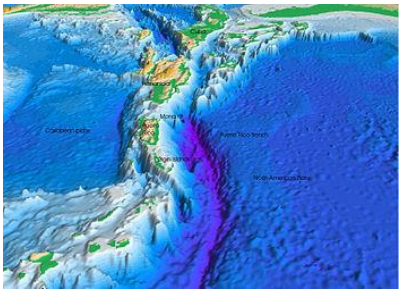
.**MIDDLE and HIGH SCHOOL**

No NGSS alignment

www.MaineAgintheClassroom.org



Climate of Change Part IV: The Future of Aquaculture

Geography of Aquaculture

Developed by the Island Institute, Rockland, Maine

Revised and formatted by Maine Agriculture in the Classroom

Overview:

Aquaculture is not a new technology. Sea vegetables, fish, and shellfish have been grown for hundreds, even thousands, of years throughout the world. China and Japan are examples of countries that have used and relied upon aquaculture for generations. This lesson will first focus on the history and origins of aquaculture followed by a geography exercise where students will locate and identify different countries that use aquaculture on a regular basis. Students will then locate and identify local aquaculture businesses along the coast of Maine using maps or charts. The goal of this lesson is to help students understand that aquaculture is not a new technology and that the U.S. is just now transitioning to this practice, with Maine being the leader in shellfish and kelp aquaculture.

Essential Questions:

- How long and in what ways have humans been involved in aquaculture as a way to produce food?
- What are the differences between wild harvest and seaweed aquaculture businesses?
- Where are some local shellfish and seaweed aquaculture businesses located along the coast of Maine?
- How might the presence of an aquaculture business affect a community?

Learning Objectives:

Students will

- recognize that humans have been practicing aquaculture for thousands of years.
- explain the difference between wild harvest and aquacultured seaweed.
- identify aquaculture businesses in their community and
- explain the impact of those businesses on the community.

Materials:

- Aquaculture history flashcards- print and cut out prior to lesson
- YouTube video of scallop ear-hanging technology: https://www.youtube.com/watch?v=B3OW3RrTo3E
- List of Maine aquaculture businesses
- Map of the Maine coast handouts
- Notecards
- Writing prompt

28 State House Station, Augusta, ME 04333
maitc@maine.gov 207.287.5522

Background Information:

Aquaculture began around 3,500 BCE with carp cultivation in China. Many southeast Asian countries have been practicing aquaculture ever since. By the early 1800s aquaculture practices were seen in the U.S., and in 1853 an Ohio trout farm became the first in the U.S. to artificially fertilize fish eggs. Since then, new aquaculture methods and technologies have been popping up around the world.

One example of new technology is sea scallop "ear-hanging" in Japan. Team members of the Maine Sea Grant visited the

State of Aomori Prefecture in Japan in 2010 to learn more about this new technology and to collect ideas to bring to Maine's growing aquaculture industry. This YouTube video is a compilation of highlights from this trip.

Over the past decade there have been numerous aquaculture businesses started along Maine's coast. Most of these businesses were started using new technology and many of the growers were uncertain about the success rates of their newly developed farms. Through trial and error, these farms have grown into viable businesses. The following is a partial list of aquaculture businesses in Maine:

AQUACULTURE BUSINESSES IN MAINE

Edible seaweeds:
Gulf of Maine, Pembroke
Maine Coast Sea Vegetables, Hancock
Maine Fresh Sea Farms, Damariscotta
Ocean Approved, Portland
VitaminSea, Buxton
Wild Ocean Aquaculture, Portland
Atlantic Holdfast Seaweed Company, Penobscot Bay
Maine Seaweed, Steuben
North Haven Seaweed, North Haven
Shearwater Ventures, Long Island
IronBound Island Seaweed, Winter Harbor

"As part of an ongoing and productive relationship, a delegation from Maine visited its sister-state of Aomori Prefecture, Japan, in 2010. Part of the trip was to revisit the Japanese scallop aquaculture industry, with a highlight of stopping at the manufacturing facility of a premier gear supplier, specific to the scallop aquaculture technique called 'ear-hanging.'"
- Dana Morse, University of Maine Cooperative Extension, Maine Sea Grant

Oysters:
The Maine Oyster Trail (A detailed list of oyster aquaculture businesses in Maine):
http://www.seagrant.umaine.edu/maine-oyster-trail#learn
Capitan B Oyster Company, Chebeague Island
Siren's Sea Farm, Yarmouth
Mook Sea Farms, Walpole
Basket Island Oysters, Peaks Island
Chebeague Island Oyster Company, Chebeague Island

Mussels:
Marshall Cove Aquaculture, Islesboro
Bang's Island Mussels, Portland
Calendar Island Mussel Company, Portland
Oceanville Seafood, Stonington

Procedure:

Begin the lesson by dividing the class into small groups and hand out a deck of aquaculture flashcards to each group

- Have students work together to put the flashcards in sequential order.
- After 15 minutes, or until students have completed the task, see which group(s) successfully sequenced the cards
- Ask students the following questions:
    - Which countries were the first to start aquaculture? (China and southeast Asian countries)
    - When did aquaculture start being practiced in the U.S.? (early 1800s)
    - What surprised you/didn't surprise you after completing the sequencing? (i.e., Surprised to learn that seaweed farming started back in the 1600s)
    - How do you think aquaculture technology has changed over the years? (i.e., We are now better able to measure water quality, which allows for a healthier aquaculture product)
- One example of new technology is sea scallop "ear-hanging" in Japan. Introduce the short YouTube video to students:
    - Team members of the Maine Sea Grant visited the state of Aomori Prefecture in Japan in 2010 to learn more about this new technology and to borrow ideas to bring to Maine's growing aquaculture industry. This YouTube video is a short compilation of highlights from this trip.
- Have a short discussion about what students learned from the video
    - Why did a team from Maine travel all the way to Japan? (They went to learn about the new technology they are using in sea scallop aquaculture in Japan that could be used in Maine)
    - What did this team learn from their trip? (Ear-hanging methods used in scallop aquaculture are successful in Japan and could be used in Maine; creative thinking can really pay off in the aquaculture business.)
    - How will this exchange trip help Maine aquaculture businesses? (By sharing ideas and learning from others, Maine aquaculture businesses can grow and diversify.)
- After the discussion, distribute the Maine coast aquaculture map worksheet. Have students work alone or in pairs to locate and pinpoint five Maine aquaculture businesses on the Maine map.
- Once students have identified the location of five aquaculture businesses, have students create a business card for one of the businesses:
- Hand out 3"x5" notecards to each student.
- The following information should be incorporated into the business card:
    - Name of business
    - Type of species that is grown (i.e., mussels, oysters, kelp, etc.)
    - Contact information
    - Creative slogan for business (created by students)
    - Students will have to do online research on the business they choose.
- After students have completed their business cards, have students do a short "sales pitch" for the class, stating why their aquaculture business is the best.
- As homework or as a class discussion, ask students the following question:
- How may the presence of an aquaculture business affect a community? Good responses should include the following:
    - Environmental (ocean acidification, climate change)
    - Regulatory (bay management and ocean planning; how the ocean space will be used by different user groups without conflict)
    - Business/economic (diversified fishery)
    - Cultural (community members supportive/opposed to an aquaculture operation)
    - Tourism (an aquaculture farm could become a possible interest to tourists)

Cultivation of carp begins in China using freshwater ponds and rice paddies

Oyster farming begins in Japan

Seaweed farming begins in Japan.

Fish farming in its modem form begins when a German farmer successfully gathers trout eggs, fertilizes them, and then grows the hatched fish to maturity.

Aquaculturists experiment with lobster and winter flounder aquaculture in New England.

Washington's oyster farming industry begins when Pacific oysters from Japan are placed in coastal waters.

Raft culture of scallops is developed in Japan.

The first commercial salmon farms are established in Norway and Scotland.

Mussel aquaculture develops on both coasts of the U.S.

The commercial farming of hard clams, or quahogs, begins in New England.

Shrimp farming industries in many parts of the world collapse due to outbreaks of disease.

Tuna farming, in which juvenile wild fish are captured and then fattened in cages, is established in Australia.

Maine begins commercial seaweed aquaculture.

Production of farmed salmon exceeds the amount of salmon caught in the wild.

Infectious salmon anemia (ISA) spreads to Maine, forcing salmon farmers to slaughter over 1 million fish.

Commercially farmed cod is available in the US for the first time.

28 State House Station, Augusta, ME 04333
maitc@maine.gov 207.287.5522

Timeline of U.S. and World Aquaculture (events on cards are in bold text)

List from Alabama Cooperative Extension Service:

http://www.aces.edu/dept/fisheries/education/documents/General_Aquaculture_Timeline.pdf

3500 BC
Cultivation of carp begins in China using freshwater ponds and rice paddies.

2500 BC
Hieroglyphics indicate tilapia were being farmed in Egypt.

2000 BC
Oyster farming begins in Japan.

746 AD
The first reference to clam culture appears in Chinese literature.

1400
Marine finfish aquaculture begins in Indonesia when young milkfish are trapped in coastal ponds at high tide.

1600s
Seaweed farming begins in Japan.

1733
Fish farming in its modern form begins when a German farmer successfully gathers trout eggs, fertilizes them, and then grows the hatched fish to maturity.

Early 1800s
Oyster farming is further developed by the French by placing strings of tiles in water for oyster larvae to settle on and then transplanting the larvae to protected beds. Oyster farming expands to the Atlantic coast of the U.S.

1853
An Ohio trout farm becomes the first in the U.S. to artificially fertilize its fish eggs.

1880s
Aquaculturists experiment with lobster and winter flounder aquaculture in New England.

1909
The first commercial trout farm in the U.S. is established in Idaho.

1910
State and federal hatcheries in the U.S. develop channel catfish farming techniques.

1919
Washington's oyster farming industry begins when Pacific oysters from Japan are placed in coastal waters.

1930s
President Franklin D. Roosevelt's Farm Pond Program encourages the growth of the U.S. aquaculture industry by providing federal subsidies for building and stocking fishponds on farms.

Researchers in Japan make major advances in shrimp-farming techniques.

1934
Raft culture of scallops is developed in Japan.

1940s
Tilapia farming is introduced to the Caribbean, Latin America and the U.S.

1950s
Netpen aquaculture is introduced in Japan for the commercial culture of yellowtail.

1951
Intensive seaweed farming begins in China.

1960s
Commercial shrimp farming develops in Japan and soon begins in Ecuador and the U.S.

Late 1960s
Sea bass production begins in the Mediterranean.

The first commercial salmon farms are established in Norway and Scotland.

1970s
U.S. catfish farm acreage grows from 400 acres in 1960 to 40,000 in 1970.

After nearly collapsing due to disease and a saturated world salmon market, Norway grows to become the world's top Salmon farming nation.

Salmon farming expands to the U.S. and Canada.

Abalone hatcheries develop in California.

Mussel aquaculture develops on both coasts of the U.S.

1976
New Zealand's first commercial salmon farm is established.

World aquaculture production is estimated to be 6.1 million metric tons (mt).

1980s
The National Aquaculture Act of 1980 is passed in the U.S. to provide for the development of the aquaculture industry.
Sturgeon farming begins in California.

The commercial farming of hard clams, or quahogs, begins in New England.

1981
Manila clam farming begins in Washington and California.

1984
World aquaculture production reaches 10 million mt, contributing 12 percent of the world's aquatic food supply.

1985
Salmon farming is introduced in Australia.

Late 1980s
Shrimp-farming industries in Asia and South America undergo rapid expansion.

Early 1990s
World aquaculture production in 1990 is 13 million mt.

Research begins in the Mediterranean on the feasibility of off-shore aquaculture.

U.S. striped bass and tilapia aquaculture industries develop.

The Irish sea trout fishery collapses because of sea lice infestations believed to be caused by salmon farms.

Shrimp farming industries in many parts of the world collapse due to outbreaks of disease.

Alaska bans commercial netpen fish farms to protect its wild fisheries.

1991
Tuna farming, in which juvenile wild fish are captured and then fattened in cages, is established in Australia.

1992
Snapper aquaculture begins in Australia.

1994
Between 1984 and 1994, world aquaculture production grows 11 percent per year on average.

Maine begins commercial seaweed aquaculture.

1995
The British Columbia government places a moratorium on new salmon farm tenures in order to conduct an environmental review of the industry.

World aquaculture production is 24 million mt.

1996
Canadian researchers patent transgenic salmon.

1997
Canada announces plans to fund research in cod farming

1998
Sea bream culture grows from 110 mt in 1985 to 41,900 mt in 1998.

1999
World aquaculture production grows 154% during the 1990s. Production tops 33 million mt and contributes nearly one third of the aquatic food supply.

Production of farmed salmon exceeds the amount of salmon caught in the wild.

2000
Farmed salmon production tops one million mt.

Research begins on new aquaculture species such as flounder, sablefish and halibut.

American aquaculturists induce spawning in cobia, marking the first step towards commercial cobia farming.

Name: _____ Date: _____

AQUACULTURE BUSINESSES IN MAINE

Mark the location of five of the following businesses on the accompanying map. You will probably have to search for the locations online. Please note, this is NOT a complete list of aquaculture businesses in Maine.

Edible seaweeds:

Gulf of Maine, Pembroke
Maine Coast Sea Vegetables, Hancock
Maine Fresh Sea Farms, Damariscotta
Ocean Approved, Portland
VitaminSea, Buxton
Wild Ocean Aquaculture, Portland
Atlantic Holdfast Seaweed Company, Penobscot Bay
Maine Seaweed, Steuben
North Haven Seaweed, North Haven
Shearwater Ventures, Long Island
IronBound Island Seaweed, Winter Harbor

Oysters:

The Maine Oyster Trail (A detailed list of oyster aquaculture businesses in Maine):
http://www.seagrant.umaine.edu/maine-oyster-trail#learn
Capitan B Oyster Company, Chebeague Island
Siren's Sea Farm, Yarmouth
Mook Sea Farms, Walpole
Basket Island Oysters, Peaks Island
Chebeague Island Oyster Company, Chebeague Island

Mussels:

Marshall Cove Aquaculture, Islesboro
Bang's Island Mussels, Portland
Calendar Island Mussel Company, Portland
Oceanville Seafood, Stonington

28 State House Station, Augusta, ME 04333
maitc@maine.gov 207.287.5522

Extension: Where in the world is aquaculture?

Essential Question:

- Which countries practice aquaculture and why?

Using the aquaculture history flashcards, ask students to locate the different countries on a large world map. It could be a simple exercise where students gather around a large poster and work together to locate countries, or it could be more interactive, like the activity below, where students have to find the "coordinates" of each country. This also introduces and reinforces the concepts of latitude and longitude.

Large world map exercise