Integrated Aquaculture Systems

Introduction

In the lessons in Unit 1, Is Aquaculture Sustainable?, we examined how aquaculture can contribute to meeting human food needs now and in the future. In this unit, Making Aquaculture Pay, we will explore other aspects of the sustainability of aquaculture food production systems, focusing on how farmers manage the resources in their aquaculture systems and on how aquaculture can help farmers achieve their goal of earning a liveable income, one of the key factors in sustainable food production systems.

In this lesson, we will explore aquaculture systems that integrate the production of two or more species of plants and animals. As we know, integrating plant and animal production is one of the key characteristics of sustainable food production systems as defined by the U.S. Congress. This lesson will also focus on how aquaculture systems can rely on natural processes and cycles, another key characteristic of sustainable food production systems. Finally, we will examine the degree to which these aquaculture systems are designed specifically to fit the biological, social, and economic conditions of specific places or the degree to which they are site specific, yet another important aspect of sustainability.

Read the Background Material on Integrated Aquaculture Systems (pages 7-9). This introductory material serves as an introduction for both Lesson 1 (Integrated Aquaculture Systems) and Lesson 2 (Aquaculture Around the World) in this unit. The material describes some types of integrated aquaculture systems. For students with a 9th grade or higher reading level, you can assign these pages as a homework assignment. For students with an 8th grade or lower reading level, we suggest that you explain the ideas in the readings to your students yourself. The examples on pages 11 to 14 can be used to illustrate the key features of each type of system.

Getting Ready

- Discuss the key features of integrated aquaculture systems with your students, drawing on the materials in the Background Material on Integrated Aquaculture Systems and using the examples provided. Point out examples of how these systems illustrate three aspects of sustainable food production as defined by the U.S. Congress: (1) integrating production of two or more species of plants and animals, (2) relying on natural processes and cycles such as using animal manure to fertilize fish ponds, and (3) designing systems to fit local

Purpose

To examine how integrated aquaculture systems help farmers use resources more efficiently.

Key Concepts

Integrated aquaculture systems can contribute to sustainable food production because:
- They integrate the production of two or more species of plants and animals;
- They rely on natural processes and cycles; and
- They are designed to fit the biological, social, and economic conditions of specific places.

Learning Objectives

Students will be able to:
- Explain how integrated aquaculture systems can help achieve sustainable food production;
- Describe some of the disadvantages of integrated aquaculture systems; and
- Analyze how resources are used in integrated aquaculture systems.
conditions, such as replacing expensive manufactured fish feed with manure and feed wastes from other animals.

**Doing the Activity**  **Time: 30 minutes**

- Cut out the arrows and component pictures (pages 15-24) and the boxed words (pages 22-26) describing products, byproducts, and issues associated with aquaculture in advance. Use an area of the chalkboard or wall where the cards can be left up for two or three days. Stick them randomly on the chalkboard with only one piece of masking tape so that they can be easily moved around. Have students take turns building an integrated aquaculture system on the board. Ask them to come to the blackboard and rearrange the different components of the integrated aquaculture system to show how they might be connected. Use the arrows to show the direction of each connection. Make sure students include the byproducts that result from each system. Label the connections with the byproducts that result from the interactions. If any component pictures or byproduct cards are left over, use those to inspire the students to read and find out how they fit in the system.

- Ask the following question to help guide students in building the system.

  What is the purpose of your system? To produce fish for sale? To produce fish for the family to eat? Raising fish for fun?

  What wastes or byproducts are produced? Animal manures? Parts of plants that people cannot eat (a byproduct)? Are they recycled in your system?

  How do the different parts of the system affect each other? Do the fish eat animal manure, for example? (You may need to refer to the NCAE materials for individual fish species to know their dietary habits.) What happens to the different products produced by the system; are they sold? Eaten by the farm family? Use arrows to show these interactions.

- The following pictures are included:

  **Components Cards**
  2 Ponds
  10 Farm Animals
  8 Fish
  Assorted Arrows
  3 Vegetable Crops
  3 Field Crops
  6 Aquatic Plants
  6 Scenes of People Working

**Subjects**
Social Studies
Science

**Materials**
Copies of pages 15-26
Transparencies of pages 10-14
Masking tape

**Extensions**
*Building and Using a Hydroponic-Aquaculture System in the Classroom.* Check out the website:


It contains a full description of how to make an integrated hydroponic-aquaculture system for the classroom. Teacher Ernest Nicol at Newton North High School in Newtonville, MA, says: “Water from this [fish] tank containing the fishes' metabolic wastes is pumped every thirty minutes through a series of five hydroponic tubes filled with lava rock. Seedlings in Jiffy 7 peat pots are inserted into circular holes in the tubes. This soilless garden can support about forty plants...” The site has full instructions for building the system.
There are several boxes that contain words. These include: (1) animal manure, (2) fish feces, (3) fishmeal, (4) algae bloom, (5) nutrient enriched water, (6) crop residues, (7) green manures, (8) money, (9) labor, (10) shared costs, (11) taste, (12) food to eat, (13) food to sell, (14) fish to eat, (15) fish to sell, and (16) health and safety. There are also a number of blank boxes that your students can fill in with their own ideas for byproducts, processes, products, or concerns associated with the system that they build.

Teachers who used this activity in their classrooms offered the following suggestions for enriching this experience.

Tailor the system to your class by having students make more component cards. Examples include fish species, beef cattle, pasture, ammonia, and irrigation.

Use the cards to build an integrated tank system.

Build two systems, one like the system that exists in your area and another that is international and compare the two.

Divide your students into teams and have them compare the different systems that they build.

Points to Discuss With the Students While Building Your System

Advantages of Integrating

- Integrating fish and agricultural systems provides farmers with a variety of income sources, gives him/her more products to sell, balances risks among different enterprises, provides fuller employment, and produces additional protein.

Disadvantages of Integrated Systems

- Byproducts of one system recycled into another may be of lower quality than purchased inputs designed specifically for fish production.

- Farmers may need to have more management and labor skills. New tasks are required for each crop or animal produced. Management decisions that are best for one crop or animal may not be good for another.

About Manures and Crop Residues

- Crop residues and animal manures fertilize the ponds. They increase photosynthesis to produce more natural food for fish.

If you want to learn more about hydroponic-aquaculture systems, visit some of the web sites shown in this lesson and in Lesson 2, "Aquaculture Around the World," in this unit. For example, visit Aloha ‘Aina Farms in Hawaii and look at their system at:

http://hawaii-shopping.com/~sammonet/hydrohome.html

Non-Formal Assessment

Do a circular whip in which all students are seated in a circle, and "whip" around the circle allowing each student to name one advantage of an integrated aquaculture system. Repeat the whip in the opposite direction having students name one disadvantage.
• Crop residues and animal manures vary in their nutrient quality and may not provide an optimum diet for aquaculture species.

• The same amount of manure used to fertilize crops instead of feeding fish may produce more energy for humans if we eat the crops directly. However, if the fish eat the manure and then we eat the fish, we usually get a higher quality protein than comes from plants.

• In taste tests, people could not distinguish between fish grown with manures from those grown with commercial fertilizers.

• Herbivorous fish can eat crop residues and green manures directly. Examples are tilapia and the grass carp.

• You can get parasites from eating raw fish. We do not know if fish transmit viruses. Remember, people who work around ponds with manures can be infected with diseases and parasites if they do not follow safety precautions.

**Animal-Fish Systems: Duck-Fish**

• Ducks can eat fish, reducing fish harvest, and farmers must feed the ducks to ensure a complete diet to get optimum production.

**Animal-Fish Systems: Pig-Fish**

• Expensive systems use large amounts of water. Inexpensive systems make seining (harvesting the fish) difficult.

**Animal-Fish Systems: Chicken-Fish**

• Labor costs are usually high in these systems and the chicken manure may be better used as a crop fertilizer.

**Animal-Fish Systems: Cattle-Fish**

• Collecting cattle manure is difficult if the animals are not raised in pens. These feedlot systems are high capital and management systems. Integrated cattle-fish production is inappropriate for cattle feeding on pasture.

**Follow-Up Discussion and Adjustment of System**  
**Time: 20 minutes**

• The first student to use any of the cards that remained unused the first day correctly and place it in the system will get extra credit. Ask students if they want to make any other changes to the system based on what they learned from the reading. Finish highlighting any key points missed when students built the system, focusing on ideas from the reading.
Close with the discussion question from the reading. “Why do you think there are very few examples of integrated aquaculture systems in the United States?” Have students look at their completed aquaculture system and ask them how much labor it would take to run it? How much skill is needed to manage it? Point out to students that we rely on machine and not human labor for many of our farm operations. Operating an integrated system here would be very expensive.

Quiz Questions
1. Integrated aquaculture systems recycle many waste products. When would this be a disadvantage?

Byproducts of both fish and animal production systems may be of lower nutrient quality compared with a concentrated complete feed such as fish offal to feed animals or crop residues to feed fish. Recycling may require more labor as often happens with green manures. Recycled products such as fishmeal can be expensive and better used in other animal feeds.

2. Give an example of an animal-fish system and name one limitation that farmers must consider

Duck-Fish: Ducks can eat fish, farmers must feed ducks a complete diet.

Pig-Fish: Expensive systems use large amounts of water, inexpensive systems make seining difficult.

Chicken-Fish: Labor costs are often high and chicken manure may be better used as a crop fertilizer.

Cattle-Fish: Collecting manure from cattle raised on pasture is difficult. Feedlot systems are expensive, require high management, and pose serious threats of contaminating water supplies.

3. Compare the disadvantages of fish-animal-plant systems to fish-plant systems.

4-5. Case Study: Fish-Animal Systems Move to Planet EATALL. Farmers on Planet EATALL are very pleased with the new fish-animal production systems they learned about on earth. They believe that these systems will feed them forever. They intend to feed the fish with only the animal manure and feed the animals with only the fish byproducts. What advice would you give the farmers on Planet EATALL? In your opinion, give examples to explain why the system is or is not sustainable.

Animal manure does not have enough nutrients to feed fish. There are not enough carbohydrates. Fish byproducts can be rich in protein, but do not have enough minerals and carbohydrates for a complete diet. Fishmeal is
also a very expensive and energy intensive feed for livestock. Both fish and animals in this system would suffer from nutrient deficiencies and/or malnutrition.

**Want More Information?**


*Rakocy, J.E. 1988-89. Hydroponic Lettuce Production in a Recirculating Fish Culture System. *Island Perspectives* 3:4-10. NAL Call No. S183.V5V54*


**Web Sites:**

Take a look at high school teacher Ernest Nicol’s project for a hydroponic and aquaculture classroom project:

See Aloha ‘Aina Hydro Farms tilapia/vegetable system in Hawaii:
http://hawaii-shopping.com/~sammonet/hydrohome.html

Hydro Aquatic Technologies specializes in hydroponic aquaculture systems:
http://www.intercom.net/biz/aquaedu/hatech/index.html
Background Material on Integrated Aquaculture Systems

In earlier lessons we have looked at how aquaculture systems can meet one important goal of sustainable food production: meeting human food needs today and far into the future. We saw that these systems are especially important for producing protein. We also saw, however, that fish farmers in the United States almost always use manufactured complete diets that contain large amounts of protein and all of the vitamins and minerals that fish need to grow well. We found that protein is the most costly part of these complete diets and saw that fish farmers have tried to reduce the cost of fish feed by finding lower cost sources of protein, such as soybean meal, to replace higher cost protein resources.

As we saw earlier, many countries do not have enough protein even to give their people a good diet. For fish farmers in these countries, buying fish feeds with high protein levels is very hard, if not impossible. Over the years, these farmers have found other ways to raise fish that do not depend on feeding them complete diets. Some farmers rely on herbivorous fish species -- fish that eat plants rather than animals. Examples are tilapia and carp. For example, farmers in China grow several different species of fish in the same pond. Grass-eating carp live near the top of the pond, plankton-eating carp live in the top, middle, and bottom-feeding carp below. The species at each lower level recycles the wastes from the species above. In this system, an output from one fish species directly becomes an input for another. These fish do not need the very high levels of protein that omnivorous or carnivorous fish need. Catfish are omnivorous. They eat both plants and animals. Sharks are carnivorous. They eat other animals.

Other farmers use aquaculture systems that integrate fish production with other farm activities. Some of these systems are very good examples of three of the key aspects of sustainable food production systems. They:

- Rely on natural processes and cycles such as using animal manure to fertilize fish ponds; and
- Fit the social, economic, and biological conditions on the farm by replacing expensive purchased fish feed with products grown on the farm, for example.

Let's look at some examples.

Animal-Fish Systems

Animal-fish systems combine producing fish such as carp or tilapia and animals such as pigs, ducks, chicken, or cattle. One of the key features of animal-fish systems is using animal manures as nutrients for fish. How does this work? Manure contains many nutrients. For example, animal manure may contain 72-79% of the nitrogen, 61-87% of the phosphorus, and 82% of the potassium that was in the food eaten by the animal. Manures stimulate the growth of plants that fish eat, such as algae. Some fish can eat the manure itself and get animal protein from it. For example, tilapia can digest 60% of the protein in pig manure. Keep in mind, however, that manures are not all the same in the amount produced or in their nutrient value. For example, one study showed that free-ranging pigs did not produce manure as rich in nutrients as pigs who ate commercial feed. Believe it or not, using manure in fish ponds did not change the taste of the fish. In taste tests, people could not tell the difference between fish raised in ponds with manures from those fed commercial feed.

There are limitations to using manures in fish production. Some people may not buy fish raised with manure because they do not like the idea or because they are afraid of health problems. So far, studies have shown that fish do not carry bacteria harmful to humans, but we do not know if fish transmit viruses. Dangers to health also depend on sanitation during processing and how the fish is cooked. You can get parasites from eating raw fish. Remember, people who work around ponds with manures can be infected with diseases and parasites if they do not follow safety precautions. The manure used to feed fish may also produce more energy for humans if we
apply it to crops and eat the crops directly. However, if the fish eat the manure and then we eat the fish, we usually get higher quality protein than we do from eating plants.

Fish byproducts in these systems can also help support the other livestock. For example, fish meal made from processed whole fish is one of the highest quality protein sources for animal feed, but it is expensive. Lower quality fish meal can be made from the wastes from fish processing, called fish offal.

**Plant-Fish Systems**

Did you know that we can't eat 60% of the crop plants grown each year? The human digestive system can handle only certain parts of the plant. For example, we can eat the kernels on an ear of corn, but not the cob, the leaves, or the stalk. However, many crops have waste products produced during processing that can be recycled by an aquaculture system. Crop wastes, called residues, can be fed directly to fish or fed to animals first and then the animal manure is used to fertilize the fish pond. Examples of crop residues from cereals are rice bran, wheat bran, and corn leaves and stalks. Lentil bran, soybean meal, and peanut meal are from legumes. Legumes can make their own nitrogen and therefore do not need as much purchased fertilizer as most other crop plants.

**Green manures** are another plant product used in fish production in some places. Green manures are freshly cut (still green) grasses, shrub prunings, or crop residues that have high moisture levels, but low nutrient content. Grasses and legumes are often grown on pond or rice paddies so that they are right next to the fish pond. Lots of labor is needed to collect the large amounts of green manure needed to fertilize a pond to increase fish production.

A third option is to grow plants such as water spinach directly in the pond. As you already know, fertilizing the pond will produce more phytoplankton, microscopic plants which are a primary food source for zooplankton, microscopic animals. Both phytoplankton and protein rich zooplankton are food for young fish and planktivorous species like tilapia. Herbivorous fish eat crop residues and green manures. Common examples of plant-eating fish are the grass carp, some species of tilapia, Wuchan bream, tawes, and giant gouramis. Fish that are omnivorous, eating both plants and animals, are tilapia, snake skin gourami, goldfish, catla, rohu, mrigal, common carp, and milkfish. Unfortunately, we still haven’t determined how well lots of fish throughout the world would do in aquaculture systems.

Byproducts from aquaculture systems can also be used to produce other crops. Nutrient-rich water from fish ponds can be used to fertilize agricultural crops.

**Recirculating systems** are a special example of plant-fish systems. They are interesting because, unlike most of the systems we have looked at in this lesson, they can be used in intensive aquaculture production systems like the ones we have in the United States. The key feature of recirculating systems is that the water in the fish ponds or tanks is used over and over again. To do this, the water must be cleaned between each use. Otherwise it will become overloaded with feces, bacteria, and other materials, which will cause water quality problems for the fish.

There are many kinds of recirculating systems. They all include some kind of biofilter or a stage where living organisms are used to "sop up" nutrients in the water. When crop plants are used as the biofilter, these systems can combine fish and crop production. These are called hydroponic systems -- or water-based systems -- because the plants are grown in water, not in soil. Cucumbers, lettuce, tomatoes, green peas, cantaloupe, strawberries, okra and many other vegetables can be grown in hydroponic systems. Plant nutrients, especially nitrogen and phosphorus, that are present in the water in recirculating aquaculture systems are pumped to the plants. Table 1 shows the production of some vegetables in recirculating aquaculture systems.

There are disadvantages to recirculating systems, however. Commercial operations may be expensive relative to land-based production of vegetables. Also, farmers need to watch the system carefully. Otherwise the system can get out of balance. For
example, if a farmer wants to combine a recirculating system with hydroponic vegetables he/she has to get the right balance of plant nutrients. The nutrient level must be low enough for fish health, but high enough for plant health. If the system gets out of balance, it is very difficult to fix. An out-of-balance system can be disastrous for the fish, the plant crop, or both.

Plant-Animal-Fish Systems

Combining fish, animal, and plant production is the most intricate system we've looked at yet. How does this work? These systems use most of the different ideas that we've already talked about: crop residues and green manures as fish feed or pond fertilizer, fertilizing crops with pond mud and water, and feeding animals with fish processing wastes. Other benefits from combining these farm activities are more efficient use of farm labor, better cost-sharing of farm improvements, and more efficient timing of farm work. For example, tasks can be combined at one place. When the fish are fed, the ducks or pigs right next to the fish pond are fed, too. The drain valve to irrigate the gardens below the pond can be opened at the same time. The cost of farm equipment, machinery, fuel, labor, and storage sheds can be shared over all the enterprises on the farm, which makes it easier for the farmer to make a profit. Fish can wait in ponds to be harvested with less risk to the farmer while other perishable crops are harvested first.

Discussion Question

Why do you think there are very few examples of integrated aquaculture systems in the United States?
Table 1. Production of Vegetable Varieties in Integrated Recirculating Aquaculture Systems

<table>
<thead>
<tr>
<th>Crop</th>
<th>Variety</th>
<th>Density (no./ft²)</th>
<th>Growing Period (days)*</th>
<th>Production in Lbs. Per</th>
<th>System</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Plant</td>
<td>Ft²</td>
</tr>
<tr>
<td>Tomato</td>
<td>Floradel</td>
<td>0.36</td>
<td>133</td>
<td>20.0</td>
<td>3.3</td>
</tr>
<tr>
<td></td>
<td>Floradale</td>
<td>0.17</td>
<td>112</td>
<td>20.0</td>
<td>3.3</td>
</tr>
<tr>
<td></td>
<td>Sunny</td>
<td>0.17</td>
<td>112</td>
<td>22.0</td>
<td>3.7</td>
</tr>
<tr>
<td>Lettuce</td>
<td>Summer Bibb</td>
<td>2.32</td>
<td>21</td>
<td>0.4</td>
<td>0.9</td>
</tr>
<tr>
<td></td>
<td>Buttercrunch</td>
<td>2.32</td>
<td>21</td>
<td>0.4</td>
<td>1.0</td>
</tr>
<tr>
<td>Cucumber</td>
<td>Triumph</td>
<td>--</td>
<td>--</td>
<td>8.9</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>Burpee Hybrid II</td>
<td>0.62</td>
<td>--</td>
<td>5.2</td>
<td>3.2</td>
</tr>
<tr>
<td>Squash</td>
<td>Golden Bar</td>
<td>--</td>
<td>--</td>
<td>5.5</td>
<td>--</td>
</tr>
<tr>
<td>Pac Choi</td>
<td>Le Choi</td>
<td>1.77</td>
<td>28</td>
<td>1.1</td>
<td>1.8</td>
</tr>
<tr>
<td></td>
<td>Pac Choi</td>
<td>1.77</td>
<td>28</td>
<td>0.9</td>
<td>1.6</td>
</tr>
<tr>
<td>Chinese Cabbage</td>
<td>50-Day Hybrid</td>
<td>1.77</td>
<td>28</td>
<td>1.4</td>
<td>2.3</td>
</tr>
<tr>
<td></td>
<td>Tropical Delight</td>
<td>1.77</td>
<td>28</td>
<td>1.3</td>
<td>2.2</td>
</tr>
</tbody>
</table>

* From Date of Transplanting.

Some Fish Can Consume Waste Feed and Manure

Waste Feed and Manure

But Be Careful! Ducks Will Eat Small Fish if They Get Hungry!


A Duck-Fish System
Some Fish Can Consume Crop Residues


A Plant-Fish System
Crops and Residues

Some Fish Can Consume Animal Manure.


A Plant-Animal-Fish System
Pond Water is Enriched in Nutrients from Fish Feces and Other Organic Matter.

Pond Water Fertilizes Vegetables in Hydroponic System

A Recirculating System with Hydroponic Vegetables
Aquatic Plants
<table>
<thead>
<tr>
<th>Green Manures</th>
<th>Labor</th>
<th>Fish to Eat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green Manures</td>
<td>Labor</td>
<td>Fish to Eat</td>
</tr>
<tr>
<td>Green Manures</td>
<td>Labor</td>
<td>Fish to Eat</td>
</tr>
<tr>
<td>Shared Costs</td>
<td>Money</td>
<td>Fish to Sell</td>
</tr>
<tr>
<td>Shared Costs</td>
<td>Money</td>
<td>Fish to Sell</td>
</tr>
<tr>
<td>Shared Costs</td>
<td>Money</td>
<td>Fish to Sell</td>
</tr>
<tr>
<td>Health &amp; Safety</td>
<td>Taste</td>
<td>Food to Eat</td>
</tr>
<tr>
<td>Health &amp; Safety</td>
<td>Taste</td>
<td>Food to Eat</td>
</tr>
<tr>
<td>Health &amp; Safety</td>
<td>Taste</td>
<td>Food to Eat</td>
</tr>
</tbody>
</table>
Introduction

Time: 10 minutes

In this lesson, we will explore how aquaculture can help farm families earn a liveable income, one of the key characteristics of sustainable food production systems as defined by the U.S. Congress. We will focus on examples from Third World nations where farmers often have a combination of goals — both earning income and meeting the food needs of their families.

Read the Background Material on Integrated Aquaculture Systems in Lesson 1, Integrated Aquaculture Systems in this Unit (pages 7-9). This introductory material serves as an introduction for both Lesson 1 (Integrated Aquaculture Systems) and this lesson. The material describes some types of integrated aquaculture systems. For students with a 9th grade or higher reading level, you can assign these pages as a homework assignment. For students with an 8th grade or lower reading level, we suggest that you explain the ideas in the readings to your students yourself. The examples on pages 10 to 13 can be used to illustrate the key features of each type of system.

Getting Ready

Time: 15 minutes

- This activity allows students to apply their knowledge about sustainability by analyzing different integrated aquaculture systems from around the world.

- Copy the case studies on Student Pages 4-7 so that each student has a copy of one case study.

- Ask students to read their case study and analyze it by answering the questions on the bottom of the page as an individual homework assignment.

- When the students do the activity, they will be divided into small work groups based on the case studies. There may be more than one work group per case study if your class is large. Copy the Check sheet on page 10 so that each work group can have one.

Doing the Activity

Time: 30 minutes

- Form small work groups based on the five case studies. Have the students in each group compare their individual analyses and then fill out the checklist Sustainability of Integrated Aquaculture Systems Checksheet as a group. They are to rank their system based on five of the seven factors of sustainability used by the U.S. Congress (Lesson 1 in Unit 1). There may be occasions when your
students feel that they do not have enough information to evaluate the system on one or more of the five factors. If this occurs, they should give that factor a zero and discuss how they could go about gathering the information needed. Each group should total the scores to get the final score for their case study (from 0 to 25).

- Ask students to share their responses to the Checksheet Discussion Questions and try to arrive at a summary of the group’s ideas. Have students share the different scores and the results of the discussion questions as a large group if time permits.

**Checksheet Discussion Questions**

- Compare your results with those of other students in the class that had the same case study. Did you have different scores? Why? Look back at your analysis of the system, did you make different recommendations to the farmers?

**Possible Answers.** Point out that students placed different values on the seven factors of sustainability based on their analysis of the system. This is what happens when sustainability is discussed because the concept includes more than biology or economics. It includes differences in how people value resources. For example, an input or product for one person can be a pollutant or waste to another.

- Why do we see fewer integrated aquaculture systems in the United States than in some of the other countries we studied in this lesson?

**Possible Answers.** Several factors affect a farmer’s ability to adopt these types of highly integrated systems. Some are (1) labor, (2) regulations, (3) health and illness concerns, (4) the need for more management time, (5) markets for the various products, (6) the cost of establishing an integrated system in the U.S., and (7) the fact that such systems may not be compatible with mechanized operations.

**Developing Your Own Case Study Time: 1-3 Days**

You may want to develop your own case study. This is a good follow-up activity for the classroom examples. If you do decide to develop your own example, here are some suggestions for the kinds of information that you will need and where to get information.

- **Background socio-economic information.** You may want to suggest that students get some background socio-economic information about your area. Sources of information include your state *Statistical Abstract*, a county fact book if your county has one, and your local representative whose office is normally willing to supply information of this sort.

- **Information on Environmental Problems.** Sources of information may include local or state regulatory agencies and environmental

---

**Materials**

- Pencils
- Copies of Student Pages (4-10)

**Extensions**

- Have students look up other examples of how farmers use aquaculture to improve the standard of living of their families. Students can write short reports and share their findings with the class.

- Build your own integrated hydroponic system in your fish tank. You can try lettuce floating on top of the tank in styrofoam blocks, or grow mint, cucumbers, or peppers on rock wool in the tank. Leafy, green vegetables will work well but we understand that you should stay away from tomatoes. Have students record the investment that they make to build the system and the profit that they get from the added components to see if the systems “works” economically.

If you do not actually want to build the system, or do not have a tank, have students design a system for a tank-based aquaculture operation. They should include all costs and the potential profit. You can add interest by making this into a student design competition, complete with judges and prizes.
groups. You might want to ask someone local who is knowledgeable about environmental issues to visit your class and discuss aquaculture's potential impact on the environment with students. As preparation for this visit, students can prepare questions that they want to ask.

- **Information about Existing or Potential Integrated Systems.** Sources of information include local aquaculture producers' associations, your local County Extension Agent, or a local fish farmer. If you cannot find any examples, you might visit a local fish farm or invite a fish farmer into class and then discuss ways that the systems could be made into a more integrated system.

- **Your Own Checklist.** You could either use our checklist or develop your own. Developing your own provides students with an opportunity to review the definition of sustainable agriculture made by the U.S. Congress to see what components they want to include in their checklist.

**Want More Information?**


**Web Sites:**

Oklahoma State University has a list of many Southern Regional Aquaculture Center publications at:

http://www.okstate.edu/OSU_Ag/agedcm4h/pearl/aquacult/aquacult.html
Home Gardens in Panama

Background Information. Panama’s population growth rate is 1.9% per year. Its population will double every 35 years. Each Panamanian woman has an average of 2.8 children during her life. Out of every 1,000 babies born, 16 die as infants. The life expectancy is 75 years. The population density is 10 to 49 per square kilometer, the same as the United States. Panamanians consume a minimum of 2,400 calories per day, just above the level that causes chronic malnutrition. The average value of goods and services that each person produces is $5,460 per year compared with $20,000 for the United States. The external debt is $2,000 or more per capita and 13% of the people are unemployed. Nearly half, 41%, of Panama’s land is in forest and 23% is used for farming. Water pollution from agriculture threatens fishery resources. Shrimp are its second biggest export. Deforestation of tropical rain forest and degradation of the land are other major environmental issues.

The System. In Panama, farmers have vegetable gardens integrated with fish and livestock production. Home gardens are a traditional part of Panamanian farms. They can contain as many as 50 different crops and serve as a major source of food for the farm family. Families in each village trade vegetables with each other. As a result, these families have a good diet, better than the average in Panama. Sometimes a few vegetables are sold, but this is rare. The farmers also raise chickens, guinea pigs, and pigs. These animals eat the residues from the garden. Chickens roam freely in the gardens eating insects, worms, and other organisms. Since people started raising fish they pen the chickens over the ponds. The pigs are kept on leashes. They are often tied to fruit trees, such as mango trees, which produce more than the family can eat in a short period. Guinea pigs are kept in cages and their manure is sometimes put into the fish ponds. Fish ponds are a new element in these farming systems. They raise two herbivorous fish, tilapia and carp, and one carnivorous fish, guapote tigre, which eats small tilapia and keeps the ponds from becoming overcrowded. Since the gardens are below the fish ponds, gravity brings water from the pond to irrigate the gardens. This saves the energy needed to pump irrigation water. The water coming from the ponds contains fish feces and other plant material that fertilize the vegetables. After harvesting the ponds, nutrient-rich pond bottom mud is moved to the garden beds. The farmers are selling a part of the fish to merchants who take the fish to the capital city, Panama City. Although it is early to tell, they believe that they can probably make $300 to $400 per year. Since they have little cash, this money is important to them.

Your task is to decide how much this system contributes to the sustainability of food production and farm family income and well-being in Panama, using five factors that the U.S. Congress considers important. Go to pages 9 and 10 and answer the questions.
High Value Crops in Rwanda

**Background Information.** Rwanda has a population growth rate of 2.8% per year. This means that its population will double every 25 years. Each Rwandan woman will have an average of 8 children during her life. The population density is 200 to 299 per square kilometer, compared to less than 49 in the United States. Of every 1,000 babies born in Rwanda, 118 die as infants. Life expectancy is 39 years. Rwanda’s people consume 2,000 to 2,400 calories per day, just below the level that causes malnutrition. The average value of all goods and services produced per person per year is only $950. Almost everyone, 93% of the people, farm for a living. Most people do not have access to safe drinking water (54%) and only have access to proper sanitation. Rwanda has serious soil erosion problems. Although only 7% of Rwanda’s land remains in forest, deforestation continues because people cut trees to burn as fuel.

**The System.** Aquaculture is new to farmers in Rwanda. Finding level land is hard because it is very mountainous. Farmers must choose between planting their high value crops, potatoes, carrots, green beans, and other vegetables, in the valleys or building fish ponds. If they build fish ponds, they can still raise some high value crops on the banks of the ponds. These vegetables are not consumed by the family, nor do many people in Rwanda eat them. However, they are a very good source of income because the hotels for tourists and international businesspeople in the capital city buy them. The tourists come to see the mountain gorillas in the game parks. Fish are also a high value product, comparable in price to beef. The farmers use pond water to irrigate their crops during the dry season. The bottom mud is used to fertilize the crops. Farmers tend these high value crops often. Since they are not native to Rwanda, they are prone to insect and disease problems and require fairly constant care. They take care of the ponds at the same time, so the tilapia that they raise get more attention than they normally would and grow better. Crop residues are used to feed the fish and fertilize the ponds. Household wastes and chicken manure are also added to the ponds. However, much of the manure is lost because the chickens are raised in open pens and the manure washes away down the steep slopes when it rains. Farmers can earn as much as $1,000 on their farms in a good year, but the vegetable crops are very risky. They often invest high amounts of labor and capital in them, only to lose the crop to insects or diseases. Most of the fish are consumed by the farm family or sold locally.

Your task is to decide how much this system contributes to the sustainability of food production and farm family income and well-being in Rwanda, using five factors the U.S. Congress considers important. Go to pages 35 and 36 and answer the questions.
Integrated Aquaculture in Vietnam

Background Information. Vietnam’s population growth rate is 1.7% per year. Its population will double every 27 years. The population density is 200 to 299 people per square mile, compared to less than 50 in the U.S. Vietnam’s infant mortality rate is 45 per 1,000 babies born. Each Vietnamese woman has an average of 3 children during her life. The life expectancy is 66 years. Its people consume 2,000 to 2,400 calories per day, below the level that causes chronic malnutrition. The value of all goods and services produced by each person each year is $1,140. The inflation rate is 14% and 20% of the population is unemployed. Between 25 and 49% of Vietnam’s population does not have access to proper sanitation and 50 to 60% do not have access to safe drinking water, partly due to contamination of groundwater. Much of the nation suffers from serious soil degradation. Its largest river, the Mekong, is severely polluted. Vietnam is the world’s 21st top fishing nation and overfishing and water pollution threaten marine life. Deforestation is high, 1.4% per year, and only 26% of Vietnam’s land remains in forest.

The System. Farmers in Vietnam combine vegetable, tilapia, pig, goose, and rice production. The system that they use has evolved over many centuries. Farmers use it because their parents, their grandparents, and many generations before them found that it worked. They raise vegetables on the banks of their fish ponds. The vegetables are consumed by the family and sold to merchants who take them to the capital. The vegetables do not provide much protein or many calories, but being a rich source of vitamins and minerals. The vegetables are fertilized with the bottom mud from the fish ponds. Pigs live in pens over the water. Their feces and urine and any food that they spill falls into the water. Outdoor toilets are built over the fish ponds so that human wastes also fertilize the fish ponds. The pigs consume leftover food from the household and fish offal. The geese serve as insect controllers in the rice fields before the rice heads (the part with the grain) form. They are turned into the rice fields where they feed upon insects that could damage the rice crop. They also eat a small green plant that grows in the fish ponds, azolla. When they are in the fish ponds, their wastes also add to the nutrient supply. Farmers earn about $1,000 per year on their farms.

Your task is to decide how much this system contributes to the sustainability of food production and farm family income and well-being in Vietnam, using five factors that the U.S. Congress considers important. Go to pages 35 and 36 and answer the questions.
Export Crop Farmers in Guatemala

Background Information. Guatemala’s population growth rate is 2.5% per year. This means that the population will double about every 24 years. The U.S. population will double in about 80 years. Of every 1,000 babies born, 52 will die as infants. Each woman has an average of 4.6 children during her life. Life expectancy is 65 years. The population consumes 2,000 to 2,400 calories per day, just below the threshold for malnutrition. Only half of the people have access to proper sanitation. The nation’s major river is severely polluted. Guatemalans are poor. The average value of all goods and services produced each year per person, is $3,080, compared with $20,000 in the United States. The inflation rate is 12%. Although only 5% of the people are unemployed, 30 to 40% are underemployed, meaning that the jobs they have do not permit them to earn a living. Guatemala suffers from serious soil degradation and water pollution. Although 39% of the land remains in forest, the deforestation rate is high, 1.6% per year. Although 60% of the people work in agriculture, Guatemala must import food.

The System. Farmers in Guatemala use chicken manure to fertilize fish ponds. The chickens include both broilers (meat chickens) and layers (for eggs). They are eaten by the family and sold in the capital city, Guatemala City. They raise tilapia (a herbivore), guapote tigre (a carnivorous fish), and snails in the ponds. The tilapia are mostly eaten by the farm family, but there is a good market for the guapote tigre and snails in the capital city. These farmers raise vegetables, primarily snow peas, for export to the United States and Europe near the ponds. They irrigate them for part of the dry season with water from the ponds. The ponds are not deep enough to use the water to irrigate crops and to grow fish for the entire dry season. Few crop residues from the gardens are fed to either the fish or the livestock. Farmers sell their vegetables either through a cooperative or to a large contractor. They can earn a large amount, $2,000 or more, from these crops. However, the cost to produce them is also very high. They must buy large quantities of pesticides and fertilizers. Further, vegetable production is a risky business. Sometimes the crop fails from insects or diseases and in some years the cooperative cannot sell the vegetables or the contractors take the vegetables, but never pay the farmers. By raising fish and chickens with the vegetables the farmers hope to secure a reliable income throughout the year.

Your task is to decide how much this system contributes to the sustainability of food production and farm family income and well-being in Guatemala, using five factors that the U.S. Congress considers important. Go to pages 35 and 36 and answer the questions.
"Cajun" Crayfish in the USA

Background Information. Few integrated aquaculture systems exist in the U.S. Crayfish or "crawfish" is an exception. They are a delicacy for many. Yet only a few species have ever been cultured. The French were the first to culture crayfish during the 19th century in Europe. Probably because of their French heritage and the vast swamps along the Gulf coastal plain, people called “cajuns” in what became Louisiana started capturing wild crawfish for food. The Mississippi River delta runs through Louisiana, Arkansas, and Mississippi and these states along with Texas are principal rice producing states in the U.S. Starting about the 1950’s cajun farmers learned how to integrate rice and crawfish production. Today this system is practiced by crawfish farmers in the other southern rice producing states.

The System. Rice is grown in fields that can be flooded with fresh water. Many fields are over 100 acres in size. Rice is planted in these fields in late March through April. In June the rice is 8 to 10 inches high and the pond is flooded with 6 to 8 inches of water and stocked with 50 to 60 pounds of adult crawfish per acre (unless crawfish have been stocked in previous years, in which case, no stocking is necessary). The crawfish cultured most commonly is called the "red swamp" crawfish (*Procambarus clarkii*). In August, the pond is drained and the rice is harvested. The crawfish borrow in the ground to keep moist. When the pond is reflooded in October and the crawfish leave the burrows, they have reproduced and release young crawfish ready to forage on the rice stubble. Crawfish harvest begins in November and goes through March or April when the pond is drained to replant rice and start the cycle over again. Crawfish are harvested using "funnel" traps that allow the crawfish to crawl in but not get out. A person can walk pushing a "pirogue" (a cajun dugout boat) and harvest about 20 acres of pond per day or can use a hydraulically powered boat, called a "crawfish combine", and harvest up to 200 acres per day. The major expenses in crawfish production are bait and harvest labor. The crawfish yield averages about 1,200 pounds per acre per year in this type of rotation. Crawfish are sold mostly live to local markets for $0.50 to $0.80 per pound. Wading and diving birds, raccoons, otters, muskrats, and Norway rats all prey on crawfish and can severely reduce yields. Rice is milled into human food and food supplements. The milling produces a by-product that is used as an ingredient in chicken feeds. The litter that is removed from the chicken houses can be used as a fertilizer on the rice fields.

Your task is to decide how much this system contributes to the sustainability of food production and farm family income and well-being in the US, using five factors that the U.S. Congress considers important. Go to pages 9 and 10 and answer the questions.
Analyzing the Case

Analyze your case study by answering the following questions.

What wastes are recycled?

What labor is made more efficient?

What costs are shared?

Who benefits? Who loses?

What could the farmers do differently?

Now in a group evaluate the sustainability of your system using the Evaluating the Sustainability of Integrated Aquaculture Systems Checklist on the next page. Fill out all columns in the table. Every time you give a score of “0,” be sure to list how you would get the additional information you need to rate the system.

Questions to consider:

Compare your results with those of other students in the class who had the same case study. Did you give the system different scores? Why? Look back at your analysis of the system. What did you interpret differently?

Why do we see fewer integrated aquaculture systems in the United States than in some of the other countries we studied in this lesson?
### Evaluating the Sustainability of Integrated Aquaculture Systems Checksheet

<table>
<thead>
<tr>
<th>Sustainability Factor</th>
<th>Rating</th>
<th>Reason Why</th>
<th>Information Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Designed specifically for the place where you are farming</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Will feed the population for a very long time</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improves farm family income and well-being</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relies on natural cycles</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Integrates animals and plants</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Directions:** Rate your case for each of the five sustainability factors in the table. Use a score of 0 to 5 where:

- 0 = Need more information to rate on this factor
- 1 = Does a *VERY POOR* job on this factor
- 2 = Does a *POOR* job on this factor
- 3 = Does a *SATISFACTORY* job on this factor
- 4 = Does a *GOOD* job on this factor
- 5 = Does an *EXCELLENT* job on this factor
Producing What People Want

Introduction

In this lesson, we will examine some of the factors that fish farmers must take into account in order to earn a liveable income, one of the key characteristics of sustainable food production systems as defined by the U.S. Congress. We will focus on how consumer preferences shape the decisions that farmers make and influence the profitability of different aquaculture systems.

Read the Background Material on Consumer Preferences (pages 6-7). This material will provide information that you can share with your students to explain the role of consumer preference in marketing aquaculture products. For students with a 9th grade or higher reading level, you can assign these pages as a homework assignment. For students with an 8th grade or lower reading level, we suggest that you explain the ideas in the readings to your students yourself.

Getting Ready

- Discuss marketing and consumer preferences using the information in the background material and transparencies of pages 8-17. Particularly emphasize the linkages between the consumer and the other parts of that marketing chain. Be sure students realize that the accumulated effect of consumer purchases is often important in determining the activities, resources, and prices at each level of the marketing system.

- Have students discuss and list on the blackboard questions to be asked in a survey on fish preferences that will be given to family members, classmates, or neighbors. An example survey is presented on Student Pages 18-19. You may want to make a transparency of this page. You can either use the survey as is, adapt the survey to local conditions, or allow the students to develop their own survey instrument using the transparency as a guide. The survey will demonstrate how a marketing study might be done to help the aquaculture industry provide the product that the consumer desires.

Doing the Activity

This activity will require two or three days outside the class to complete the survey. Time in class needed to compile and discuss the results and to complete a marketing plan will vary from one to two hours, depending on how much time you want the students to devote to these activities.

- Make copies of the completed survey form for each student. Each student should complete the survey form with three or four people, who could be classmates in other classes, family members, or

Purpose

To understand how markets and consumers help determine what is produced and how it is produced.

Key Concepts

Commercial aquaculture producers must take market opportunities and consumer preferences into account in order to manage profitable aquaculture businesses.

Consumer preferences have important impacts on the production systems used.

Learning Objectives

Students will be able to:

- Explain the concepts of marketing and consumer preferences
- Conduct studies to evaluate consumer preferences
- Discuss how consumer preferences affect aquaculture production systems

Subjects

Business and Economics
Social Studies
Mathematics
Science

Lesson 3: Producing What People Want
Unit II. Making Aquaculture Pay
neighbors. Point out that it would be better to get a range of people in the survey -- some older, some younger, some male, some female, etc. This will help ensure that the survey includes a variety of preferences, not just those of one single group.

- Discuss and compile results of each question included in the survey. For example, how many people and what percentage of those interviewed preferred each kind of fish? How many people and what percentage of those surveyed preferred frying as the form of preparation? Students can use these survey results to make graphs, bar charts or pie charts.

- Divide the students into four or five groups, one for each of the four or five most-favored fish species selected by participants in the survey. Have each group develop marketing and production plans that incorporate some of the concepts discussed in the background material and shown in the transparencies, basing their plans on the preferences of the people interviewed for the survey. Have each group complete Student Pages 20-21. They should fill in the species, the preferred product form, the price that people are willing to pay, and what they know about the characteristics of the species (see Background Material on Aquaculture in the USA in Lesson 1, Unit I, for information on the species). The marketing and production plans should include the activities and decisions that each person (fisherman, fish farmer, fish processor, etc.) would need to implement in order to fulfill the consumer preferences found for their species in the survey. Note that some of these players will not enter into the process for some species. For example, a cultured fish that is sold directly by the processor to the grocery store would not include a fisherman, a wholesaler, or a restaurant. Students should list the key resources that would be needed to carry out the activities and implement the decisions that they suggest. For example, if a fish producer decides to sell filleted fish instead of whole fish, he/she would need additional equipment, labor, and energy (electricity) to do so.

- Each group should present their marketing and production plans to the rest of the class. Encourage your students to discuss differences that they found in regard to the activities needed and decisions to implement and in the resources that would be needed.

Discussion Questions

- If consumer preferences changed to prefer larger fish, how would producers adjust their systems? What impact might this change in preferences have on sustainability?

Possible Answers. Fish farmers might stock less fish per acre or per tank, feed more, or feed higher protein diets.
• If consumer preferences changed to prefer more fillets, how would producers adjust their systems? What impact might this change in preferences have on sustainability?

Possible Answers. Fish farmers might raise larger fish, resulting in lower stocking rates, higher protein diets, or more feeding. Processors might buy a more standard sized fish.

• If consumer preferences changed to prefer more live fish, how would producers adjust their systems? What impact might this change in preferences have on sustainability?

Possible Answer. Processors, wholesalers, and distributors might shift to more energy intensive transportation systems to keep fish alive and healthy.

• If consumer preferences changed to prefer to cook at home more and eat out less, how would producers adjust their systems? What impact might this change in preferences have on sustainability?

Possible Answers. Fish producers might produce a larger volume of fish of a uniform size and concentrate on year-round availability by staggering harvests.

• What other changes in consumer behavior might affect producers and sustainability?

Possible Answers. Encourage students to brainstorm for this question. Almost any change in consumer preference could affect fish producers and sustainability.

Quiz Questions

• What are the major marketing channels used by fish producers? List at least one activity or decision for each channel.

Possible Answers. (1) Fish farmers: stocking density, feeding rate, aeration, harvest size. (2) Fishermen: where and when to fish, choice of gear and boat, fishing regulations and restrictions. (3) Processors: where to purchase fish, services to provide to fish farmers, product form, packaging, how to sell to wholesalers and other distributors, how to store product. (4) Wholesalers or distributors: where to purchase fish, how to store product, how to sell to retailers, advertising and promotion. (5) Restaurants: which fish to sell; how to prepare, present and provide service to consumer, how to use fish in the "whole" meal, how to provide an enjoyable environment, advertising and promotion. (6) Grocery stores: which fish to sell, how to package and display, advertising and promotion. (7) Customer: what fish to buy (which characteristics are important), where to buy.

• List the four "P's" of marketing.
Answer. Price, place, product form, and preferences.

- Give an example of how consumer preferences affect the sustainability of aquaculture production systems.

Possible Answers. Consumer price preferences may lead people to buy imported fish produced where production costs are lower. Consumer preferences for filleted fish may increase energy use in aquaculture production. Consumer preferences for aquaculture products from distant places can increase the use of many resources, including energy for transport and storage, for example.

Want More Information?


Dellenberger, L.E.; Schupp, A.R.; and Zapata, H.O. 1990-91. Targeting Metropolitan Markets Out of State for Crawfish. The Station 34(2):12-13. Louisiana Agricultural Experiment Station, Louisiana State University, Baton Rouge, LA. NAL Call No. 100 L939


Web Sites:

Go to the USDA's Aquaculture Information Center. They have a page called "Links to Aquaculture Information" that can connect you with many sources of information on marketing aquaculture products. They have a hyperlink to a list of the aquaculture associations:
http://www.nal.usda.gov/aic/

Or try AquaNIC (Aquaculture Network Information Center):
http://www.ansc.purdue.edu/aquanic/
Marketing is often divided into the four “P’s” - price, place, product form, and preferences. These four aspects of marketing are helpful ways to organize a class discussion.

**Price.** The price of a product like a fish is a result of the purchases of consumers and the sales of producers. Consumers make a judgement on whether they are willing to pay a certain price for the fish and producers decide how much to produce and sell based on the price they expect to receive. The price is based on many characteristics like the size, freshness, and time of year. Think about how this happens in your life. Have you noticed that when a new computer comes out, the price of the old models usually drops dramatically?

**Place.** The place is very important in marketing because the effort required to move a product from where it is produced to where it is consumed is substantial. For example, a fish in the pond is not in a place that is ready for most consumers to eat. Transportation cost play a major role in marketing and is particularly important for international markets. That is, it might be possible for a producer in a distant country to produce a fish very cheap but the cost of transportation could cancel out this advantage. Have you ever been hungry at a football game, movie theater, or amusement park? How much did the food cost at those places? This is an example of the effect of place. When you are at one of these places you are a “captured audience.” You’re not going to leave to go get a hot dog. If you want it, you have to pay the price.

**Product Form.** The product form involves how much processing has been done to the fish. That is, is it a whole fish, has it been gutted, has it been filleted? The more processing the greater the price received and of course the more cost that has been incurred.

**Preferences.** Tastes and preferences are essential in marketing. Consumers have preferences based on their previous experiences with consuming the fish or based on what someone has told them about it. Also, preferences can be based on age, gender, income, region and other socio-demographic factors. For example, some fast food chains have started advertising campaigns that target adults because their restaurants came to be thought of as “kids places.” People’s preferences for foods can vary greatly by geographic region. Figures 1 and 2 (pages 9 and 10) show regional variations in preference for fish and seafood at supermarkets and restaurants in the United States.

**Marketing channels and margins**
Marketing channels refer to the way a product flows through the marketing system from the producer of the raw product to the final consumer. Marketing channels are often represented by flow diagrams (Fig. 3). If you buy a stereo or computer directly from the producer or from a warehouse, you save money because these places offer little customer service and sell large quantities of their products.

The marketing margin refers to the increase in price that occurs at each step along the flow of the product through the marketing channels. Such flow diagrams could become increasingly detailed as we add all the activities and people involved along the way to the consumer, including transportation labor and fuel, dress-out loss, storage, storage loss, insurance, bank loans, and further processing (breaded). Pages 11-17 list some of the activities that are needed or decisions that must be implemented for each step in the marketing channel.

**Discussion Questions**
- If consumer preferences changed to prefer larger fish, how would producers adjust their systems? What impact might this change in preferences have on sustainability?
• If consumer preferences changed to prefer more fillets, how would producers adjust their systems? What impact might this change in preferences have on sustainability?

• If consumer preferences changed to prefer more live fish, how would producers adjust their systems? What impact might this change in preferences have on sustainability?

• If consumer preferences changed to prefer to cook at home more and eat out less, how would producers adjust their systems? What impact might this change in preferences have on sustainability?

• What other changes in consumer behavior might affect producers and sustainability?
Fig. 2. Top-selling Fish/Seafood in Restaurants, by Region
Numbers Refer to Percentage of Respondents Indicating Each Type
Fig. 1. Flow Diagram of Marketing Channels (Prices Received in Parentheses)

Fish Farmer (0.75) → Processor (1.75) → Wholesaler (2.50) → Restaurant (8.00) → Customer

Fisherman (0.60) → Processor (1.75) → Wholesaler (2.50) → Grocery Store (5.00)
Fish Farmer

Average Price Received:
$0.75/pound (15% of final consumer price)

Activities/Decisions
Stocking density
Feeding rate
Aeration
Harvest size

Resources
Feed
Labor
Fingerlings
Equipment
Energy
Credit
Fishermen (Wild Harvest)

Average Price Received:
$0.60/pound (12% of final consumer price)

Activities/Decisions
Where/when to fish
Choice of gear/boat
Fishing regulations and restrictions

Resources
Labor
Boat
Equipment
Energy
Credit
Processor

Average Price Received:
$1.75/pound (35% of final consumer price)

Activities/Decisions
- Purchase fish from producers
- Services to farmers (custom harvest, taste testing)
- Product form changed from live fish to processed form
- Fish packaging
- Sales to wholesaler and other distributors
- Storage

Resources
- Labor
- Equipment (processing)
- Energy
- Processing plant
- Transport vehicles
- Storage/refrigeration
- Credit
Wholesaler or Distributor

Average Price Received:
$2.50/pound (50% of final consumer price)

Activities/Decisions
- Purchase fish from processors
- Storage
- Sales to retailers
- Advertising and promotion

Resources
- Transportation vehicles
- Energy
- Storage/refrigeration
- Credit
Restaurant

Average Price Received:
$8.00/pound (includes other items such as vegetables)

Activities/Decisions
Fish sold to consumer
Fish preparation, presentation, and service
Fish provided as part of 'whole' meal
Enjoyable environment
Advertising and promotion

Resources
Labor
Energy
Building
Food ingredients
Grocery Store

Average Price Received:
$5.00/pound (100% of final consumer price)

Activities/Decisions
Fish sold to consumers
Package and display
Advertising and promotion

Resources
Energy
Building
Labor
Packaging materials
Refrigeration equipment
Customer

Average Price Paid:
Depends on where purchased (restaurant or grocery store)

Activities/Decisions
Consumer Fish Preferences:
Available all year
Mild tasting flesh
Nutritious
Few/no bones
Low price
Purchases from retailer

Resources
Money
Time
Transport
Questionnaire

Your Name ________________________________

Person Interviewed ________________________

His/Her Age ________ His/Her Gender (circle one) Male Female

1. Circle your three favorite fish and seafood products.
   Catfish  Clams  Cod  Crab  Crawfish
   Flounder  Halibut  Lobster  Mussels  Oysters
   Red Snapper  Striped Bass  Tilapia  Trout  Tuna
   Yellow Perch  Other - what? ________________

2. What is your favorite way to prepare fish and seafood? Circle one.
   Fried  Boiled  Baked  Raw  Grilled
   Blackened  Breaded  Broiled  Other - what? ______

   Whole  Gutted  Headed & Gutted  Fillet  Deboned
   Strips  Other - what? ________________

4. What are the most important characteristics of the product? Rank the following characteristics, using 1 as the most important and 9 as the least important.
   ______ Price  ______ No Bones  ______ Nutrition
   ______ Flesh Color  ______ No Smell  ______ Taste
   ______ Easy to Prepare  ______ Available All Year
   ______ Other - what? ____________________________________
Questionnaire - Page 2


<table>
<thead>
<tr>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 4 oz.</td>
</tr>
<tr>
<td>5 to 6 oz.</td>
</tr>
<tr>
<td>7 to 9 oz.</td>
</tr>
<tr>
<td>10 to 15 oz.</td>
</tr>
<tr>
<td>More than 1 pound</td>
</tr>
</tbody>
</table>

6. For each of your top three fish or seafood products listed in question 1, write down a price that you consider reasonable that you have either paid recently, or are willing to pay.

<table>
<thead>
<tr>
<th>Fish Product</th>
<th>Price per Pound</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
</tr>
</tbody>
</table>

Thank you!
Marketing and Production Plans

Species: _______________  Product Form _______________

Average Price People Are Willing to Pay _______________

Other Characteristics They Want

________________________  ________________________

________________________  ________________________

________________________  ________________________

Fill out the table on the next page. For each person involved in producing and marketing your species, write down what kind of activities they must conduct or decision they must make to please consumers. Write down the kinds of resources that they will need to put their decisions into practice.
<table>
<thead>
<tr>
<th>Person</th>
<th>Activities or Decisions</th>
<th>Key Resources Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fish Farmer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fisherman</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Processor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wholesaler or Distributor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Restaurant</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grocery Store</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consumer</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>