW, 2010)
- Copper Rockfish Release, after implantation of acoustic tag (Footage provided by Fishtracker project)

Name:_____

Port Orford Guided Viewing Worksheet

1. Who are some of the stakeholders interested in protecting the natural and cultural resources of the Port Orford area? Are there any stakeholders missing?

2. In your own words, describe marine reserves and marine protected areas. Why are these spaces important? What purpose do they serve?

3. Describe the difference between local knowledge and scientific knowledge gathered through research. Why are different types of knowledge important in ocean conservation?

4. List some of the research activities taking place in the Redfish Rocks Marine Reserve. How might the knowledge gained be used for planning in the future?

Fishtracker Data Handout

Fishtracker Tagging Data* - Redfish Rocks Marine Reserve, Island Rock, Oregon - 2011 - Tom Calvanese

Species	Fish ID	Total Length (cm)	Tagging Date	Number of days the fish was detected	Total number of detections	Residency Index (Ir)	Home Range (square km)
S. caurinus	669	46	5/1/2011	124	3924	0.36	0.76
S. caurinus	671	49	6/27/2011	235	20713	0.66	0.73
S. caurinus	676	42	12/7/2011	90	6750	0.38	0.20
S. caurinus	677	50	12/7/2011	230	28746	0.96	0.70
S. caurinus	678	52	12/7/2011	180	11786	0.75	0.45
S. caurinus	679	55	12/7/2011	191	35370	0.8	0.20
S. maliger	661	36	5/1/2011	57	3284	0.17	0.20
S. maliger	670	41	6/27/2011	275	24832	0.77	0.73
S. maliger	673	46	6/27/2011	111	1003	0.31	1.04
S. maliger	674	40	6/27/2011	152	17365	0.43	2.15
S. maliger	675	45	6/27/2011	287	32629	0.81	0.71
S. maliger	681	40	12/7/2011	138	20155	0.58	0.20
S. maliger	682	50	12/7/2011	199	37584	0.83	1.47
S. nebulosus	662	31	5/1/2011	320	27335	0.94	0.20
S. nebulosus	663	32	5/1/2011	315	27530	0.93	0.38
S. nebulosus	664	37	5/1/2011	273	25406	0.8	0.27
S. nebulosus	666	36	5/1/2011	231	24845	0.68	0.45
S. nebulosus	667	38	5/1/2011	338	75651	0.99	0.62
S. nebulosus	668	38	5/1/2011	86	14396	0.25	0.29
S. nebulosus	680	39	12/7/2011	37	1629	0.15	0.45

*Data are provided for educational purposes only. Not be used in publication of findings.

Name:_____

Fishtracker Data Research Questions Handout

1. Calculate the average residence time for each of the three species. Graph these parameters for each species. Are there differences between species?

2. Calculate the average home range for each of the three species. Graph these parameters for each species. Are there differences between species?

3. Based on these findings and data, do you think the marine reserve will protect individuals of these species of fish? Why or why not?

4. Compare different methods for visualizing these data (graphs, charts, images, etc.). Are some methods better than others? Why? Can you think of another way to communicate this information?

5. What are the common names of the species researched? What is the meaning of the genus name Sebastes?

Name:_____

Fishtracker Data Research Questions Handout (Teacher Copy)

1. Calculate the average residence time for each of the three species. Graph these parameters for each species. Are there differences between species?

   Residency is the % of time the species was detected in the reserve.
   S. caurinus: 0.68 // S. maliger: 0.56 // S. nebulosus: 0.72

2. Calculate the average home range for each of the three species. Graph these parameters for each species. Are there differences between species?

   Home range is the area of each fishes' regular activities (in square kms).
   S. caurinus: 0.57 // S. maliger: 0.88 // S. nebulosus: 0.42

3. Based on these findings and data, do you think the marine reserve will protect individuals of these species of fish? Why or why not?

   Assuming that fishers do not fish inside the marine reserve, then protection of individuals will be based on how much time they spend within the reserve. Student responses could focus on amount of time (residency), amount of space (home range) or both. Students could compare individual fish that are being fully protected to those that spent less time within the protected area and consider the effect of this. It would be useful to have students compare the home ranges to the size of the reserve.

4. Compare different methods for visualizing these data (graphs, charts, images, etc.). Are some methods better than others? Why? Can you think of another way to communicate this information?

   With access to tools like Google Sheets or Excel, students can create different types of charts to find different ways to communicate the data (for example, a bar graph vs a line graph vs a bubble plot). Students could consider the audience looking at the data to determine if one type of visualization is better than the other for different audiences. This website has some examples of when to use different types of visualization tools, and why: https://datavizcatalogue.com.

5. What are the common names of the species researched? What is the meaning of the genus name Sebastes?

   China Rockfish (S. nebulosus)
   Quillback Rockfish (S. maliger)
   Copper Rockfish (S. caurinus)

   ***Sebastes** is a genus of fish in the family Sebastidae - the rockfish and similar fish, mostly native to the north Pacific.*

Ocean Planning Appendix: Background Information

Ocean planning has been identified by scientists, policy makers and stakeholders around the globe as a practical approach to manage both conflicts and compatibilities in the marine environment in the face of both increasing development pressures and increasing interest and understanding of human interdependence on healthy ecosystems. It is a comprehensive, ecosystem-based planning process, built on sound science to analyze and plan for current and anticipated uses of the ocean. Pioneered in Western Europe, ocean planning is underway in more than 60 countries.

In the early 2000s two bi-partisan ocean commissions, the Pew Ocean Commission and the U.S. Commission on Ocean Policy, articulated a vision for comprehensive ocean governance in the United States, seeing a growing need to support stewardship, multiple use management and science-based decision making. Initial U.S. ocean planning efforts were local and state-based, with Massachusetts, Rhode Island, Oregon, Washington, New York and Connecticut creating state ocean plans for their coastal waters. Ocean planning has been used to reduce ship strikes on endangered whales outside of Boston Harbor by more than 80%, and the Florida Keys National Marine Sanctuary developed ocean plans to reduce conflicts among ocean stakeholders and to protect their coral reefs.

Ocean planning on a regional scale began as a result of the National Ocean Policy, established in 2010 by President Obama. This policy was the result of more than 10 years of work by scientists, policy makers and stakeholders, including ocean industries, coastal residents and conservationists. To implement ocean planning, nine ocean planning areas were designated in the U.S., mostly along large marine ecosystems. In 2016 the Northeast and Mid-Atlantic completed regional ocean plans and began implementing them in 2017. Other regions now have ocean plans in development.

In 2018 the White House revoked the National Ocean Policy, replacing it with one that emphasizes security and commerce over conservation and stewardship. The new policy shifts leadership of regional ocean planning to the states and allows for federal participation and data sharing to continue. With state leadership, ocean planning continues to move the U.S. away from an overly-simplistic issue-by-issue management approach toward comprehensive, informed and strategic ocean management.

Resources Appendix: List of URLs by Lesson

Uncovering GIS Data: Saving Whales at Stellwagen Bank

- *Ocean Frontiers: Saving Whales at Stellwagen Bank* - http://bit.ly/OF1-Stellwagen
- Stellwagen Bank GIS Map PDF - http://bit.ly/StellwagenGIS
- Legend and Layer Descriptions Handout (PDF) - http://bit.ly/StellwagenLegend
- Stellwagen Bank Observations and Research Notes Worksheet (writable PDF) - http://bit.ly/StellwagenNotes
- Adobe Acrobat Reader - https://get.adobe.com/reader
- Stellwagen Bank National Marine Sanctuary - https://stellwagen.noaa.gov
- National Marine Sanctuaries - https://sanctuaries.noaa.gov
- ESRI website - What is GIS? - https://www.esri.com/en-us/what-is-gis/overview
- California Shipping Lanes Moved in Attempt to Avoid Killing Whales - https://www.wired.com/2013/05/whales-and-shipstrikes
- Shipping Lanes in Greater Farallones National Marine Sanctuary - https://farallones.noaa.gov/eco/vesselstrikes/shipping_lanes.html
- Whale Alert - http://www.whalealert.org

Stakeholder Engagement: Playing and Working in the Florida Keys

- *Ocean Frontiers: An Ocean Blueprint for the Florida Keys* - http://bit.ly/OF1-FloridaKeys
- Florida Keys National Marine Sanctuary - https://floridakeys.noaa.gov
- How to Create the Perfect Public Service Announcement - http://www.govtech.com/education/news/How-to-Create-the-Perfect-Public-Service-Announcement.html

Rivers Connect: Iowa Farmers & the Gulf of Mexico

- *Ocean Frontiers: Iowa Farmers & Gulf of Mexico* - http://bit.ly/OF1-Iowa
- Mississippi Watershed Map 1- http://bit.ly/MissWatershedMap
- The Rivers of the Mississippi Watershed (animated map) - https://svs.gsfc.nasa.gov/4493
- Video: What is a Watershed? - http://bit.ly/WhatIsAWatershed
- Gulf of Mexico Alliance - www.gulfofmexicoalliance.org
- Mississippi River, Gulf of Mexico Hypoxia Task Force - http://water.epa.gov/type/watersheds/named/msbasin/index.cfm
- Iowa Department of Agriculture and Land Stewardship, Water Resources Dept. - http://www.iowaagriculture.gov/waterResources.asp
- Iowa Conservation Reserve Enhancement Program - https://www.iowacrep.org

Sustainable Fishing in Port Orford, Oregon: Collaboration in Action

- *Ocean Frontiers: Port Orford Fisherman Protect Ocean & Way of Life* - http://bit.ly/OF1-PortOrford
- Redfish Rocks Map 1 - http://bit.ly/RRMap1
- Redfish Rocks Map 2 - http://bit.ly/RRMap2
- Fishtracker Map - http://bit.ly/Fishtracker
- Port of Port Orford - https://portofportorford.org
- Redfish Rocks Marine Reserve and Marine Protected Area - http://oregonmarinereserves.com/reserves/redfish-rocks

- Oregon Department of Fish & Wildlife Marine Reserves Program, Maps and Coordinates - http://oregonmarinereserves.com/rules
- Fishtracker Research in Redfish Rocks Marine Reserve - www.fishtracker.org

Videos:

- Fisherman of the Port Orford Ocean Research Team - https://ocean-frontiers.org/reflections-on-change-port-orford-ocean-resource-team
- Aerial Footage of Redfish Rocks, with Island Rock - http://bit.ly/RedfishRocksAerial
- Underwater video of Redfish Rocks (ODFW, 2010) - http://bit.ly/RedfishRocksUnderwater
- Copper Rockfish Release, after implantation of acoustic tag - http://bit.ly/RockfishRelease