

Class 39

FOOD RESOURCES OF THE OCEANS

World Fish Catch

Dynamics of fish populations and fishing

Over-exploited fisheries

Potential harvest of fish

Increasing fish production

Recent history of marine food production:

World fish catch increased 4-fold from 1950 to 1990

1953 23 Million Metric Tons

1970 68 Million Metric Tons

1990 86 Million Metric Tons

Increase is leveling out, despite more technology and greater intensity of fishing.

Types of animals harvested:

88% fin fish

8% shell fish

4% crustaceans

Use of the harvest:

60% for human consumption

40% for oil, fishmeal for livestock and fish farms (!)

Importance to human diet (not huge):

- 1% of total food production
- 16% of total animal protein

Distribution of fishing areas: Controlled by:

1. Primary productivity -- nutrient availability
2. Trophic structure. More fish produced if...
 - number of trophic levels is low
 - efficiency of energy transfer in food chain is higher

Open Ocean Areas- Small Harvest

- Fisheries in upwelling zones: equatorial and polar -- moderate nutrient supply
- But the harvest is fin fish (e.g., tuna) from high atop an inefficient food chain.

Coastal Areas: Large Harvest

- Nutrient supply and regeneration is good-
 - runoff from land
 - Shallow water- nutrients retained, recycled
- Harvest both pelagic fish (herring) and bottom fish (cod, hake, haddock in northern waters)
- Shorter, more efficient food chain -- less energy expended by consumer organisms because of the higher population density of phytoplankton.

Upwelling Areas -- West coasts of Americas and Africa

- Very high primary productivity.
- Harvest small, fast-growing, phytoplankton-eating species that travel in dense schools, and are easy to catch: anchovies, sardines.
- Short, very efficient food chains.

DYNAMICS OF FISH POPULATIONS AND FISHERIES MANAGEMENT

Recent history of marine food production:

- 4-fold increase in past four decades.
- Increase is leveling out, despite more technology and greater intensity of fishing.
- Declines in many traditional fisheries.

Important questions to address:

- What controls the size of fish stocks?
- Effect of fishing on the population of fish stocks?
- Effects of over-fishing?

Steady-state biomass of a population of fish: Gains = Losses

- Without human impact (balance):
 - Growth of individuals + reproduction (new members) = deaths + natural predation
- Effects of fishing: add human predation --> decrease steady-state population

Harvesting decreases the average age and size. This leads to decrease in harvest, but not immediately...

1. Older, larger fish taken first --> increased growth of younger fish --> net growth of population.
2. To maintain yield, smaller & younger fish (breeding population) are taken.
3. Reproduction decreases, yield decreases; population may not rebound even if fishing stops -- Over-fishing!

Important question: What is the "maximum sustainable yield?"

- Not known for most commercial fish stocks.
- Estimates range from 1/3 to 2/3 of total production

EXAMPLES OF OVER-EXPLOITATION

1. Peruvian anchovies.

- Over-fished at peak harvest (1970; 12 million metric tons)
- Devastating 1972 El Nino
- Decrease to 2 million metric tons per year
- Recent recovery...
 - 9.7 million metric tons in 1994
 - Dropped after 1997 El Niño
 - Rapid Recovery in 1999 and 2000

2. Pacific Salmon -- Overfishing and environmental degradation.

Degradation of spawning streams:

- dams
- altered stream banks (reduced shade)
- water quality

3. Atlantic Cod, see: <http://www.nefsc.nmfs.gov/sos/spsyn/pg/cod/>

- Baleen Whales -- Overfishing.
- Harvest and populations of many species have declined markedly since 1960's

4. Whales -- Harvest and populations of many species declined markedly since 1960's

POTENTIAL HARVEST OF FISH FROM THE OCEANS

Zone	Net Primary Prod. [million metric tons) / yr.]	Trophic level harvested	Trophic efficiency(%)	Max. fish production [million metric tons / year]
Open Ocean	209,000	5	10	2
Coastal	68,000	3	15	230
Upwelling	1,000	1.5	20	120
Total	278,000			352

Current fish yield about 90 Million metric tons, ~25% of maximum production.

Are we approaching the maximum sustainable yield for many commercial fish species?

Probably so.

WAYS TO INCREASE PRODUCTION FROM THE OCEANS.

1. Mariculture / Aquaculture. > 20% of fish consumed

- (a) salmon raised in near-shore pens
 - Fish meal used as feed!
 - Recent ecological worries
- (b) molluscs and crustaceans raised in ponds.
- (c) Ocean "ranching."
 - release eggs/young, harvest adults later
 - Genetic "engineering" to improve harvest (?)

2. Development of new and underexploited fisheries.

Pollock and whiting populations of the northeast Pacific

- Abundant
- Oily, smelly -- not very appealing
- Processing -- remove oils, process flesh to artificial crab and shrimp meat.

3. Harvest lower on the food chain

- Antarctic krill?
- Harvest phytoplankton directly?

4. Proper regulation and management of currently fished stocks.

But... Even if we were able to double the current yield of fish from the oceans, we would not add substantially to total global food production