SECTION 3

Animals and Agriculture

We have seen that the total energy needed to grow plants for food is much less than the energy needed to raise animals as food. However, most animal proteins contain more essential amino acids than proteins found in plants do, and most humans include some animal products in their diet. Food from animals has been the basis of life for some human populations for centuries. For example, many human populations have traditionally obtained most of their protein from fish and seafood.

Our ancestors obtained animal protein by hunting and fishing, but today most people get animal protein from domesticated species. About 50 animal species have been **domesticated,** which means that they are bred and managed for human use. Domesticated animals include chicken, sheep, cattle, honey bees, silkworms, fish, and shellfish. In many parts of the world, goats, pigs, and water buffalo are also important domesticated animals.

Objectives

- Explain how overharvesting affects the supply of aquatic organisms used for food.
- Describe the current role of aquaculture in providing seafood.
- Describe the importance of livestock in providing food and other products.

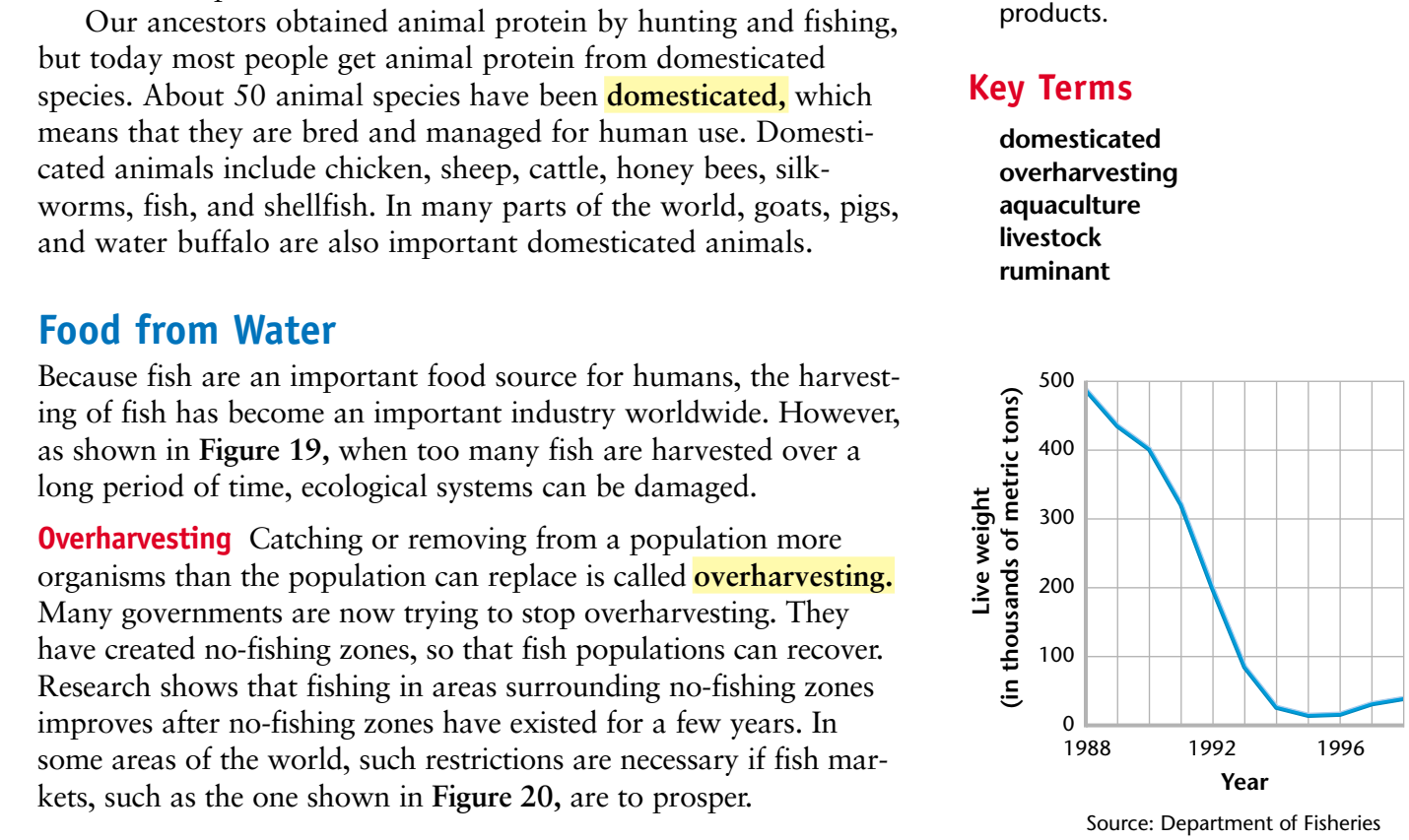
Key Terms

domesticated
overharvesting
aquaculture
livestock
ruminant

Food from Water

Because fish are an important food source for humans, the harvesting of fish has become an important industry worldwide. However, as shown in **Figure 19,** when too many fish are harvested over a long period of time, ecological systems can be damaged.

Overharvesting Catching or removing from a population more organisms than the population can replace is called **overharvesting.** Many governments are now trying to stop overharvesting. They have created no-fishing zones, so that fish populations can recover. Research shows that fishing in areas surrounding no-fishing zones improves after no-fishing zones have existed for a few years. In some areas of the world, such restrictions are necessary if fish markets, such as the one shown in **Figure 20,** are to prosper.



Source: Department of Fisheries and Oceans, Canada.

Figure 19 ▶ The North Atlantic cod fishery has collapsed because of overharvesting.

Figure 20 ▶ Whole, fresh tuna are one of the many types of seafood for sale at the Tokyo fish market, the largest fish market in the world.

Figure 21 ▶ This oyster farm in Washington State shows how aquaculture concentrates seafood production.

Aquaculture

Fish and other aquatic organisms provide up to 20 percent of the animal protein consumed worldwide. But overharvesting is reducing the amount of fish and other organisms in the world's oceans. One solution to this problem may be a rapid increase in **aquaculture** (AK wuh KUHL chuhr), the raising of aquatic organisms for human use or consumption.

Aquaculture is not a new idea. This practice probably began in China about 4,000 years ago. Today, China leads the world in using aquaculture to produce freshwater fish.

There are a number of different methods of aquaculture. The oyster farm shown in **Figure 21** represents one such method. The most common method is known as a fish farm. Fish farms generally consist of many individual ponds that each contain fish at a specific stage of development. Clean water is circulated through the ponds and brings in oxygen while sweeping away carbon dioxide and fecal wastes. The fish grow to maturity in the ponds and then are harvested.

Another type of aquaculture operation is known as a ranch. In this method, fish such as salmon are raised until they reach a

CASE STUDY

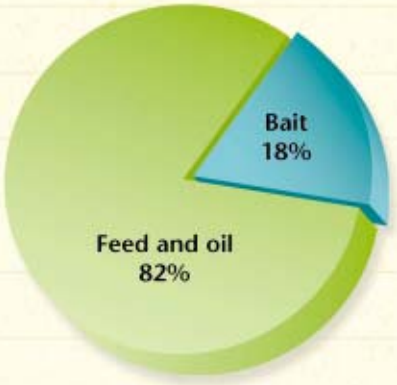
Menhaden: The Fish Behind the Farm

One of the largest commercial catches in the United States each year is of a fish that most people have never heard of—the menhaden (men HAYD 'n). Menhaden are small, silver, oily fish in the herring family and are found in the Atlantic Ocean from Maine to Florida. More than one-third of the weight of commercial fish caught on the East Coast each year is menhaden. But menhaden are so full of bones that they are inedible. So why are they so important?

When the first colonists arrived in the area we now call New England, local Indians showed them how to fertilize their crops with menhaden. This is where the legend that the best corn is grown by planting a fish with each seed came from. Later, menhaden oil was used in oil lamps, and ground menhaden were added to cattle feed.

The menhaden catch is processed to produce fishmeal and fish oil. The oil is used in cooking oils and margarine. The fishmeal has a high protein content, and it is added to the feed of pets, chickens, turkey, hogs, cattle, and farm fish. Menhaden is also used by recreational fishermen as bait for fish such as bluefin, striped bass, shark, and tuna.

Menhaden spawn in the ocean. The eggs hatch into larvae, which are carried into estuaries where they spend their first year. After the menhaden mature, they return to the ocean and usually live within 50 km of the coast. The Chesapeake Bay is one of the most important nurseries for menhaden.



Source: Menhaden Resource Council.

▶ The enormous menhaden catch is used entirely to produce feed and oil and as bait for catching other fish.

Menhaden live in large schools near the surface, so they are easily caught with *purse seine* nets, nets that hang down from the surface. Boats towing the nets encircle the

certain age and then are released. The salmon, for example, migrate downstream to the ocean, where they live until adulthood. When they are mature, the fish return to their birthplace to reproduce. When they return, they are captured and harvested.

Today, most of the catfish, oysters, salmon, crayfish, and rainbow trout eaten in the United States are the products of aquaculture. In the 1980s, domestic production of these species quadrupled, and imports of these species increased even faster. Worldwide, about 23 percent of seafood now comes from aquaculture.

However, as with other methods of food production, aquaculture can cause environmental damage if not managed properly. For example, the aquatic organisms can create a large amount of waste, which can be a source of pollution. Also, because aquaculture requires so much water, the process can deplete local water supplies. In a few cases, sensitive wetlands have been damaged when large aquaculture operations were located within the wetland. Despite these problems, aquaculture will continue to be an important source of protein for the human diet.

▶ A menhaden catch is unloaded from purse seine nets in Chesapeake Bay, Virginia.

fish, which are pumped out of the ocean into refrigerated containers.

An adult menhaden is an important member of the marine ecosystem. The fish are filter feeders that scoop up large mouthfuls of water and filter out the plankton for food. An adult menhaden can filter a million gallons of water in six months.

The Chesapeake Bay Ecological Foundation estimates that the menhaden population removes up to one-fourth of the nitrogen pollutants dumped into the Chesapeake Bay each year. Because nitrogen runoff from lawns and farms is a major pollutant of the Chesapeake Bay, this function of the fish is important. Sport fishermen also value menhaden as bait because they are the natural food of many sportfish.

Both environmentalists and the sport fishing industry were worried when the menhaden catch declined during the 1990s. The catch in 2000 was the second-lowest catch on record. Both groups believe that overharvesting by commercial fishing boats was the reason for the reduced catch. As a result, the Atlantic Menhaden Management Board, which manages the menhaden fishery, has been restructured to have fewer members who represent the commercial fisheries.

CRITICAL THINKING

1. Applying Ideas Many different groups have potentially conflicting interests in the future of the menhaden fishery. Write a paragraph that explains the opposing points of view of two of these groups. WRITING SKILLS

2. Expressing Viewpoints If you were on the Atlantic Menhaden Management Board, what changes would you suggest to prevent the fishery from declining? Write a paragraph that explains these changes. WRITING SKILLS

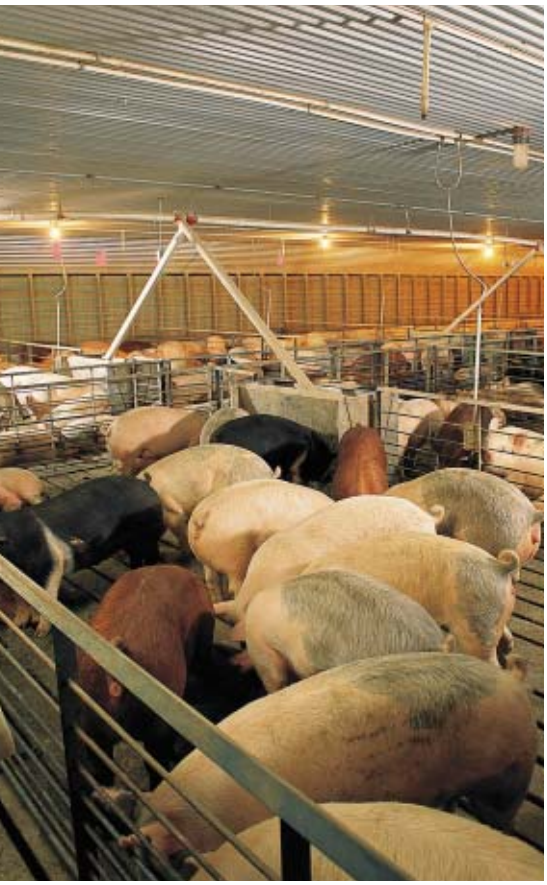
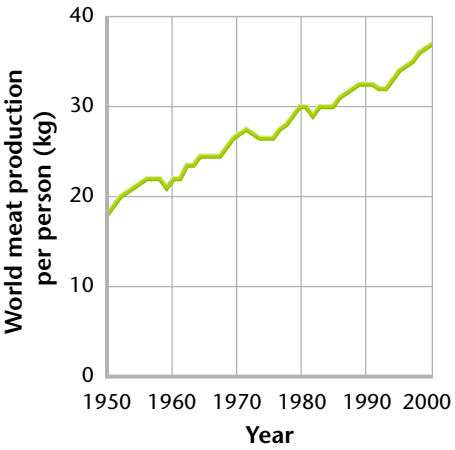


Figure 22 ▶ Modern livestock operations, such as this pig farm in North Carolina, are large and efficient.



Source: Worldwatch Institute.

Figure 23 ▶ Worldwide meat production per person has increased significantly since 1950.

Table 3 ▼

UN FAO Estimates of Animal Populations			
	Global Livestock Populations		
Species	1961	2001	Increase
Chickens	3.9 billion	14.8 billion	280%
Sheep	1 billion	1 billion	0%
Cattle	942 million	1.4 billion	53%
Pigs	406 million	928 million	129%
Goats	349 million	702 million	101%
Horses, donkeys, and mules	110 million	114 million	4%

Livestock

Domesticated animals that are raised to be used on a farm or ranch or to be sold for profit are called **livestock.** As shown in **Table 3,** populations of livestock have changed dramatically in the last 40 years. Large livestock operations, such as the pig farm shown in **Figure 22,** produce most of the meat that is consumed in developed countries. Meat production per person has increased worldwide since 1950, as shown in **Figure 23.** Livestock are also important in developing countries. In these countries, livestock not only provide leather, wool, eggs, and meat, but also serve many other functions. Some livestock are used as draft animals to pull carts and plows. Other livestock provide manure as the main source of plant fertilizer or as a fuel for cooking.

Ruminants Cattle, sheep, and goats are **ruminants** (ROO muh nuhnts), cud-chewing mammals that have three- or four-chambered stomachs. *Cud* is the food that these animals regurgitate from the first chamber of their stomachs and chew again to aid digestion. Ruminants also have microorganisms in their intestines that allow the animals to digest plant materials that humans cannot digest. When we eat the meat of ruminants, we are using them to convert plant material, such as grass stems and woody shrubs, into food that we can digest—such as beef.

Humans have created hundreds of breeds of cattle that are suited to life in different climates. Cattle are most common in North America, India, and Africa. But the cattle are not always slaughtered for meat. In Africa for example, traditional Masai herders drink milk and blood from their cattle, but the herders rarely kill them for meat. India has almost one-fifth of the world's cattle. However, many of these cattle are not killed or eaten because cows are sacred to Hindus, who make up a large part of India's population. These cattle instead produce milk and dung, and the cattle are used as draft animals.

Poultry Since 1961, the population of chickens worldwide has increased by a greater percentage than the population of any other livestock, as shown in **Table 3.** Chickens are a type of *poultry,* domesticated birds raised for meat and eggs, which are good sources of essential amino acids. In more-developed countries, chickens and turkeys are usually raised in factory farms, as shown in **Figure 24.** Some people have criticized this industry because the animals live in cramped, artificial environments.

Fewer ducks and geese are raised worldwide than chickens, but in some areas ducks and geese are economically important. For example, the Chinese use ducks not only for meat, but also as part of an integrated system that produces several types of food at one time. The ducks' droppings are used to fertilize fields of rice called *rice paddies*. The rice paddies are flooded several times per year with water from nearby ponds. Mulberry trees, which feed silkworms, are also irrigated by the ponds. Plant materials and filtered sewage are dumped in the ponds and serve as food for carp and other fish. The integrated system uses little fresh water, recycles waste, and produces ducks, silk, rice, and fish.

Figure 24 ▶ Modern chicken farms, such as this one, are often huge, industrial-scale operations.

SECTION 3 Review

1. **Explain** why the percentage of seafood produced by aquaculture is increasing so rapidly.
2. **Explain** how overharvesting affects the supply of fish such as salmon.
3. **Describe** the importance of livestock to cultures that consume no meat.

CRITICAL THINKING

4. **Inferring Relationships** Read the description of poultry above and explain why chickens are such an important source of food for humans. READING SKILLS
5. **Applying Ideas** Look at the graph in Figure 23. Write a short paragraph explaining why meat production has increased so rapidly. WRITING SKILLS