

LECTURE 5.1:
FISHERY RESOURCE MANAGEMENT:
FAILURES AND SUCCESSES

1. Fisheries have harvested increasing amounts of fish flesh throughout human history.

1.1. The annual world fish harvest has quadrupled in only 50 years.

[OVERHEAD: Figure of World Fish Harvest]

1.2. Greatest growth and overall harvest has been in Pacific Ocean.

[OVERHEAD: Figure of Harvest and Consumption by Country]

1.2.1. Total consumption is greatest in China and Japan.

1.2.2. Consumption per capita is greatest in Japan, Russia, and the U.S.

1.2.3. Harvest is greatest by Japan, China, Peru and Chile.

1.3. Harvest has been facilitated by technological developments.

[OVERHEAD: Figure of Fishing Technologies]

1.3.1. Ships have become larger and processing has moved to at-sea processing.

1.3.2. Fishing gears have improved (bigger nets, high-tech sonars).

1.4. Fisheries have opportunistically exploited new stocks and species (fishing up).

[OVERHEAD: Map of World Fishing Grounds]

1.4.1. All countries have exploited worldwide stocks.

1.4.2. Exploited stocks and species have collapsed periodically.

[OVERHEAD: Map of Fish Stocks in Jeopardy]

1.4.2.1. The California sardine fishery (crashed in the 1950s).

1.4.2.2. The Peruvian anchovy fishery (crashed in the 1960s).

1.4.2.3. The North Sea herring fishery (crashed in the 1970s).

1.4.2.4. The Pacific Northwest chinook salmon fishery (crashed in the 1980s).

1.4.2.5. The Northwest Atlantic cod fishery (crashed in the 1990s).

1.4.2.6. The Pacific halibut fishery (sustained since the 1800s).

2. The California sardine fishery.

2.1. The Pacific sardine (*Sardinops sagax*).

[OVERHEAD: Picture of Pacific Sardine]

2.1.1. Largest sardines are up to 15.5 inches, but most are smaller than 12 inches.

2.1.2. May live as long as 10 years usually near the coastline.

2.1.3. Entire population spawns off California coastline.

2.2.Cannery Row arose in the early 1900s to process abundant sardines.

[OVERHEAD: Picture of Cannery Row]

2.2.1. At its peak, about 60,000 tonnes of sardines were landed in Monterey Bay.

[OVERHEAD: Graph of California Sardine Catch]

2.2.2. Largest fishery in the United States in the 1930s and 1940s.

2.2.3. Abundance may have been 2.5-million tons.

2.2.4. Primarily harvested for fish meal, bait, and human consumption.

2.3.After World War II, catches declined erratically for unknown reasons.

2.3.1. In the mid-1950s, catches declined precipitously.

2.3.2. Moratorium on sardine fishing was imposed in 1967-1968.

2.3.3. Cannery row closed down and a way of life died.

2.4.Sardine collapsed before fishery science was born--didn't know any better!

2.4.1. Modern era of fishery science was born in 1950s.

2.4.2. *On The Dynamics of Exploited Fish Populations* (Beverton and Holt 1957).

2.4.3. *Handbook of Computations for Biological Statistics of Fish Populations* (Ricker 1958).

3. The Peruvian anchovy fishery.

3.1.The Peruvian anchovy (*Engraulis ringens*).

[OVERHEAD: Picture of Peruvian Anchovy]

3.1.1. Largest anchovy are up to 10 inches, but most are smaller than 7 inches.

3.1.2. Usually mature in 2 years and live only as long as 3-4 years

3.1.3. Travel in large schools and prefer to live near the coastline.

3.1.4. Entire population lives off Peruvian coastline in the coastal current.

3.2.Anchovy fishery grew after California sardine fishery collapsed in the 1950s.

3.2.1. Harvesting and processing equipment moved from California to Peru.

[OVERHEAD: Picture of Anchovy Fishery]

3.2.2. As a result, the fishery grew dramatically to the largest in the world.

3.3.By the 1960s, the fishery was the largest in the World.

[OVERHEAD: Graph of Peruvian Anchovy Catch]

3.3.1. Peruvian current causes inshore waters to be highly productive.

[OVERHEAD: Diagram of Ocean Currents]

[OVERHEAD: Diagram of Peruvian Coast]

[OVERHEAD: Diagram of Coastal Upwelling]

3.3.2. In 1960, experts were consulted to determine if stock were over-fished.

[OVERHEAD: Graph of Peruvian Anchovy Catch]

3.3.3. Maximum sustainable yields were generally overestimated (7-10 million tons).

3.3.4. In 1965, an *El Nino* event caused stocks to decline.

[OVERHEAD: Diagram of *El Nino*]

3.4. In 1972, a second *El Nino* led to recruitment failure.

3.4.1. Warm inshore waters inhibited upwelling.

3.4.2. Adult anchovy were clustered inshore where they were vulnerable.

3.4.3. Juvenile anchovy survived poorly due to a lack of food supply.

3.5. In 1982-1983, a third *El Nino* thwarted stock recovery.

3.6. *The greatest failing of fisheries scientists* (Hilborn and Walters 1992).

3.6.1. Focus of interest was on predicting maximum sustainable yield.

3.6.2. Failed to appreciate natural variability of fish stocks (*El Nino*).

3.6.3. Failed to account for uncertainty of their estimates ($\pm 50\%$).

4. The North Sea herring fishery.

4.1. The Atlantic herring (*Clupea harengus*).

[OVERHEAD: Picture of Atlantic Herring]

4.1.1. Largest herring are up to 17 inches, but most are smaller than 12 inches.

4.1.2. Mature in 3 years and usually live no more than 9 years.

4.1.3. Travel in large schools in open water areas off coastlines.

4.1.4. Populations live on both sides of the northern Atlantic Ocean.

4.2. During 1903-1965, stock sustained yields between 300,000 and 1,000,000 tons.

[OVERHEAD: Graph of North Sea Herring Catch]

4.3. In the 1960s, the stock began to decline precipitously.

4.3.1. Biologists were accustomed to large natural variation.

4.3.2. Estimates of fishing mortality were much too low.

4.3.3. Consequently, estimates of stock abundance were much too high.

4.4. By 1970, biologists recommended substantial cuts in harvest.

4.4.1. However, the recommended quota exceeded the stock size (hindsight)!

4.4.2. Effective regulation was not enforced until 1977!

4.4.3. By that time, stocks had declined to 0.2-million tons.

4.5. *The second greatest failure of fisheries scientists.*

4.5.1. Herring collapsed under the watchful eye of the world's best scientists!

4.5.2. Cannot detect overfishing until the problem is quite severe.

4.5.3. Even when detected, it is nearly impossible to effect cuts in harvest.

5. The Pacific Northwest chinook salmon fishery.

5.1. The Chinook salmon (*Oncorhynchus tshawytscha*).

[OVERHEAD: Picture of Chinook Salmon]

5.1.1. Largest salmon are 100 pounds, but most are closer to 30 pounds.

5.1.2. Mature in 1-5 years and usually live no more than 6 years.

5.1.3. Travel in large schools in open oceans to feed on pelagic fishes.

5.1.4. Populations live on both sides of the northern Pacific Ocean.

5.2. Spawning runs have supported fisheries since 1800s.

5.3. Spawning runs are now dwindling all along the Pacific Coast.

[OVERHEAD: Graph of Chinook Salmon Catch]

5.3.1. Older ages of fish are disappearing.

5.3.2. Growth rates are declining.

5.4. Management is coordinated through Pacific Fishery Management Council.

5.4.1. Treaties mandate half of the harvest be reserved for tribes upriver.

5.4.2. Ocean harvest is taken mostly by trolling fisheries (sport, commercial).

5.4.3. Escapement goals are set to ensure adequate numbers of spawners.

5.4.4. Quotas are estimated from abundance estimates, minus escapement goals.

5.4.5. Harvest often exceeds targets and abundance estimates are often too high.

5.5. Habitat limitations reduce total harvest.

5.5.1. Spawning fish are "lost" between dams during their spawning migrations.

5.5.2. Logging practices (clear-cutting) damages spawning habitat.

5.5.3. Juvenile fish are killed as they pass through dams.

5.6. Institutional arrangements inhibit stock protection and restoration.

5.6.1. Nations did not wish to unilaterally reduce harvest.

5.6.2. Administrators did not wish to hear bad news about stock status.

5.6.3. Biologists were often asked to modify their stock status reports.

5.7. Institutional and biological complexity impeded management.

5.7.1. Possess best data on stock and recruitment in the world!

5.7.2. Agencies were unwilling to do the right thing, until everyone else did!

5.7.3. Administrators polluted the pure biological recommendations.

6. The Northwest Atlantic groundfish fishery.

6.1. The Atlantic cod (*Gadus morhua*).

[OVERHEAD: Picture of Atlantic Cod]

6.1.1. Largest cod are up to 6 feet (200 pounds), but most are smaller than 25 pounds.

6.1.2. Mature in 3-8 years and usually live longer than 8 years.

6.1.3. Live in large aggregations over rocky shoals in deep water (250 fathoms).

6.1.4. Live on both sides of the northern Atlantic Ocean.

6.2. Fisheries have been present from Newfoundland to New England since 1800s.

6.2.1. Major domestic industries for salted and fresh fish have been present since 1900.

6.2.2. Otter trawls became important in the first half of the 1900s (very effective).

6.3. Foreign fishing fleets increased after World War II.

[OVERHEAD: Graph of Northern Cod Catch]

6.3.1. Fishing effort intensified in international waters beyond 12 miles.

6.3.2. Landings increased from 1-million tons in the 1950s to 2-million tons by 1965.

6.4. Soon thereafter, stocks declined sharply despite restrictive regulations.

6.4.1. International Commission for the Northwest Atlantic Fisheries (ICNAF).

6.4.2. Frustration over declining stocks prompted a change in the international line.

6.5. In 1977, the U.S. and Canada extended their exclusive fishing zones to 200 miles.

6.5.1. Foreign fishing was severely curtailed within 200-mile limit.

6.5.2. Fish stocks began to recover in the 1980s.

6.5.3. Canadian and U.S. began to modernize and expand!

6.6. In the late 1980s, domestic fishing effort increased sharply and stocks declined.

[OVERHEAD: Graph of Fishing Effort Changes]

6.6.1. In the early 1990s, landings of most species declined sharply.

6.6.2. Both countries severely curtailed or closed fishing for most valuable species.

6.6.3. Recovery of the most important species is uncertain.

6.7. *The largest natural disaster in the history of Canada* (Carl Walters, 1993).

6.7.1. Biologists were overly optimistic about stock status.

6.7.2. Fishermen lied about the amount and location of their harvest.

6.7.3. Nations permitted, rather than managed, fishery growth!

7. The Pacific halibut fishery.

7.1. The Pacific halibut (*Hippoglossus stenolepis*).

[OVERHEAD: Picture of Pacific halibut]

7.1.1. Largest halibut are up to 8'9" (500 lbs), but most are about 35 pounds.

7.1.2. Mature in 12 years and usually live considerably longer than 15 years.

7.1.3. Live in deep oceans (150-225 fathoms) and feed on crabs and fishes.

7.1.4. Live on both sides of the northern Pacific Ocean (California to Kamchatka).

7.2. Fisheries have been present from California to Alaska since 1800s.

[OVERHEAD: Graph of Pacific Halibut Catch]

- 7.2.1. By 1910, fishing had already been depleted inshore stocks.
- 7.2.2. By 1920, diesel engines enabled long lining in very deep waters.
- 7.2.3. By 1931, stocks had been fully exploited so catch declined.
- 7.2.4. In 1932, International Fisheries Commission regulated the fishery.
- 7.2.5. Catches grew along with stock sizes through the early 1960s.
- 7.2.6. In 1960s, foreign trawlers began harvesting halibut.
- 7.2.7. Excessive fishing effort caused stocks to decline through early 1970s.
- 7.2.8. IFC reduced fishing season to accommodate offshore harvest.

[OVERHEAD: Graph of Pacific Halibut Seasons and Catch]

- 7.2.9. Soon thereafter, stocks increased steadily.

7.3. The most successful fishery management in history (Carl Walters, 1993).

- 7.3.1. Biologists worked in cooperation with fishermen.
- 7.3.2. Data was of excellent quality, so predictions were accurate.
- 7.3.3. Imposed restrictive regulations that accounted for all harvest.
- 7.3.4. Imposed restrictive regulations in time to save the stock!