Introductory Lesson: Working Together With … Sherman and The National System of Marine Protected Areas

FOCUS: Marine protected areas, the National System of MPAs, stakeholder participation

GRADE LEVEL: 6-8 (Humanities, language arts, life science)

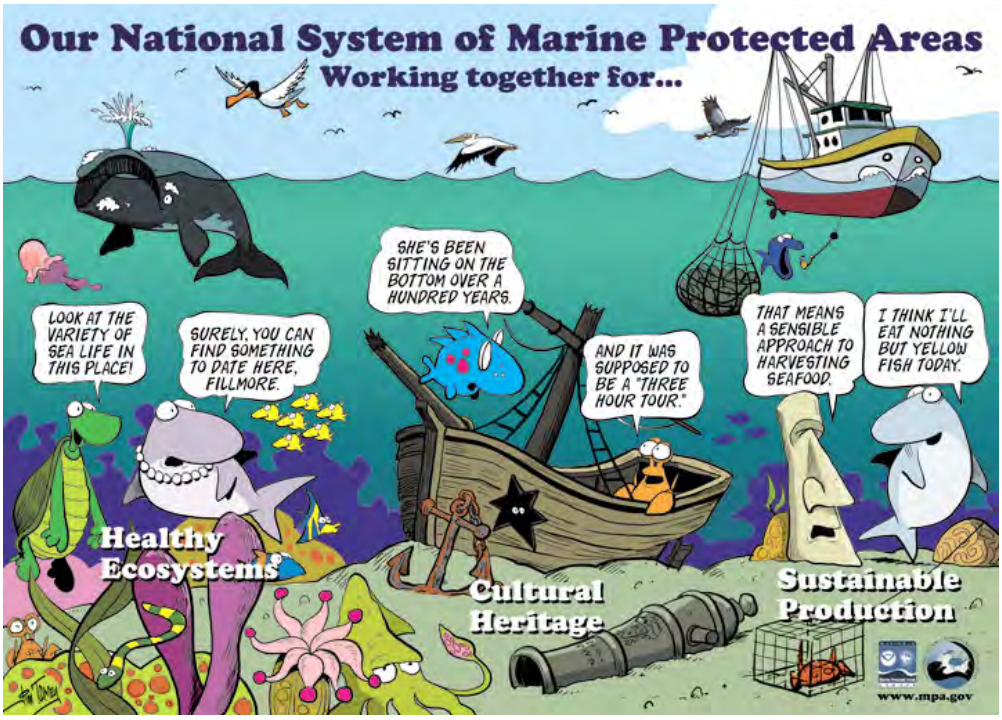
FOCUS QUESTIONS:
- What is a marine protected Area and why is the National System of MPAs important?
- Why is stakeholder participation important in MPA design and management?

MATERIALS:
- Copies of *Joining the National system of MPAs: Frequently Asked Questions* and *Benefits of the National System of MPAs* fact sheets
- Copies of the Lesson Vocabulary Guide (see "resources" to access these)

AUDIO/VISUAL MATERIALS: Computer with internet access to view *Protecting Our Planet* video and other web links

BACKGROUND INFORMATION

Somewhere in a lagoon near the fictional Kapupu Island in the North Pacific, a great white shark named Sherman is planning his next meal. And, thanks to the healthy and sustainable marine environment he calls home, Sherman has a delicious variety from which to choose. According to Jim Toomey, the creator of *Sherman's Lagoon,* the cartoon features "a dimwitted shark named Sherman, his sea turtle sidekick, and an assortment of other coral reef critters who team up to battle the encroachment of civilization on their remote tropical paradise." If "Sherman's Lagoon" were real, chances are it would be a marine protected area (MPA).



What Is a Marine Protected Area?

Some people interpret marine protected areas to mean areas closed to all human activities. Others interpret them as special areas set aside for recreation, much like national parks. In reality, “marine protected areas” are defined areas where natural and/or cultural resources are given greater protection than the surrounding waters. In the United States, nearly all MPAs are multiple use, and allow activities such as fishing, diving and beach use.

The official federal definition of an MPA is: “any area of the marine environment that has been reserved by federal, state, tribal, territorial, or local laws or regulations to provide lasting protection for part or all of the natural and cultural resources therein.” -- Executive Order 13158 (May 2000). U.S. MPAs span a range of habitats including the open ocean, coastal areas, inter-tidal zones, estuaries, and the Great Lakes. They also vary widely in purpose, legal authorities, agencies, management approaches, level of protection, and restrictions on human uses. Some common examples of MPAs in the U.S. include National Marine Sanctuaries, National Parks and Seashores, National Wildlife Refuges, fisheries closures and state counterparts to these programs.

What is a system of MPAs?

A system of MPAs is a set of areas connected by their shared conservation goals, managing agency (such as a Federal or State organization), or other common interests. A system of MPAs is not necessarily confined to a geographic region, but can span regions and ecosystems, like the U.S. National System of MPAs. The National System of MPAs is the group of MPA sites established and managed by federal, state, tribal and/or local governments. Although individual MPA sites and programs are managed independently, together these MPAs work to achieve common conservation goals. Collectively, these sites help conserve the nation’s natural and cultural marine heritage and represent its diverse ecosystems and resources.

Why the National System of Marine Protected Areas?

MPAs offer valuable natural and cultural assets greater protection than the surrounding waters. They include areas such as deep-water habitats, estuaries, inter-tidal zones, fish spawning grounds and the Great Lakes. The U.S. has more than 1,600 MPAs, established by federal, state, territorial, and local governments to protect ecosystems, conserve cultural resources, and sustain fisheries.

The National System of MPAs:

- enhances protection of U.S. marine resources by providing new opportunities for MPA programs to collaborate and cooperate;
- supports the national economy by helping to sustain fisheries and maintain healthy marine ecosystems for tourism and recreation businesses; and
- promotes public participation in MPA decision-making by improving access to scientific and public policy information.

Building awareness of MPAs as valuable tools for conserving the nation's natural and cultural marine resources encourages a global view of a healthy planet for future generations. Use this series of lessons to enhance your team’s curriculum in science, social studies, math, and English/language arts. Or use them as an interdisciplinary project for more than one of these disciplines. The lesson plans center on the Jim Toomey poster and utilizes Internet resources to

encourage critical thinking and give students tools for understanding and evaluating authentic source materials.

Use these key words to make the connection to your state or district standards:
Balance, culture, diversity, economic impact, ecosystem, estuary, food chain, food web, habitat, life cycle, marine environments, marine organisms, maritime history, ocean resources, population, predator, prey.

GETTING STARTED

Engage

Show the poster and ask for student observations (for information on how to receive a copy of the poster for your classroom, see "For More Information" at the end of this lesson). Ask if any have seen these cartoon characters elsewhere, and if so, what the general essence of the cartoon's message is. That theme of "battling the encroachment of civilization on a remote tropical paradise" is extended to Marine Protected Areas in general. For more about the characters, visit the Sherman's Lagoon website at http://slagoon.com/charactr/character.html.

Elicit the main idea and supporting details of the poster.

- Help students determine that the information on the poster is segmented into three vignettes. Have students use dictionaries if needed to create operational definitions of *healthy ecosystems, cultural heritage,* and *sustainable production.* You might use the MPA Glossary, found in the "resources" section of this lesson, as background on how the MPA Center defines these terms.

- Ask volunteers to read the speech bubbles in each vignette and solicit other volunteers to tell what they think each conversation means. Work with students to connect their responses to their operational definitions of healthy ecosystems, cultural heritage, and sustainable production.

Explore

Take students to the National Marine Protected Areas Center website found at http://mpa.gov/ to begin their exploration of the National System of Marine Protected areas. Introduce this site as a collaboration of two government agencies—the National Oceanic and Atmospheric Administration and the Department of the Interior. Tell them to treat the information at a site such as this as nonfiction text. Have volunteers tell how the home page is structured and what kind of information they can find here or navigate to.

Explain

Show students the short video *Protecting Our Planet* (http://mpa.gov/resources/multimedia/) (approximately 10minutes). Before viewing, ensure students know the definitions of these terms: comprehensive system, management tool, network, and stakeholders. Use the lesson vocabulary guide found in the "reference" section. Ask the students to take notes while viewing the video and facilitate a discussion using the students' observations and these key points from the video.

- Contrast the amount of ocean that is protected compared to the total amount of ocean on Earth with the amount of land that is protected compared to the total amount of land on Earth.
- How the ocean may be affected by the shift of the population to within 60 miles of a coastline.
- Examples of the kinds of ecosystems they saw in the video and habitats that are protected.
- How an MPA is similar to a state or national park or refuge on land, and how that is beneficial to the marine ecosystem.
- How having a national network of MPAs can be beneficial to individual MPAs.
- Why stakeholders have to be involved in establishing MPAs.
- The number of people world-wide who depend on the ocean for food.
- That marine protected areas are one of many tools for conserving resources, ensuring sustainable production, and protecting long-term health of ocean ecosystem.

Elaborate

Take students to the tab About MPAs (http://mpa.gov/aboutmpas/). First have them discern how this page is structured for navigation, with summary text in the main column and links on the left that correlate to sections in the summary.

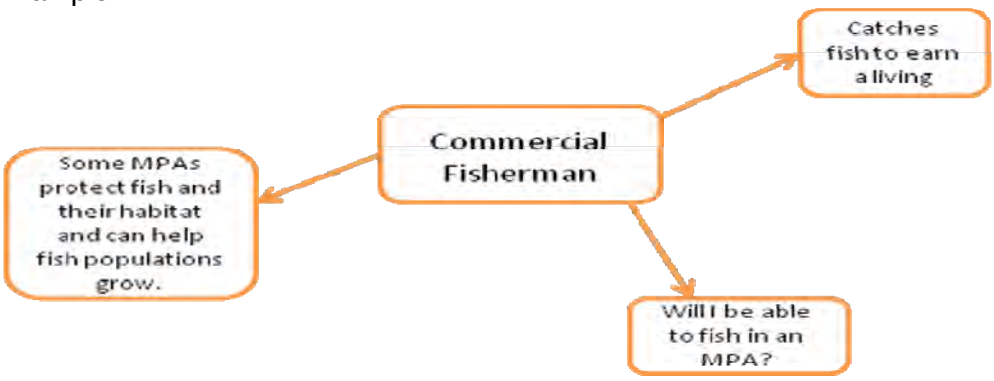
Under the National System tab, point out to students the three goals of the National System of MPAs—natural heritage, cultural heritage, and sustainable production. Ask volunteers to read the three points. Then elicit from students how to set up the description of the goals as a simple graphic organizer, such as a Venn diagram or word web, telling the main idea and supporting details. Refer back to the operational definitions of Healthy Ecosystems, Cultural Heritage, and Sustainable Production they created for the poster and make comparisons.

Ask students about the purpose of FAQs or Frequently Asked Questions. Download *Joining the National System of MPAs: Frequently Asked Questions* and give small groups black and white copies of them. Then click on *Benefits of the National System of MPAs* and download the fact sheet. Have black and white copies available of pages 1-3 of the fact sheet for small groups. Students should use markers to highlight key descriptive phrases in each section. You might direct them to the lesson vocabulary guide to ensure students understand terms such as: stewardship, partnership, outreach, connectivity, and transparent. Students might also benefit from *The National System of MPAs: Snapshot of the United States* fact sheet (see “resources” section).

Evaluate

Brainstorm an operational definition of “stakeholder” and lead the class in a discussion of which individuals or groups might be interested in the designation and management of an MPA. Help focus the class by providing examples such as a commercial fisherman or an environmentalist. Have students create a list of stakeholders and discuss how each stakeholder is interested and invested in MPAs. Have small groups choose a stakeholder and create a web diagram illustrating the characteristics, interests, and concerns of that particular stakeholder. Groups might use the Benefits fact sheet and the FAQs as background.

Example:



Have each group use their web diagram to present their stakeholder's situation to the class and their position on whether the stakeholder might be supportive, undecided, or against MPAs.

Closing

Ask the class why is it important to include stakeholders in MPA management decisions? Follow with a group discussion.

The Bridge Connection

www.vims.edu/bridge/- Click on "ocean science" in the navigation bar on the left, then "human activities," then Oceans for Life Resources Library

Resources

MPA Glossary - http://mpa.gov/resources/glossary/

Lesson Vocabulary Guide – http://mpa.gov/resources/education

Joining the National system of MPAs: Frequently Asked Questions fact sheet- http://mpa.gov/resources/faqs/

Benefits of the National System of MPAs fact sheet- http://mpa.gov/nationalsystem/#benefits

The National System of MPAs: Snapshot of the United States fact sheet – http://mpa.gov/aboutmpas

http://coralreef.noaa.gov/education/educators/resourcecd/lessonplans/ - NOAA Coral Reef Conservation Program educational resources website

http://sanctuaries.noaa.gov/education/welcome.html - NOAA's Office of National Marine Sanctuaries offers a variety of educational materials and activities

http://estuaries.gov/ - NOAAs National Estuarine Research Reserves Program education website offers extensive lessons and activities for all ages.

www.seaweb.org – A not-for-profit, SeaWeb is the creator of Trade Off! a board game that illustrates the importance of stakeholder participation in marine protected area management decisions

http://www.uri.edu/news/releases/?id=5231 – Article about the importance of community involvement in MPAs

Ocean Literacy: Essential Principles of Ocean Sciences Grades K-12

- Essential Principal 1: Fundamental concept h
- Essential Principal 3: Fundamental concepts e and h
- Essential Principal 5: Fundamental concepts c,d,e,f,i
- Essential Principal 6: Fundamental concepts a,b,c,d and g

Promoting the Goals of the National System of MPAs

Lesson 1: Healthy Ecosystems

Engage

Use the poster to remind students of the most important aspect of healthy ecosystems—diversity—as Megan the Shark (Sherman's wife) responds to Fillmore's observation that life this part of the ocean is many and varied. Finding someone "to date" OR "to eat" shouldn't be a problem!

Fillmore would find all he needs in an ecosystem such as those that are part of the Monterey Bay National Marine Sanctuary, one member of the National System of Marine Protected Areas. Take students to Monterey Bay Interactive MPA Mapping Tool (www.mpa.gov).

This MPA is home to a rich, diverse community of marine life. Thirty three species of marine mammals, 94 species of seabirds, 345 species of fishes, a variety of invertebrates, and the largest kelp forest in the United States can all be found within Monterey Bay. The waters of the Sanctuary also provide full or part-time homes for several endangered species including the blue whale, sea otter, and the California brown pelican[1].

Explore

One of the more spectacular year-round species is the giant kelp, a brown algae that forms the base of many of the food chains in the ecosystem. And this organism is found in many human foods and products as well—shampoo, some pharmaceuticals, toothpaste, some salad dressings, some canned soups and vegetables, cottage cheese, fuel oil, kelp bass (as part of the food chain), tarter sauce, frozen onion rings, ice cream, cheesecake, cakes with frosting, skin creams, cosmetics, lipstick, beer, and paint.

Show students a video of giant kelp in The Monterey Bay National Marine Sanctuary while you give them these facts or show video clips from the National Marine Sanctuary Media Library.

Fast facts

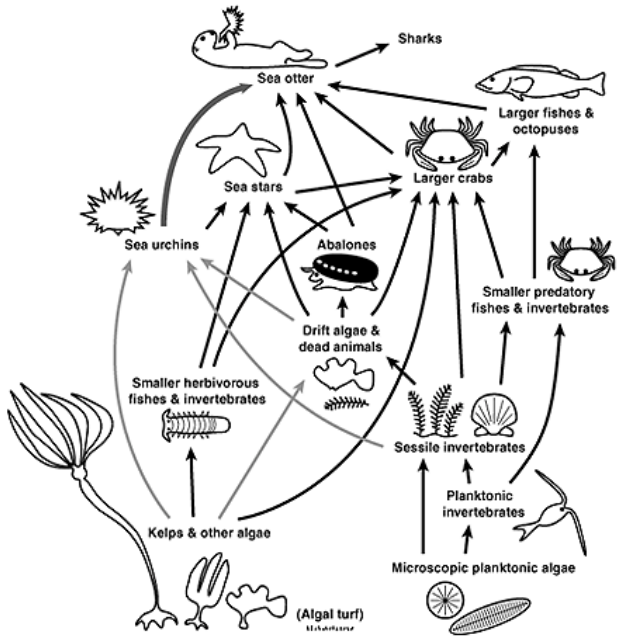
- Giant kelp can grow up to 2 feet per day and reach lengths of over 100 feet.
- The kelp forests resemble terrestrial forests in that there is a canopy with several layers below in which other organisms live.
- Giant kelp doesn't have typical roots, stems or leaves. It absorbs nutrients and light through leaf-like structures called blades, is supported by a stemlike structure called a stipe, and clings to the ocean floor by the holdfast, which is similar to roots but doesn't absorb nutrients.
- In California, giant kelp is harvested by ships that cut off the top 3-6 feet. Because it grows quickly, it can be harvested again in about a month.
- Monterey Bay is the only National Marine Sanctuary that allows commercial kelp harvesting.

Explain

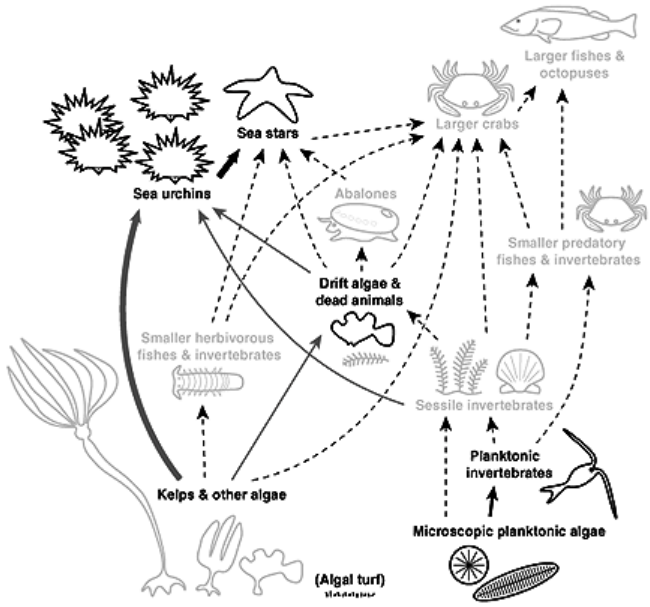
To illustrate the importance of diversity in an ecosystem and focusing on the presence or absence of the top carnivore, show students these two food webs that might be found in an ecosystem such as Monterey Bay. Enhance the diagrams by showing students images of individual organisms using the National Marine Sanctuaries Media Library

[1] Office of National Marine Sanctuaries: Encyclopedia of the Sanctuaries

Food Web A



Food Web B



Tell students that shaded organisms and dotted lines represent organisms and food chains that are rare or missing. As students compare the two food webs, ask:

- How do the primary producers compare in the two webs?
- What are some food chains that are present in Food Web A but not in Food Web B?
- At what point do most food chains end in Food Web A? In Food Web B?
- How does the presence of sea otters change Food Web A?

Food webs adapted from the American Museum of Natural History's publication *Biodiversity in Crisis.* <http://cbc.amnh.org/crisis/foodweb.html >

Divide the class into small groups and have each group research one of the organisms in these food webs. Among their findings should be that because sea otters do not have blubber, they eat a huge amount of food each day to stay warm, and sea urchins are their favorite prey. Sea urchins are able to consume nearly everything on the ocean floor, including kelp, other algae, corals and other sessile invertebrates. Then have the class share their descriptions. After the presentations, have students write short paragraphs that draw conclusions about the following.

- Sea stars feed on urchins. So how does the absence of sea otters lead to overpopulation of sea urchins?
- How does the overpopulation of sea urchins upset the balance and diversity of the ecosystem?

Elaborate

Explore the Monterey Bay National Marine Sanctuary using the Interactive MPA Mapping Tool (www.mpa.gov/mpaviewer) or the Monterey Bay Sanctuary homepage. Help students connect this MPA to the national system goal of conserving Natural Heritage Marine Resources. Another good source of information is: http://sanctuarysimon.org/index.php

Goal for Natural Heritage Marine Resources: *Represents the diverse living species, habitats, and marine ecosystems that are found in the oceans and Great Lakes of the United States. These important habitats include some of the most biologically diverse in the U.S. Mangrove forests, Humpback whale breeding grounds, and the unique habitats of rare and threatened species are just some of the areas protected for their natural heritage.*

Elicit from students observations about these aspects of this MPA.

- That human impact is mainly recreational although it is zoned for various levels of use.
- Protection efforts in this MPA are focused on habitat diversity although other elements of cultural heritage and sustainable production are at play in the Monterey Bay Sanctuary.
- That the Monterey Bay National Marine Sanctuary is just one of many MPAs along the California coast.

Evaluate

Give small groups a map that pinpoints the Monterey National Marine Sanctuary and other marine protected areas along the west coast. Then direct groups to www.topp.org to follow predators as they migrate along the west coast. Have each group choose an animal from the TOPP Predators tab and see where the animals are found along the west coast. Groups should note on their maps where the animals go during the course of the year.

Have groups come together to see how the paths of their chosen animals overlap and the marine protected areas they pass through. Ask students to write a short paragraph on why a network or system of MPAs with common conservation goals might be advantageous for these organisms.

References

Brumbaugh, Dan. “Biodiversity in Crisis.” American Museum of Natural History. Center for Biodiversity and Conservation. 1998

Resources

National Marine Protected Areas Center www.mpa.gov

- Lesson Vocabulary Guide www.mpa.gov/resources/education

Tagging of Pacific Predators (TOPP) www.topp.org

Monterey Bay National Marine Sanctuary http://montereybay.noaa.gov/

Encyclopedia of the Sanctuaries http://www8.nos.noaa.gov/onms/park/

Ocean Literacy: Essential Principles of Ocean Sciences Grades K-12

- Essential Principal 1: The Earth has one big ocean with many features.
- Essential Principal 5: The Ocean supports a great diversity of life and ecosystems.
- Essential Principal 6: The Ocean and humans are inextricably interconnected.

Lesson 2: Cultural Heritage

Engage

If the poster's conversation between intellectual Ernest and crabby Hawthorne gives students pause with the reference to the old TV show *Gilligan's Island,* have them focus on Ernest's quip. Ask volunteers to suggest what kinds of objects might be preserved at cold depths and what those objects might tell us about a culture or society.

To give students a taste of what can be preserved at the bottom of lakes and oceans, introduce them to the Thunder Bay Marine Sanctuary using the Interactive MPA Mapping Tool (www.mpa.gov/mpaviewer). Locate Thunder Bay and then show the Thunder Bay video from the MPA Center case study.

Relate this information to the earlier operational definition of cultural heritage resources students generated. Then expand on the concept with the Cultural Heritage Marine Resources goal of the National System.

Goal for Cultural Heritage Marine Resources: *The nation's existing MPAs preserve and protect important cultural resources. These cultural resources reflect the nation's maritime history and traditional cultural connections to the sea, as well as the uses and values they provide to this and future generations. Examples include archeological sites that contain significant cultural artifacts; sunken historic ships, aircraft, or other vessels; and areas important to specific cultures. Protecting cultural resources in MPAs reduces the chance that artifacts will be removed or damaged from modern day commercial or recreational activities.*

Explore

Use Google Earth or Google Maps to orient students to the area of Thunder Bay. Start with a wider view and bring students from the Atlantic through the St. Lawrence Seaway to the Great Lakes. Zoom into Thunder Bay and its relationship to the city of Alpena, Michigan. Use the introduction from the MPA Center's Thunder Bay case study and information from the Thunder Bay National Marine Sanctuary home page to give context to the area.

Have students research the historical significance of this area in commerce and why this area was a major shipping port. Have small groups explore the topics on this link. Each group should create a small poster that gives the topic and lists or illustrates key activities and points in history, and then give a short oral summary presentations so all students have a sense of the area. After the presentations, ask volunteers to cite examples that contribute to cultural heritage.

Explain

Examine Thunder Bay Sanctuary's interactive map of shipwrecks. Have students make observations about the way they are concentrated. Help them recall that "Shipwreck Alley," as the area came to be known, was plagued by heavy fog and sudden severe storms that were a result of weather patterns caused by the interaction of the large lake, which heated and cooled more slowly than the adjacent land masses. Navigating around small Thunder Bay Island in dense fog was also problematic, so often ships would simply stop in the fog and others would hit them.

Students can use the resources on this map, the Thunder Bay National Marine Sanctuary website, and at the Alpena County Public Library to find out about the documented shipwrecks.

With the class, find the location of the wrecked *Oscar T. Flint* on the interactive map. Note the overview of the barge presented. Have a volunteer explain which poster from the previous activity that the *Oscar T. Flint* could be added to as an example. All of the references include a link to the nearshore marine forecast. Click on this and discuss with students how weather forecasting has changed and what the impact of having immediate access to weather information such as this might have been in the late 1800s and early 1900s. This particular callout box also includes a drawing of the shipwreck site you might want to share with students. Have students make note that the ship was laden with limestone and suggest an internet search to find out where the limestone might have come from. They might surmise that it came from a huge quarry not far from Alpena as suggested by this Michigan historical marker. Using the link to view the detailed Google map on this page you can show students the proximity of the quarry to Alpena.

Then take students to the Alpena County Public Library. After you "enter" you will find a vessel database. By navigating to F and then searching for Flint, Oscar T. in the alphabetical listing, you will find a more extensive history of the ship accompanied by photos of the ship and its enrollment.

Small groups should then explore ships and shipwrecks using these sources to find out more about the economic background of the area and Thunder Bay and Alpena as a stopping point on the way east or west. Each group might take on the role of a crewmember telling a story about the vessel, its cargo, its expected trip, and its eventual demise.

Elaborate

Help students expand their definition of cultural heritage to include a wider range of factors. Take students to a member of the National System of Marine Protected Areas: Kahoolawe Island Reserve in Hawaii. There, have volunteers make comparisons between the cultural contributions of this reserve and those of Thunder Bay. Ask students for specific examples of how the Kahoolawe Island Reserve contributes to the cultural heritage of the area.

Evaluate

Have small groups revisit the cultural heritage goals of the National System of Marine Protected Areas, then use the Interactive MPA Mapping Tool (www.mpa.gov/mpaviewer) to explore MPAs of local interest. Students can look under the site data box to find sites that have a conservation focus of "Cultural Heritage." The groups should suggest how the MPAs might have cultural significance.

Resources

National Marine Protected Areas Center www.mpa.gov

- Lesson Vocabulary Guide www.mpa.gov/resources/education

Office of National Marine Sanctuaries Maritime Heritage Program
http://sanctuaries.noaa.gov/maritime/welcome.html

Thunder Bay National Marine Sanctuary http://thunderbay.noaa.gov/

- Encyclopedia of the Sanctuaries http://www8.nos.noaa.gov/onms/park/

Alpena County Public Library http://www.alpenalibrary.org/special/tbrc/tbrc.html

Michigan Historic Markers http://www.michmarkers.com/startup.asp?startpage=S0214.htm

Kahoolawe Island Reserve http://kahoolawe.hawaii.gov/home.php

Ocean Literacy: Essential Principles of Ocean Sciences Grades K-12

- Essential Principal 1: The Earth has one big ocean with many features.
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Lesson 3: Sustainable Production

Engage

Revisit the poster with students focusing on Sherman's conversation with an Easter Island moai. Elicit from students how "eating only yellow fish" might upset the food web in an area. Then ask what do they think might happen if "yellow fish" became one of the most popular dishes on the menu in most fish restaurants? Take students back to their operational definition of sustainable production to remind them at least some "yellow fish" must be left behind in the ecosystem or there will no longer be any "yellow fish."

MPAs in which commercial fishing is a mainstay struggle with how to meet the economic demands of livelihoods and public consumption and maintain the overall health of the ecosystem. The National System works towards protecting sustainable production of marine resources.

Goal for Sustainable Production Marine Resources: *Some U.S. MPAs are designated and established to help ensure the sustainability of renewable living resources and their habitats. Spawning, mating, and nursery grounds are just some of the areas protected. MPAs can help protect commercial and recreational fisheries by controlling how many fish are caught and protecting critical life stages in particular fish species.*

One area that typifies MPAs with critical commercial fishing aspects is the Chesapeake Bay. Take students to visit it via the Interactive MPA Mapping Tool (www.mpa.gov/mpaviewer) Students will find that Chesapeake Bay is not only a place for recreation in an area of high population density but also vitally important to the economy of the area. There, "yellow fish" are not the most important species economically and ecologically, "blue crabs" are.

Explore

Introduce students to the blue crabs of the Chesapeake Bay area by creating a slideshow using photos from http://www.chesapeakebay.net/photos.aspx?menuitem=19363. You might also use short video: *Life as a Waterman: Tangier Island*. This segmented, first-person account depicts the life of a waterman and the role his personal faith plays in this difficult vocation.

Then use these links to give students an overview of the blue crab, where it lives, what it eats, and how it reproduces:

- http://www.chesapeakebay.net/bfg_blue_crab.aspx
- http://www.serc.si.edu/labs/fish_invert_ecology/bluecrab/reproduction.aspx
- http://www.serc.si.edu/education/resources/bluecrab/lifecycle.aspx

Next, direct students to these two links:

- Blue Crab http://www.chesapeakebay.net/bluecrab.aspx?menuitem=19367 and
- Blue Crab Harvest http://www.chesapeakebay.net/crabs.aspx?menuitem=1470 .

Give students this goal for exploring these two web pages: Determine how the blue crab is economically important in the Chesapeake Bay and cite problems that are affecting the blue crab population. Guide students to notice the heads and subheads on the pages and use them as a reading guide. Students should discover they can move a mouse over certain terms they might not know the meaning of. Tell them to use additional links on the page for more information, but help them stay focused on the main informational goal.

Students might cite that blue crabs are a keystone species like the sea otter in Monterey Bay, that they are both predator and prey in the Chesapeake Bay food web, and that about one-third of the blue crabs available in the U.S. come from the Bay and the harvest is worth millions to those who work and depend on the Bay. Since the 1990s, the harvest has declined due to increased fishing, habitat loss, and poor water quality.

Explain

The Virginia Institute of Marine Science (VIMS) has conducted a monthly trawl survey of fishes and blue crabs in 60 stations throughout the Chesapeake Bay since 1955. The data is used to monitor blue crab population size. The following chart summarizes certain blue crab data from eight of the VIMS trawl stations from a past survey. Have students use colored pencils to map this data on the map (included at the end of this activity) to see where in the Chesapeake Bay blue crabs are found during different life stages and during certain times of the year. [2].

Materials

Chesapeake Bay map (PDF located at www.mpa.gov/education or at the end of this lesson)
Colored pencils (red, blue, green and orange)

Seating arrangement

Whole class activity or small groups

Instructions

Print off color copies of the data chart and black and white copies of the Chesapeake Bay map for the class.
Use a different symbol to note the presence of larvae, juvenile, or adult crabs at the appropriate station and use the correct color from the list to note what time of the year the crab is found there.

Dec.-Mar.—Red
Apr.-May—Blue
Jun.-Aug.—Green
Sept.-Nov. -- Orange

For example: At station 1 there are larval crabs present from June through August and September through November. Mark station 1 with a green X and an orange X to indicate the life stage of the crab (larval) and the months it was found there (Jun-Aug and Sept- Nov).

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[2] The original activity, *"Blue Crabs in the Chesapeake* "can be found at the following url: http://web.vims.edu/bridge/bluecrabworkshop2.pdf?svr=www

The presence of a higher number of blue crabs at various life stages at different stations in various seasons are indicated with an x, *, and +.

Station	Larvae (x)	Juvenile (*)	Adults (+)
1			
Dec - Mar			+
Apr - May			+
Jun - Aug	x		+
Sep - Nov	x		+
2			
Dec - Mar		*	+
Apr - May		*	+
Jun - Aug		*	+
Sep - Nov		*	+
3			
Dec - Mar		*	+
Apr - May		*	+
Jun - Aug			
Sep - Nov		*	+
4			
Dec - Mar		*	
Apr - May		*	
Jun - Aug		*	
Sep - Nov		*	
5			
Dec - Mar		*	
Apr - May		*	
Jun - Aug			
Sep - Nov		*	
6			
Dec - Mar		*	+
Apr - May		*	+
Jun - Aug			
Sep - Nov		*	
7			
Dec - Mar		*	
Apr - May		*	
Jun - Aug		*	
Sep - Nov		*	
8			
Dec - Mar		*	
Apr - May		*	
Jun - Aug		*	
Sep - Nov		*	

Data adapted from *"Blue Crabs in the Chesapeake"* Classroom resource produced at the Virginia Institute of Marine Science by Lisa Lawrence, Vicki Clark, Jaques van Mortfrans, and Susanna Musick

After students have used the data to mark their maps bring the class together, and as a group, have students use their maps to make a timeline that delineates activities and locations of the blue crab during its life cycle. Use these facts to give dimension to the mapping activity and the timeline.

- Reproductive activity begins in early spring.
- Females mate once and have a life span of about 2.5 years.
- Male and female crabs mate in the greatest numbers from spring to summer in the mid-salinity areas near the inner Chesapeake Bay and its tributaries where the salinity of the water is between that of ocean water and fresh water.
- A female's sponge, or egg mass, may contain several million eggs.
- Larvae take about 2 weeks to develop inside the egg. The egg mass turns from orange to black as the larvae consume the orange egg yolks.
- Eggs hatch. This generally occurs near the mouth of the Chesapeake Bay in water that is between 66-84 °F and in water with a higher salinity near that of ocean water.
- Larval crabs, called zoeae, hatch and are swept away from the mouth of the Chesapeake into the Atlantic's inner continental shelf for about 45 days where the feed and molt several times.
- The zoeae's final molt results in metamorphosis and the more crab-like shape of the megalopa.
- The megalopae move back into the Chesapeake Bay during the summer and early fall into areas with lower salinity.
- The megalopae molt, becoming juvenile crabs that may molt 18-20 more times over the next 14-18 months.
- Mature adults result and the life cycle begins anew.

Use these questions to prompt discussion.

- How does the salinity, or salt content, of the water in the ocean compare with that of rivers and lakes?
- Why are fewer adults than juveniles found during these surveys?
- Where do you think the salinity of the water is greater? At the mouth of the bay or in the tributaries? Use the data to support your answer.

Elaborate

Students should begin to develop a sense of how the entire Chesapeake Bay is involved in the ecological and economic importance of the blue crab. While much recreation occurs on Chesapeake Bay, the watermen of the Bay depend on it for their livelihoods. Direct students to the following two articles from the *Chesapeake Bay Journal*: Virginia Creates Sanctuary to Protect Spawning Female Blue Crabs and VMRC Greatly Expands Deep Water Sanctuary for Blue Crab. Tell students their task is to discern what it means to create a sanctuary and how its creation, while conceived to present solutions, can cause concern. Be sure students understand terms such as over fishing, watermen, and catch rates before they begin reading. Have them consult the MPA glossary or the lesson vocabulary guide for assistance. Guiding questions for students include:

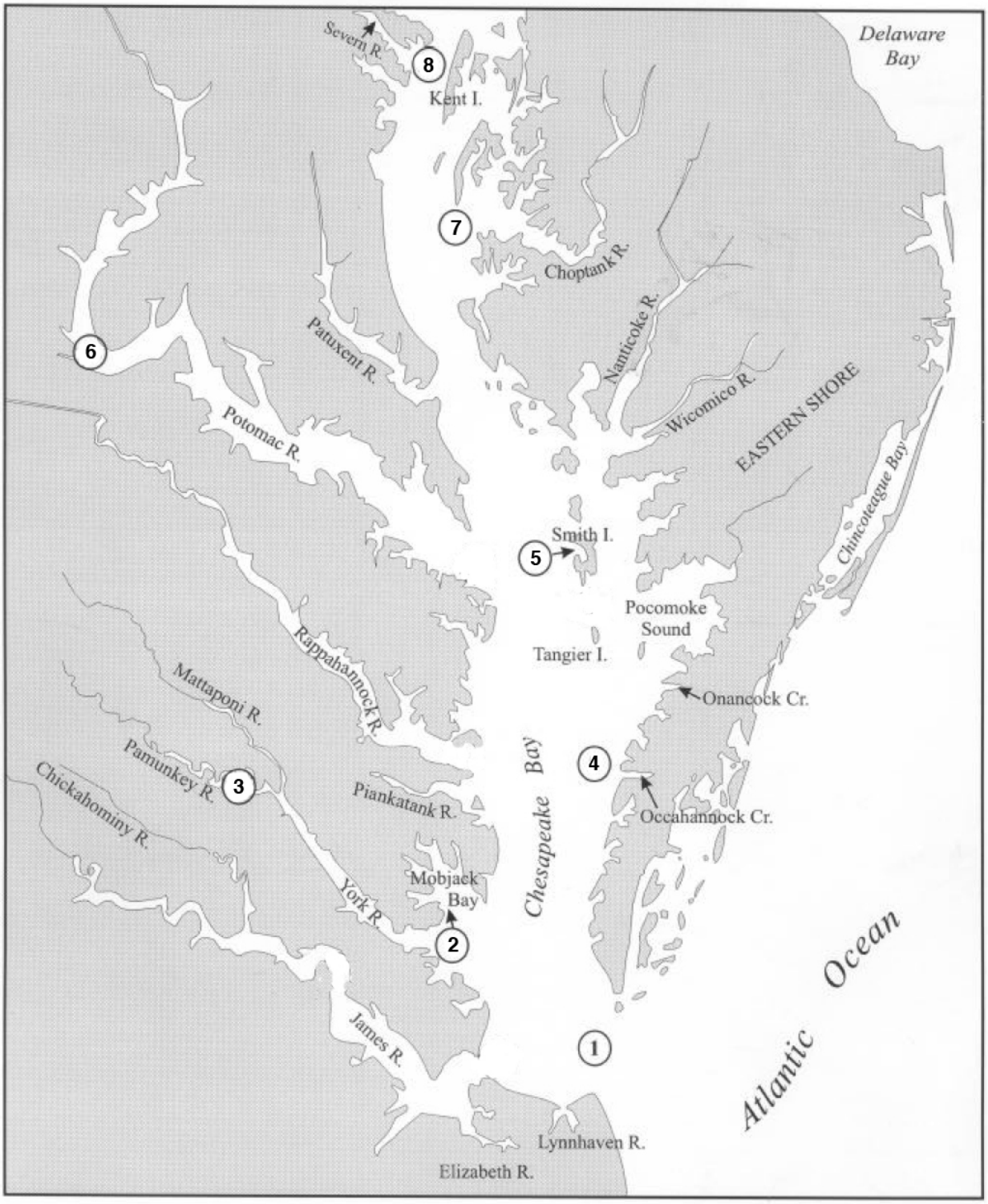
- Why was this area of the Chesapeake Bay chosen to be protected?
- When is the crab's spawning season?
- Why is closure important during that time?
- When was the agreement established, and expanded?
- Why was the sanctuary expanded?

- Besides limiting fishing during spawning, what are some other ways sanctuary guidelines are protecting blue crabs

Evaluate

Have students consider how the National System of MPAs goal of sustainable production is being addressed in the Chesapeake Bay. Have students use their maps and timelines, and review the times of the year when the sanctuary would need to be closed to crabbing in order to ensure blue crab survival. Students could write statements either opposing or defending the actions of the Virginia Marine Resources Commission and the establishment of a sanctuary. Students should make connections between the time(s) of the year that crabbing is off limits and the spawning and growing seasons for blue crabs. Then ensure that their statements are supported by facts they have gleaned from this or other research.

Chesapeake Bay Blue Crab Research Stations



Map adapted from *"Blue Crabs in the Chesapeake"* Classroom resource produced at the Virginia Institute of Marine Science by Lisa Lawrence, Vicki Clark, Jaques van Mortfrans, and Susanna Musick.

References

Blankenship, Karl. “VA Creates Sanctuary to Protect Spawning Female Blue Crabs.” The Bay Journal July/August (2000): < http://www.bayjournal.com/article.cfm?article=1310 >

Blankenship, Karl. “VMRC Greatly Expands Deepwater Sanctuary for Blue Crabs.” The Bay Journal July/August (2000): < http://www.bayjournal.com/article.cfm?article=703 >

Clark, Vicki. Musick, Susanna. van Mortfrans, Jaques. “Blue Crabs in the Chesapeake.” Virginia Sea Grant and Virginia Institute of Marine Science

Life as a Waterman: Tangier Island. Producers John Kondis, Miki Meek. Narr. James Eskridge. National Geographic.

Resources

Chesapeake Bay Program: A watershed Partnership

- http://www.chesapeakebay.net/bfg_blue_crab.aspx
- http://www.chesapeakebay.net/bluecrab.aspx?menuitem=19367
- http://www.chesapeakebay.net/crabs.aspx?menuitem=1470

Smithsonian Environmental Research Center: Fish and Invertebrate Ecology

- http://www.serc.si.edu/labs/fish_invert_ecology/bluecrab/reproduction.aspx
- http://www.serc.si.edu/education/resources/bluecrab/lifecycle.aspx

National Marine Protected Areas Center www.mpa.gov

- www.mpa.gov/resources/education
  Lesson Vocabulary Guide
  Chesapeake Bay map

National Marine Fisheries Service www.nmfs.noaa.gov

- NOAA Fisheries Office of Protected Species Education
  http://www.nmfs.noaa.gov/pr/education/

Ocean Literacy: Essential Principles of Ocean Sciences Grades K-12

- Essential Principal 1: The Earth has one big ocean with many features.
- Essential Principal 5: The Ocean supports a great diversity of life and ecosystems.
- Essential Principal 6: The Ocean and humans are inextricably interconnected.

Joining the National System of Marine Protected Areas

Part I

After students have explored the examples of healthy ecosystems, cultural heritage and sustainable production, direct their attention back to the poster. Ask volunteers to remind the class how each example MPA exhibited all three aspects to some degree. Help the class surmise that MPAs have some elements of cultural heritage and sustainable production along with a healthy ecosystem (or any combination thereof).

Ask students to use the Interactive MPA mapping tool (www.mpa.gov/mpaviewer) to find an MPA that is already a member of the National System of Marine Protected Areas. (This can be done by clicking on “national system” in the filter menu, and opening the “member” folder). Have students use the mapping tool to determine where the MPA is located and which agency manages the site. Use the national system member’s website as a research tool and have students answer the questions in the worksheet below. Using the answers, students can discuss how the MPA meets at least one of the three conservation goals of the national system: Natural Heritage, Cultural Heritage and Sustainable production.

Part II

Many marine protected areas in the United States that are not yet members of the national system. Direct students to use the Interactive MPA Mapping Tool (www.mpa.gov/mpaviewer) to find a site that is not in the national system. (This can be done by clicking on “national system” in the filter menu, and opening the “eligible” folder). Using the Internet, have students find as much information as possible about the MPA. Students should use the worksheet to guide research.

Next, have students write letters to the National Marine Protected Areas Center explaining why they feel an MPA should be a member of the national system. After students write the letters, photocopy them and divide the class into small groups. Have each group act as a review panel for all recommendations. Then have each group choose the one they think is most deserving. Compare the results among the groups and ask for their critical thinking processes on how their judgments were made. As a class, agree on which recommendation has the most support and submit it!

Worksheet

Site Name_____

Site Location_____

Who Manages the Site? (Agency Name) _____

Natural Heritage	**Yes**	**No**	**Explain in more detail**
Does this site protect a specific species of marine animal or plant?			
Is the site home to federal or state endangered or threatened species?			
What migratory species, if any, pass through the site?			
Cultural Heritage			
Does this site contain cultural heritage resources such as, a shipwreck, archeological remains, or culturally significant areas?			
Sustainable Production			
Does the site protect important habitat for fish? (e.g. refuges (hiding places), reproduction areas, etc)?			
Does this site protect food resources for commercially and recreationally important fish species?			

Lesson Vocabulary Guide

Marine Protected Area (MPA): Any area of the marine environment that has been reserved by federal, state, territorial, tribal, or local laws to provide lasting protection to part or all of the natural and cultural resources that reside within.
-OR- Defined areas where natural and/or cultural resources are given greater protection than the surrounding waters.

Stakeholder: Individuals, groups of individuals, or organizations that have an interest in MPA management decisions or are affected by management outcomes. Some examples of stakeholders interested in MPAs include: fishermen, scientists, politicians, researchers, kayakers, homeowners and marine educators, among others.

Transparent (MPA planning process): Ensuring balanced stakeholder involvement and respecting local and indigenous values throughout the process of designing and designating a MPA.

System of MPAs: A set of MPAs connected by shared program priorities, administrative priorities, and other purposes. A system is not necessarily confined to a specific geographic area such as a region or ecosystem.

Management tool: Specific technique used to manage and protect marine habitat, resources, and other important marine areas.

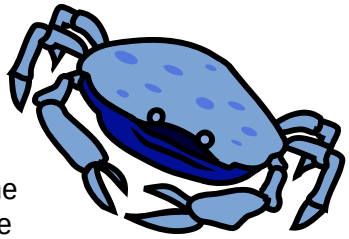
Network: A set of discrete MPAs within a region or ecosystem that are connected through common conservation purposes or ecological processes. For example, an ecological network of MPAs could be connected through the dispersal of eggs from one MPA to another MPA or the movement of juveniles and adults. (See connectivity)

Stewardship: Careful and responsible management of an MPA to ensure the goals and objectives of the MPA or site are being achieved for the benefit of current and future generations.

Partnership: Two or more managing agencies, programs, or communities working together toward a common conservation goal.

Connectivity (among MPAs): The ecological processes that link one MPA to many MPAs. For example, due to a specific area's oceanographic features such as currents, eggs and larvae can be transported across MPAs connecting the MPAs by specie and habitat.

Outreach: Increase public awareness and understanding of the importance of marine resources and conservation efforts.



Blue Crab Lesson reading Guide

Sanctuary: A marine protected area where the level of protection inside the MPA boundaries is greater than outside the MPA. A sanctuary can protect the natural and cultural features found inside, while allowing people to use and enjoy the ocean in a sustainable way.

Blue Crab Fishery: The catch of blue crabs for commercial purposes, such as to sell in a restaurant or store; or for recreational purposes.

To spawn (spawning): Blue crabs and other crustaceans reproduce by releasing eggs. The female crab will hold her eggs to her underside. She is then called a "sponge crab" because of the large orange egg mass.

Healthy spawning biomass: The population of blue crab that is able to successfully reproduce in a spawning season.

Overfishing: A level of fishing that does not allow for the long-term sustainable harvest of a fishery resource (e.g. leaves too few adult fish to reproduce and maintain healthy population levels for future fishing)[3]

Crab stocks: The blue crab population in the Chesapeake Bay.

Waterman: Someone who uses the water; in this case, a crab fisherman.

Harvest: The number of crabs that are caught from the Chesapeake Bay.

Catch rates: How fast and how many blue crabs are harvested from the Chesapeake each season.

Targets: The number of blue crabs that can be harvested and at the same time leaving enough blue crabs in the Bay to spawn and maintain the population.

Bi-State Blue Crab Advisory Commission: An advisory group established in 1996 made up of Chesapeake Bay users, government officials, state officials, industry representatives and conservationists. This group uses science and data to determine what a healthy blue crab population is for the Chesapeake Bay and to provide advice on the best way to manage them.

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[3]Definition derived from the National Marine Fisheries Service: "Overfishing" on a stock or stock complex occurs whenever the stock or stock complex is subjected to a level of fishing mortality or annual total catch that jeopardizes the capacity of a stock or stock complex to produce MSY (maximum sustainable yield) on a continuing basis. A stock or stock complex is considered "overfished" when its biomass has declined below a level that jeopardizes the capacity of the stock or stock complex to produce MSY on a continuing basis.