Human Impact in Aquatic Systems: Fish Catching vs. Fish Raising
What are human impacts?
• Fish and aquatic invertebrates (clams, crabs, squid, etc.) currently supply 16% of world protein, higher in developing countries

• Also important raw materials for pigments, medicines, agricultural fertilizer

• According to UN Food & Agriculture Organization (2005):
  – 3% of commercially valuable fish spp. are under-harvested
  – 21% “moderately” exploited, could support a little more fishing
  – 52% fully exploited
  – 16% overexploited
  – 7% seriously depleted
  – 1% “recovering” from depletion
• Some assessments are even more pessimistic: Nature (2006) study estimated that large, predatory ocean fish were only at 10% of their abundance prior to the 20th century

• On a global level, catches peaked in mid-1990s, fell 13% between 1994 and 2003

• Modern ‘industrial’ fishing tends to catch many unintended species, disturb ocean floor, and catch younger fish before they have time to reproduce

• Today, many fisheries can survive only by being heavily subsidized

![Graph showing shelf and pelagic fisheries](image-url)
• **Case studies....**

- Traditionally cod was extremely abundant in North Atlantic
- Until 1960, steady harvests of about 300,000 tons per year
- In 1960s, increased to 800,000 tons .... led to collapse of fishery
- When Canada closed the fishery in 1992, cod stocks at 1%-10% of historical levels

- Crab fishing in Newfoundland exhausted most of the stock in just 6 years, going from 8600 tons in 1981 to 75 tons in 1985

- Hake in Puget Sound went from 45 million lbs in 1983 to 1 million in 1998
• Theory of sustainable harvesting: Maximum Sustained Yield

• The idea is that when fish populations are reduced from their carrying capacity, they will reproduce at a faster rate (because there are more available resources)

• When the number removed each year is equal to the net production of young, then the population will stay stable

• Can stay stable at low or high levels

• This can work, but needs to take account of population fluctuations, and has to be done correctly!
• Fish culture as an alternative

• Currently 33% of all fish and shellfish is raised on fish farms

• Practiced for centuries in China and Southeast Asia, now becoming popular in developed and developing countries

• Tilapia, carp, salmon, milkfish, trout, catfish, as well as crustaceans (shrimp, crayfish) and mollusks (clams, oysters, etc)

• Aquaculture is rapidly rising in importance while wild-caught fisheries stagnate

• May raise fish on farms their whole lives, or raise & release (esp. with shellfish)
• **Problems of fish culture**

• Carnivorous fish and shellfish (salmon, trout, shrimp) require fish meal for food, which has in turn placed heavy pressure on wild stocks of anchovies and other small fish

• Deforestation of mangroves to make room for shrimp and milkfish farming

• Intensive aquaculture may foster diseases and parasites which can escape to wild populations. Waste and effluents can damage marine habitat

• Almost 10% of global mangrove habitat replaced by shrimp farms since 1980

• Shrimp farming in, e.g. Brazil increased by 3000% in last 10 yrs so the problems we see beginning today will only become bigger
In nature, only about 10% of the energy from one trophic level makes it to the next trophic level—the rest is lost as waste. (For example, it should take 10 lbs of prey to make 1 lb of predator.)

http://www.cod.edu/PEOPLE/FACULTY/FANCHER/TrophicPyramids.htm
• General problems with consuming predatory animals (e.g. shrimp, tuna, salmon)
• Energy is lost as we go to higher trophic levels
• Conversion efficiency = how much of an organism’s food goes into increasing its body mass
• 5-20% efficiency in land systems, 10-40% in marine systems
• So raising herbivorous fish is more efficient than raising cows or chickens…..BUT more fish are carnivorous
• Greater conversion efficiency in fish (cold-blooded) leads to more trophic levels in the ocean
• Trophic cascades: Caribbean Coral reefs

• Coral reefs critical for soaking up excess CO₂ and limiting global warming
• Also one of the world’s most productive environments, comparable to saltmarshes and tropical rainforests
• Overfishing has had indirect damaging effects on coral reefs
• Depletion of sharks leads to more medium-sized fish, which reduce population of parrotfish, which lead to more algae….algae are taking over from coral
• **Trophic Cascade in North Pacific**

• Fishing for pollock reduces this highly productive fish to a low but stable level

• However this is not enough to support sea lion population

• Decline in pollock $\rightarrow$ decline in sea lions $\rightarrow$ need to switch food source among killer whales

• Killer whales switch to sea otters $\rightarrow$ decline in otters $\rightarrow$ increase in sea urchins $\rightarrow$ decline in kelp forest, and many species that depend on the kelp suffer
• Food for thought…..Where should we get the fish we eat?
• Are there sustainable ways to get fish? (look at your handouts)
• What is sustainability?

• Time for activity & debate!