CHAPTER 17
RESOURCES FROM THE SEA

G-SLO 8*. The student will be able undertake a comprehensive examination of the human use of marine resources, both living and non-living.*

The student will be able to…

- **SLO 8.1** … to identify the major food resources and the current situation of the world's fisheries including both capture and aquaculture production; their use and misuse.
- **SLO 8.2** … List some of the most important non-living resources that we obtain from the ocean floor and from seawater.

In Summary:

- Part IV of the textbook is a comprehensive examination of the **relationship between humans and the sea**. It will be easy to understand that the oceans are not a bottomless source of food and a free-for-all receptacle of garbage.

1. THE LIVING RESOURCES OF THE SEA

- The oceans, which cover most of the surface of the earth (71%), are the planet's largest factory of "organic matter". In turn, this highly productive environment furnished to humans the possibility of harvesting a wealth of marine organisms for food and other needs.
- Marine Resources are utilized for:
  - Food
  - Products (fish meal, fish oils…)
  - Materials (aquarium trade; live rock…)
  - Recreation (recreation fishing; sport diving…)

1.1 Food from the Sea

- The oceans provide food as well as employment for millions of people.

What types of organisms are harvested?

- **Finfish** (about 90% of worldwide harvest) – "finfish" is the fisheries terminology for the fishes
- **Shellfish** (is the fisheries terminology meaning together the mollucs and crustaceans)
  - Shellfish are less important than finfish in the "size" (volume) of their catch but the "value" of the catch is very significant.
- **Other species**: such as jellyfish, sea cucumbers, polychaetes (palolo worms…),seaweed, marine mammals, saltwater crocodiles and other reptiles (sea turtles; sea snakes)

Importance of seafood for the world's food supply

- Protein from fish and shellfish currently **accounts for 16% of all animal protein** consumed by the human population.
- Catches are consumed fresh, frozen, canned, or cured (salted; marinated; dried, smoked…) and the by-products may be processed into pet food, chicken feed, or fertilizer, and other products. (fish meal, fish oils…)

Marine fisheries as a source of employment and income

- In 2014, worldwide ≈ **58 million people** were directly engaged in the primary sector of capture fisheries and aquaculture (includes both marine and freshwater fisheries); 80% of them are in Asia
  - 33% in aquaculture and 67% in capture fisheries
- **10-12% of the world population** is associated directly or indirectly to the fisheries and aquaculture industry.

Worldwide Capture Fisheries

- **1950 (18 Mt) – 1969 (56 Mt) --- 6% increase/yr during 2 decades**
  - rapid fleet expansion and technical development
- **1970s-1980s --- 2% increase/yr during this decade**
  - Peruvian Anchoveta (*Engraulis ringens*) collapsed in 1971; many stocks deteriorated because of overexploitation
- **Since the 1990s --- about 0% increase**
  - Worldwide catches remain relatively constant despite increases in the fishing effort (1950s to present – there was a five-fold increase in fishing effort)

- Capture fisheries production has apparently reached the "maximum potential"
- Many of world's most important catches are overexploited or exhausted

Worldwide "Aquaculture" production – shows the opposite tendency:
Inland and marine aquaculture

1950 – 1969	5% increase/yr
1970s &1980s	8% increase/yr
Since the 1990s	10% increase/yr

- Aquaculture continues to grow more rapidly than all other animal food-producing sectors, with an average annual growth rate for the world of **8.8% per year since 1970**, compared with only **1.2% for capture fisheries** and **2.8% for terrestrial farmed meat production** systems.

- The increase demand for "seafood" in affluent countries and the "expansion of the world's population" have steadily increased the pressure on food resources of the sea.
  - In 2014, worldwide, the overall consumption of food fish supply was **20.1 kg/capita**. These figures can reach much higher levels in certain countries.
  - The total human population in 2014 was estimated to be **7.3 billion**.

World Fisheries and aquaculture production: 2014

Reference: FAO. 2016. The State of World Fisheries and Aquaculture: 2016. FAO Fisheries Department, Rome, Italy. (p.4)
www.fao.org/sof/sofia/index_en.htm

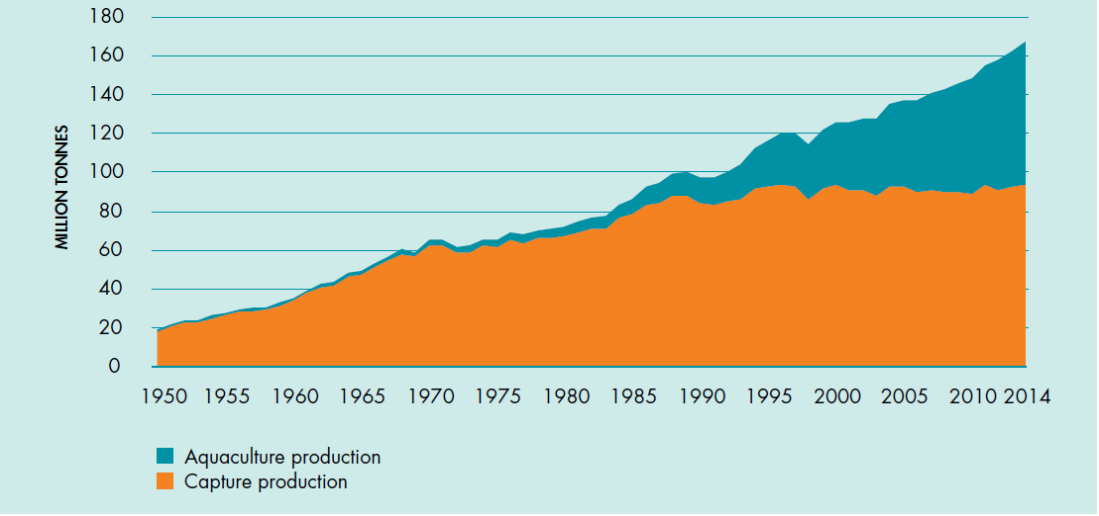
Total World Fisheries (2014)	167.2 mt**	
• **Marine (Cap. + Aq.)**	108.2	65 %
• **Inland (Cap. + Aq.)**	59.0	35 %
MARINE FISHERIES	108.2	
• **Capture**	81.5	75 %
• **Aquaculture**	26.7	25 %
INLAND FISHERIES	59.0	
• **Capture**	11.9	20 %
• **Aquaculture**	47.1	80 %
TOTAL CAPTURE	93.4	56%
TOTAL AQUACULTURE	73.8	44 %
Human Consumption	146.3	87.5%
Non-food uses (fishmeal; oils…)	20.9	12.5%

* Preliminary data ** Million metric tonnes

- **Total world fisheries (2014): 167.2 million metric tonnes**
  - Notice the importance of "marine fisheries (Capture + aquaculture) with 108.2 mt (65%) as opposed to "inland fisheries" with 59.0 mt (35%)
- **Total Capture: 93.4 mt (56%)**
  - Marine – 81.5 mt
  - Inland – 11.9 mt
- **Total Aquaculture: 73.8 mt (44%)**
  - Marine – 26.7 mt
  - Inland -- 47.1 mt (note the importance of inland aquaculture as compared to marine aquaculture)

FIGURE 1

WORLD CAPTURE FISHERIES AND AQUACULTURE PRODUCTION



(FAO 2016 yearbook)

State of the stocks (2014):

Collapse of a Fishery

- A fishery is regarded as collapsed if numbers fall to 10% of historic highs

Collapse fishery:* Overexploited Depleted Recovering from depletion	31.4%
Fully exploited [Catches at or close to their Maximum Sustainable Yield (MSY) or limit]	58.1 %
Underexploited **Moderately exploited** [i.e. Still potential for expansion]	10.5%

* The Johannesburg Plan of Implementation that resulted from the World Summit on sustainable Development (Johannesburg, 2002) demands that all these stocks be restored to the level that can produce maximum sustainable yield (MSY) by 2015.

Marine Capture Fisheries – Dominant Species Landed (2014 data)

Marine capture fisheries production: top ten species in 2014	
species	**2014 (million tonnes)**
Alaska Pollock	3.2
Anchoveta (Peruvian Anchovy)	3.14
Skipjack tuna	3.06
Sardinellas nei	2.3
Chub mackerel	1.8
Atlantic herring	1.6
Yellowfin tuna	1.47
Scads nei	1.46
Atlantic Mackerel	1.42
Japanese anchovy	1.40
Atlantic cod (no 11)	1.37

Major Dangers to Fisheries

Habitat destruction

- Critical breeding grounds like seagrass beds, estuaries and mangroves are destroyed each year.
- Trawls used in fisheries is equally very damaging to the ocean floor which is detrimental to demersal species; this is another form of habitat destruction

By-catch

- **By-catch (incidental catch; "trash fish" or discards)**, organisms that are caught unintentionally while fishing for other species (the "target species), is a major problem.
- around **10% of the total global catch** is discarded, but in some fisheries (such as the shrimp fisheries) this percentage can easily reach 25% or more of the catch might be thrown overboard

Inefficient use of the catch:

- Some fisheries use only a portion of the catch and waste the rest.
  - Example – some species of shark are caught only for their fins; after the fins are removed, to make shark fin soup, the helpless shark is thrown overboard to die.

Ghost fishing

- **Ghost fishing**, trapping by abandoned fishing gear such as gillnets, longlines, and various kinds of traps, also kills millions of organisms each year.

Pollution

- Pollution from sewage, oil spills, plastics, and toxic chemicals all have major impact on fish stocks.
- The high level of heavy metals like mercury in large fishes such as tuna and swordfish is of particular concern to consumers.

1.2 Marine Life as Items of Commerce and Recreation

- The living resources of the sea are used in many ways other than food.

Other items harvested for reasons other than direct consumption:

- Mangroves – are used for timber and charcoal
- Pearls, shells, coral (black or precious corals) and sea turtle shells serve to produce jewelry
- Leather from the saltwater crocodile, sea snakes, sharks, and other fishes
- Some species are harvested for their chemical compounds that are used as "**marine natural products**" – used in medicine.
- Seaweeds provide chemicals (alginates and carrageenans) that are widely used in food processing, cosmetics, plastics, and other products.

- **Amateur anglers** – in general, marine resources caught by recreational anglers; in the USA, it is about 30% of the amount caught by commercial fishermen
  - However, for some species, the number of individuals caught each year may be solely from recreational anglers
- Other species are harvested each year for the **aquarium trade**
  - This can equally a destructive method since in some countries such as the Philippines and other countries, the aquarium species are often collected by using poisons or explosions that kill hundreds or thousands of fish.

2 NON-LIVING RESOURCES FROM THE SEA FLOOR

- The non-renewable resources are not naturally replaces. They included oil, natural gas, and minerals.

2.1 Oil and Gas

- The offshore oil industry has undergone tremendous expansion since the 1970s, as the high price of oil and gas makes offshore drilling immensely profitable.
- The continental shelves are a major source of oil and natural gas.
- Huge steel or concrete platforms are erected and secured to the bottom to extract the fossil fuels **(Fig. 17.18, p.402)**
- The potential threat of oil pollution is a factor of great concern. Pollution from drilling operations can affect coastal fisheries, tourism, and recreation.

2.2 Ocean Mining

- The seabed is a potential source of many types of minerals.
- About 60% of the world's supply of magnesium and 70% of the world's supply of bromine come from seawater.
  - Magnesium – used to form alloys (forms lightweight metals)
  - Bromine is used as a disinfecting and bleaching agent
- Deposits of phosphates are widely used as fertilizers.
- The **polymetallic nodules (manganese nodules)**, which are lumps of minerals that are scattered on the deep-ocean basins over the abyssal plains, are rich in manganese, nickel, copper, and cobalt.
  - It is estimated that 16 million metric tons of these commercially valuable nodules accumulate on the ocean floor each year.
- Other mineral-rich sediments, essentially deposits of sulfides (mineral compounds containing sulfur) are found along the mid-ocean ridges and **hydrothermal vents**. These deposits are rich in iron, zinc, copper, gold, silver, platinum, molybdenum, lead, and chromium. At this time, however, the technology does not exist for selective sampling of these deposits or for mining them.
- Deep-sea mining still remains unfeasible. But as price of minerals change and new technology develops, future economic prospects are foreseen.
- Now looking into exploring the "rare earths"

Sands and gravels:

- Sand and gravel for the construction industry are mined along beaches and offshore in many parts of the world.
- Sand is also extracted for its use in the glass industry.
- Sands and gravel extraction are the most widespread seafloor mining operations. Approximately 112 billion metric tons are extracted worldwide annually.
- Coastal sands in some areas of the world contain deposits of iron, tin, uranium, platinum, gold and even diamonds.

3- NON-LIVING RESOURCES FROM SEAWATER

- Seawater, which contains a combination of many different **ions**, is a potential source of resources.

3.1 Fresh Water

- **Desalination** plants that convert seawater into fresh water are greatly used in regions where there is a water shortage (Arabian Peninsula, Israel, North Africa). More than 13,000 desalination plants had been built around the world by 2009.
- Desalination requires a great deal of energy and is therefore expensive. It can equally produce a highly saline residue that can cause environmental problems.

3.2 Minerals

- Every element on Earth is present in seawater, but mostly in extremely small quantities.
- The chief product presently obtained from seawater is **table salt** (NaCl) **(Fig. 17.20, p.404)**
  - About 30% of the world's supply of salt (NaCl) comes from seawater. The remaining 70% comes from terrestrial salt depsits that were formed when water from ancient seas evaporated.

3.3 Energy

- The use of tidal energy is pollution free and relatively efficient, but the resulting changes in the tidal patterns can be highly destructive to the nearby environment. (because of the construction of barriers across narrow bays) **(Fig. 17.21, p.404)**
  - The marshes in estuaries may be damaged or destroyed.
  - Pollutants from other sources tend to accumulate upstream because normal tidal flushing is restricted.
  - River flows can be altered.

- Wind-generated waves and strong ocean currents are other potential sources of energy.

- Another way to harvest energy from the ocean is to take advantage of the temperature difference between surface and deep water, a process called **ocean thermal energy conversion (OTEC).** Temperature differences of at least 20°C between the surface and below are needed, a condition met in the tropics.