Shrimp Farming –
Environmental and Social Impacts

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NCSR curriculum modules are designed as comprehensive instructions for students and supporting materials for faculty. The student instructions are designed to facilitate adaptation in a variety of settings. In addition to the instructional materials for students, the modules contain separate supporting information in the "Notes to Instructors" section, and when appropriate, *PowerPoint* slides. The modules also contain other sections which contain additional supporting information such as assessment strategies and suggested resources.

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NCSR Marine Fisheries Series

The marine fisheries issue is complex and represents an opportunity to approach the nature and management of a natural resource from several different perspectives in courses in natural resource or environmental science programs. Complete coverage of all fisheries-related topics is probably impractical for most courses unless the course is entirely devoted to fisheries. Instructors may select some topics for coverage and de-emphasize or ignore others. Thus, these curriculum materials are designed to meet a variety of instructional needs and strategies. The *NCSR Marine Fisheries Series* is comprised of the following:

1. *PowerPoint* Presentations

These presentations include *PowerPoint* slides, lecture outlines and detailed instructor notes on various marine fisheries topics.

- *Marine Fisheries Overview*
- *Marine Fisheries – Introduction and Status*
- *Marine Fisheries – Causes for Decline and Impacts*
- *Marine Fisheries – Management and Proposed Solutions*
- *Declining Expectations – The Phenomenon of Shifting Baselines*
- *The Role of Marine Reserves in Ecosystem-based Fishery Management*

2. *The Decline of Atlantic Cod – A Case Study*

This module provides a comprehensive examination of the decline of the Atlantic cod. Instructional materials include student learning objectives, a *PowerPoint* presentation with instructor notes, student handouts, suggested resources and assessment. Brief descriptions of other fisheries for development as case studies are also provided.

3. *Comprehensive Resources for NCSR Marine Fisheries Series*

This module provides detailed summaries for six excellent videos that examine various aspects of the marine fisheries issue:

- *Empty Oceans, Empty Nets* (2002) – an overview of major marine fisheries issues (one-hour) – student handout provided
- *Farming the Seas* (2004) – an examination of issues associated with aquaculture (one-hour) – student handout provided
- *Deep Crisis* (2003) – an examination of current research on salmon and bluefin tuna using modern technology (one-hour)
- *Strange Days on Planet Earth – Episode 3- Predators*
- *Strange Days on Planet Earth – Episode 5 – Dangerous Catch*
- *Journey to Planet Earth – The State of the Planet's Oceans*

This module also provides a comprehensive glossary of terms commonly used in marine fisheries.

In addition, complete citations and brief summaries of web, print and video resources are provided that can be used to:

- Enhance existing lecture topics
- Develop lectures on new topics
- Develop geographically relevant case studies
- Update fishery statistics
- Select articles for student reading
- Access video and photos for presentation purposes

4. Activity-based Instructional Modules

    - *Shrimp Farming –Environmental and Social Impacts* an evaluation of the environmental and social impacts of shrimp aquaculture (one hour)
    - *Where Does Your Seafood Come From?* – students evaluate the sustainability of locally available seafood and the criteria that are used to make that determination (3-4 hours)

The manner in which instructors use the modules in this series will depend upon:

- The course in which the module will be used

The marine fisheries modules are most appropriate for inclusion in undergraduate courses such as *Environmental Science*, *Introduction to Natural Resources*, *Marine Biology*, *Introduction to Fisheries* and *Fisheries Management*. Parts of the modules may also have application in courses with a broader scope such as *General Ecology* and *General Biology*.

- The background of the students

The marine fisheries modules assume some understanding of basic ecology including populations, communities and ecosystem structure and function. The treatment of ecology in either a college-level or high school-level general biology course should be sufficient. Instructors may need to provide additional background to students who are not familiar with this material.

- The time that will be dedicated to the study of marine fisheries

There is sufficient information and resources in the marine fisheries modules to present anything from a single one-hour lecture to a major portion of a full academic term, lecture-only course. Instructors may select from the various components depending on course objectives and the amount of time allocated for marine fisheries topics.

Shrimp Farming –
Environmental and Social Impacts

MODULE DESCRIPTION

This is a lecture-based activity designed to stimulate discussion in the classroom. Students are introduced to shrimp aquaculture and harvest and consider the environmental and social impacts of shrimp farming. The activity takes about 30 minutes.

INTRODUCTION

Shrimp are the most commonly consumed seafood in the U.S. with an annual per capita consumption of over 4 pounds. Shrimp are both caught in the wild and farmed. Although some shrimp are harvested in U.S. waters, the majority are now imported from over 40 countries with Thailand as the leading supplier. A dramatic increase in the number of shrimp farming operations in Asia and Latin America in the 1990s resulted in increased availability of shrimp in the U.S. marketplace. The sustainability of shrimp fisheries is highly dependent on species, location and methods of harvest and varies from "sustainable" to "highly unsustainable."

OBJECTIVES

Upon successful completion of this module, students should be able to:

1. Describe the environmental and social impacts of shrimp aquaculture
2. Develop recommendations for improvements in shrimp aquaculture operations to reduce these impacts

PROCEDURE

1. Introduce the shrimp farming activity by showing the associated slide presentation entitled, *Shrimp Farming – Environmental and Social Impacts*. This presentation includes a pair of satellite images from the United Nations Environmental Programme that illustrates the impact of shrimp farm development. "Before" (1987) and "after" (1999) images in the Gulf of Fonesca, Honduras are shown and described as follows:

This image illustrates the rapid development (over only 12 years) of shrimp farming in the delta of the Gulf of Fonesca, Honduras. Large areas have been converted from natural mangrove forests and estuaries of the delta into shrimp farms (shrimp aquaculture). Shrimp aquaculture began in the 1970s and continued in the 1980s with the support of international financial organizations and the Honduran government. By the 1990s shrimp aquaculture was one of the country's top grossing industries. The rapid growth of the industry has resulted in both social and environmental impacts.

SOURCE:

UNEP. 2005. One Planet Many People: Atlas of Our Changing Environment. Division of Early Warning and Assessment. United Nations Environment Programme, Nairobi, Kenya. 320 pp.

2. Students should predict the potential environmental and social impacts of this change based on their understanding of ecosystems, viewing of the image and the brief description above. Student responses may be part of a classroom discussion or may be recorded more formally as a written exercise. Some possible answers follow:

Environmental *– altered hydrology of the area, destruction of mangroves, estuaries and seasonal lagoons resulting in declines of biodiversity and loss of ecosystem services they provide; degraded water quality (runoff of enriched water from ponds), impacts on fisheries due to bycatch associated with capture of shrimp post-larvae, which are used to stock the ponds seen in the image. Estimates of direct loss of the mangrove ecosystem due to shrimp farm construction range from 20 - 40 km^2. If conservation measures are not implemented, mangroves will disappear within 20 years.*

Note that the Estero Real Nature Reserve is located near the center of the image. What impacts might be expected on this conservation area?

Social *– Although new employment opportunities have been provided by this new shrimp farming industry, other industries have been negatively impacted. Rapid development has deprived fisherman, farmers and others access to mangroves, estuaries and seasonal lagoons.*

3. Show the 10-minute video segment of Shrimp farming in Thailand from "Farming the Seas" video. This video production may be ordered from:

Farming the Seas. 2004. Habitat Media. VHS 56 min.
734 A Street
San Rafael, CA 94901
415-458-1696
www.habitatmedia.org

4. After viewing the video segment, have students again describe the potential environmental and social impacts of shrimp farming. Both positive and negative impacts should be included. After viewing the video, descriptions should now be more complete and more detailed. This can be done as an instructor-led discussion or as a student writing assignment.

5. Once the environmental and social impacts are discussed, students should discuss what changes could be implemented to reduce these impacts. What benefits would be achieved if these changes were to be implemented?

PowerPoint Presentation with Instructor Notes

Shrimp are the most commonly consumed seafood in the U.S. with a per capita consumption of 4.2 pounds in 2004. The U.S. imported $3.6 B worth of shrimp in 2001 from over 40 countries. Thailand is the leading supplier. The terms “shrimp” and “prawns” are used interchangeably although “prawns” tend to be larger.

Shrimp are both caught in the wild and farmed and there are environmental impacts associated with each. The sustainability of shrimp fisheries is highly dependent on species, location and methods of harvest and varies from “sustainable” to “highly unsustainable.”

For wild-caught shrimp, bycatch, habitat impacts and over-exploitation of stocks are among the most pressing environmental concerns. The Food and Agriculture Organization (FAO) estimates prawn trawl by-catch at 1.9 million tonnes a year which is 27% of annual global by-catch.

A large-scale shrimp aquaculture facility in Thailand (2001). This facility was developed on once-pristine mangrove forest impacting coastal ecosystems. Antibiotics are commonly used to treat or prevent diseases and marine waters are used as a water source for the facility. Most shrimp produced here are exported to the U.S. and Europe.

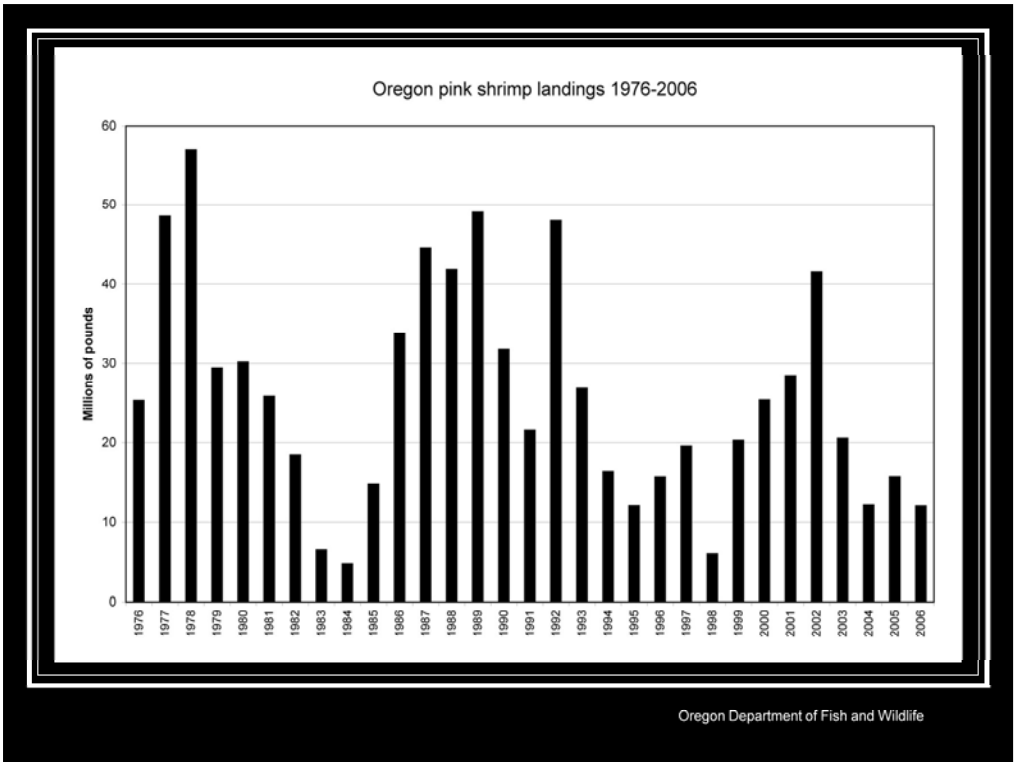
Shrimp aquaculture need not be as environmentally damaging as illustrated in the previous slide. For example, this is a Florida shrimp aquaculture operation that produces certified organic shrimp for domestic markets. A small artificial pond is shown here that is used to hold shrimp broodstock (adult shrimp used to produce eggs for shrimp production). The facility uses no antibiotics, does not impact coastal ecosystems and uses freshwater pumped from deep aquifers as their water source.

Determining the sources of shrimp can be complex. Tiger prawns, for example, are imported to the U.S. from Asia, Australia and South America where they are both wild-caught and farmed. Since bycatch reduction devices are not required by most countries outside the U.S. these species are seen as a less desirable choice for consumers.

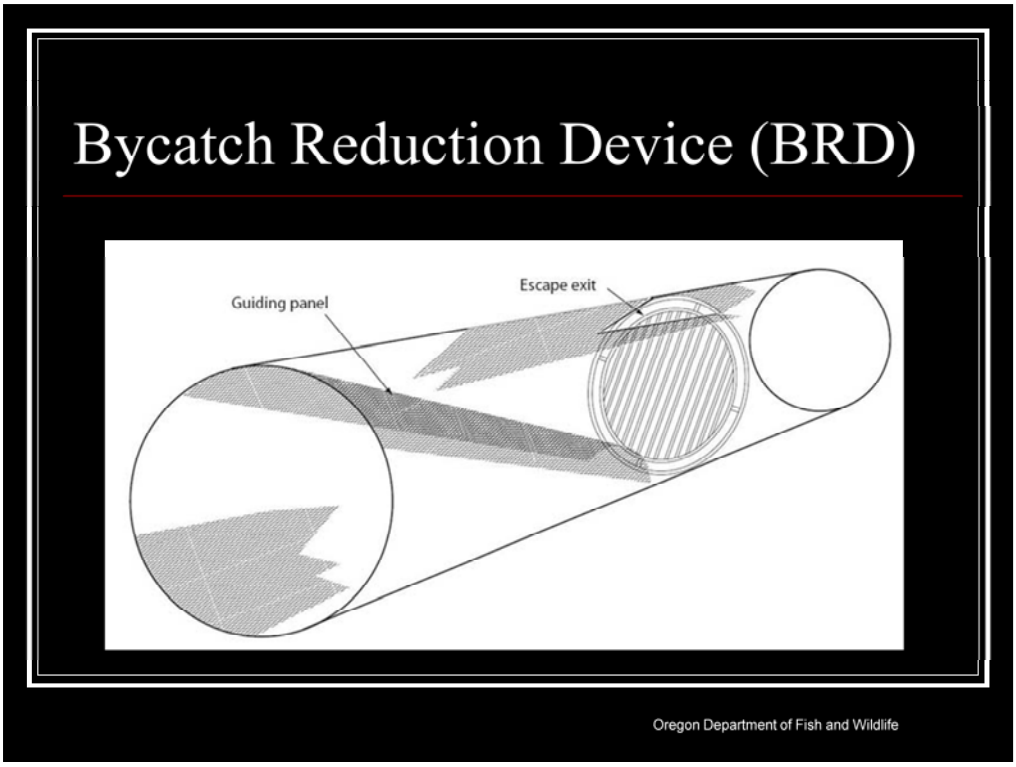
The environmental impacts of tiger prawn aquaculture, in addition to the loss of mangrove forests, include artificial enrichment of natural waterways and the harvest of other fish to feed captive shrimp. This further reduces the appeal of tiger prawns and some other farmed shrimp as a consumer choice.

By contrast, Oregon pink shrimp (*Pandalus jordani*) are only wild-caught and have been harvested in Oregon since 1957. Pink shrimp are marketed as “salad shrimp” or “cocktail shrimp.” In 2009 the Oregon pink shrimp fishery received Marine Stewardship Council certification as a sustainable fishery. This designation was in part based on the management system in place, stock abundance and gear modifications that reduce bycatch of fish in shrimp trawls.

The Oregon pink shrimp management system includes a seasonal opening (April to 31 October) that nearly eliminates interference with reproductive activities in December through March. Also, only larger shrimp (160 per pound or less) can be landed. If shrimp fishers find that they are harvesting smaller shrimp, they move to another area.



Landings have averaged 26 million pounds per year over the past 31 years and are highly variable year to year (common for small marine crustaceans).



Bycatch reduction devices are now used by all shrimp trawlers in Oregon. The device reduces bycatch of fish in shrimp trawls while providing some distinct benefits to the fishery. BRDs make sorting of the catch easier since there is less fish in the catch and the devices allow shrimp boats to work in areas that could not be fished due to unacceptably high levels of bycatch.

The design is similar to that that is used in “turtle excluder devices” used in the Gulf of Mexico shrimp fishery. As fish and shrimp enter the opening of the net (at left) they are guided by a panel of netting towards the bottom of the device and towards a metal grate with vertical bars spaced 1.25 - 1.5 inches apart (seen at center of diagram). Shrimp and fish smaller than 1.5 inches wide are allowed past the grate into the cod end (terminal net bag) of the net, while larger fish are directed to an escape exit at the top of the device (see diagram).

See video of operation of device at
http://www.dfw.state.or.us/MRP/shellfish/commercial/BRDs.asap

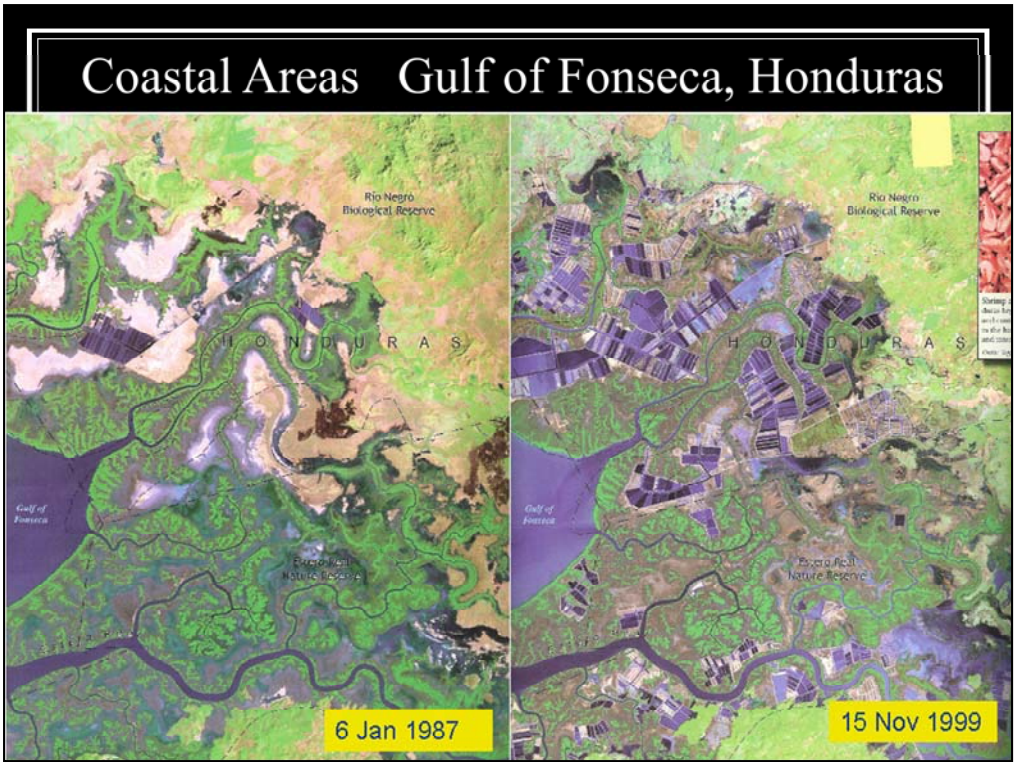
As an illustration of the effectiveness of BRDs, this photograph shows the catch from a single haul using a BRD with a 1.25 inch spacing. Bycatch is shown in the two containers at right.

This photo shows the results of experimental side-by-side trawling with (right) and without (left) a BRD device. Bycatch without BRD is mostly large hake and rockfish; bycatch with BRD is far less and includes small hake and occasional small rockfish. BRDs have also been shown to nearly eliminate bycatch of species of special concern such as Pacific halibut, Canary rockfish and Yelloweye rockfish.

http://www.dfw.state.or.us/MRP/shellfish/commercial/BRDs.asap

From the examples shown here, it should be clear that the environmental impacts of shrimp fishing and production in aquaculture operations are highly variable. Any consumer who desires to make environmentally conscious choices when buying shrimp, would have to “do their homework” to determine the specific source of their purchase.

For more information see the Monterey Bay Aquarium web site at www.montereybayaquarium.org.



This image illustrates the rapid development (over only 12 years) of shrimp farming in the delta of the Gulf of Fonesca, Honduras in Central America. Large areas have been converted from natural mangrove forests and estuaries of the delta into shrimp farms (shrimp aquaculture). Shrimp aquaculture began in the 1970s and continued in the 1980s with the support of international financial organizations and the Honduran government. By the 1990s shrimp aquaculture was one of the country's top grossing industries. The rapid growth of the industry has resulted in both social and environmental impacts.

SOURCE:

UNEP. 2005. One Planet Many People: Atlas of Our Changing Environment. Division of Early Warning and Assessment. United Nations Environment Programme, Nairobi, Kenya. 320 pp.

Photo Credits

- Marine Photobank: Ellen Hines, OceanBoy Farms, Stephen McGowan,
- Oregon Department of Fish and Wildlife
- *One Planet Many People: Atlas of Our Changing Environment*. UNEP. 2005.

NOTES TO INSTRUCTORS

1. Detailed notes from the *Farming the Seas* video are included below. The segment is 10 minutes long and can be found at the 30-minute to 40-minute interval in the video.

Shrimp Farming in Thailand

- The recent development of shrimp farming has been driven by demand for this preferred food in the U.S. and Europe
- 2/3 of shrimp are caught by trawlers (5 pounds of bycatch for every 1 pound of shrimp)
- Some trawlers have excluder devices that reduce bycatch of sea turtles (but not all nations)
- 1/3 of shrimp are farmed, most in tropical countries (with few environmental or labor regulations)
- targets markets in U.S., Japan and Europe (vs. native countries)
- purpose of agriculture in these countries has become to feed rich countries
- operations transform coastal ecosystems (mangrove forests)
- Mangrove forests are breeding grounds for many fish and shellfish species
- Ecosystem was first impacted by charcoal industry (Mangrove trees used to produce charcoal) and more recently by shrimp aquaculture
- There are 30,000 shrimp farms in Thailand alone
- Exponential growth of shrimp farms since mid-1980s has only recently stopped
- Provides economic opportunity but also brings a "way of life" to an end
- Waste from these farms goes into the sea and contaminates traditional fishing grounds
- Use of antibiotics is added to shrimp feed to control disease - can create antibiotic-resistant bacteria, which can pose a threat to human health
- Also, waste from these operations can contaminate aquifers and drinking water supplies for humans
- Water filtering function of mangrove forests and swamps is removed
- Some recent efforts have been made to make shrimp farming operations more sustainable in Hawaii and Florida

2. Intact mangrove forests provide a number of ecosystem services including the following:

- Nursery and adult habitat for marine organisms (including a number of commercially important species)
- Seafood
- Fuelwood
- Timber
- Trapping of sediments
- Detoxify pollutants
- Protect coastline from erosion and disaster (e.g., Indian Ocean tsunami had less impact where mangrove forests were intact)

Conversion of these mangrove forests into shrimp farms certainly provide economic benefits; however, those benefits are achieved at the cost of the loss of ecosystem services listed above.