● ECONOMICS ○ HISTORY GEOGRAPHY ● LANGUAGES ○ PHYSICS CHEMISTRY ● BIOLOGY LIFE&EARTH SCIENCES ○ TECHNOLOGY

SHEET N°17

FISHING IN THE ARCTIC AND ANTARCTIC: EXPLOITING LIVING RESOURCES

Human beings depend on the oceans to a large extent; half of the world's population lives less than 100 km from the coast. Until recently, the proportion of marine resources taken by human beings to feed themselves (i.e. by catching species of wild fish, molluscs and crustaceans) had never seriously disrupted the natural balance of these marine environments. However this is no longer true today. Since 1960, the consumption of living marine resources has more than doubled. Fishing fleets have been expanding rapidly and the techniques they use have become increasingly effective, which has resulted in overfishing of dwindling stocks across the globe. In some cases stocks of traditionally harvested living marine resources have run down to the point where traditional fishing as a means of subsistence is no longer possible. On top of this, yet another factor has been complicating the situation even further: climate change. Climate change can affect fish populations directly through increased water temperature and indirectly through reduction of primary production from the oceans for example.

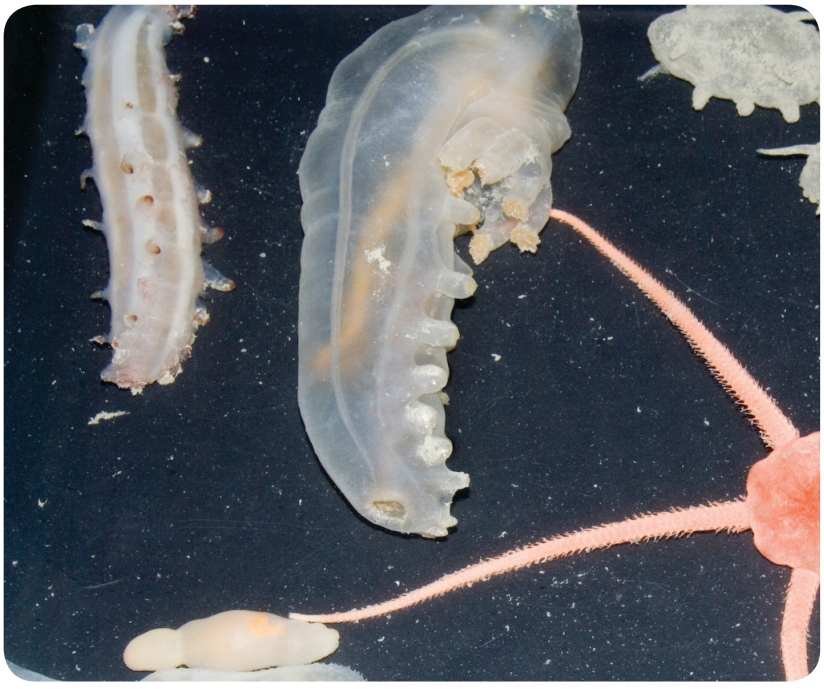
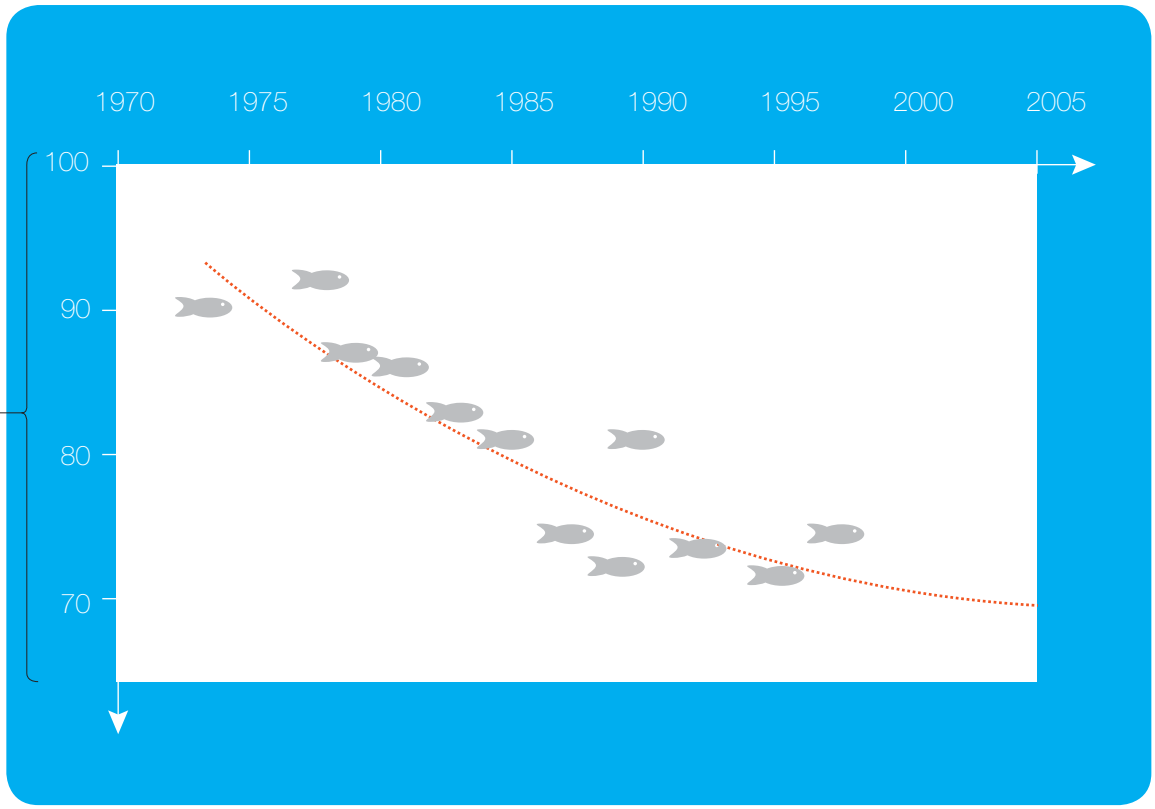


Figure 1

Changes to fish stocks in the world's oceans between 1974 and 2002.

NB:

Stocks are compared over this period using the 1970 value as a baseline reference value.



1) OVERALL LOWER PRIMARY PRODUCTION FROM THE OCEANS:

What impact will climate change have on marine ecosystems? At the moment, we can see that the warming of the ocean waters occurring on the surface is increasing the difference in density between the layer of the water nearer the surface (which is heated by the sun's rays, but is low in nutrient salts) and the deeper water (which is darker, colder and has more nutrient salts). Increased stratification of the ocean would make exchanges between these layers even more difficult, resulting in a reduction in the transfer of nutrient salts from the depths to the surface. Yet nutrient salts are needed for the photosynthesis of phytoplankton - tiny plant organisms that live in the photic zone and are at the bottom of the entire marine food web. Any depletion in the level of nutrients would result in a reduction in the primary production of phytoplankton, which in turn will have an effect up the entire food web. Satellite observations of the colour of the ocean's surface conducted over the past ten years indicate that overall productivity is down.

2) THE ARCTIC'S LIVING RESOURCES:

At present, marine protein (obtained from fishing and aquaculture) represents over 20% of human consumption of animal protein, and is a principal protein source for half of the world's population (FAO, 2006). To meet a growing demand for an increasing global population, fishermen have introduced new techniques and have extended their fishing grounds to include the great depths of the sea. This has resulted in massive overfishing in many areas. The FAO estimates that 75% of the marine species they looked at in a study are either exploited to the full, overexploited or have already become locally extinct. This means that the maximum potential for exploiting the living resources of our oceans has already been reached or exceeded in many locations. Overfishing is responsible for decline in fish populations (Atlantic cod, for example) and affects food webs. With sea ice decreasing, fishing in the Arctic is becoming an issue of increasing interest.

Water temperature changes affect fish populations' distribution either directly or indirectly through the food web. The CAFF report "Arctic Biodiversity Trends 2010" indicates that "The length of the ice-free period in the Arctic, for example, affects annual primary production, which is at the base of the food chain supporting populations of fish, sea mammals, and seabirds. As the amount of ice in the Arctic has considerably reduced since the 1970s, and projections indicate that the reduction will continue, it seems likely that primary production in the Arctic will increase during this century".

In addition, species of zooplankton with calcareous shells are also being affected as the oceans become more acidic as they absorb

greater amounts of man-made carbon dioxide being pumped into the atmosphere. The oceans naturally absorb a good deal of CO_2 from the atmosphere as part of the carbon cycle, making them important "carbon sinks". It is estimated that the oceans absorb about a quarter of all the CO_2 produced by human activity, and the colder the water, the more CO_2 it can absorb. This is why the polar oceans are particularly important carbon sinks. Numerous surveys are currently underway to evaluate their future absorption potential. Rising temperatures could therefore cause this vital CO_2 absorption system to become inefficient, or even have the reverse effect (due to reduced solubility of CO_2 in warmer water) and contribute to increasing CO_2 concentration in the atmosphere.

The CO_2 captured from the atmosphere reacts with the water to make it more acidic, reducing its pH. A significant increase in the amount of CO_2 dissolved in the water would cause the partial dissolution of any calcareous material (made from calcium carbonate - $CaCO_3$) present in marine waters (e.g. the shells of marine organisms, the skeletons of coral reefs, limestone). The ocean's pH has fallen by 0.1 of a unit since the beginning of the industrial age, when it was 8.3 on average. This is a huge drop given that the pH scale is logarithmic (it ranges from 0 to 14, with 0 being the most acidic and 14 being the most alkaline). Models show that if the trend in CO_2 emissions continues, the average pH of the oceans will be 7.8 by the end of the century. This would mean a fall of 0.5 of a unit compared with the pre-industrial era as well as the lowest pH level reached in the world's ocean in several million years.

In the Arctic, pteropods are particularly endangered. Pteropods are tiny planktonic organisms living in these cold waters and represent an important part of the Arctic food web.

3) LIVING RESOURCES IN ANTARCTICA

In the 19th century, whalers and sealers were drawn to the Antarctic to hunt the prolific marine fauna. The first voyages date to 1873, when German hunters hunted the great marine mammals of the southern seas. They were the first to benefit from the modern harpoon gun invented by Norwegian Svend Foyn in 1870. The populations of marine animals declined sharply; seals and sea-lions were hunted for their fur, and sea elephants and cetaceans for their oil. Factories producing whale and seal oil were established on the sub-Antarctic islands. The hunt intensified once factory ships were introduced in 1929. Each year, tens of thousands of animals were harpooned. The most sought-after species were the humpback whale, blue whale and common rorqual.

Realising that several of these species were at risk of extinction, the **International Whaling Commission** was created in 1964 to control catches. By 1969, only the USSR and Japan were still whaling in Antarctica, A moratorium was finally put in place in 1986; however illegal trafficking of whale meat continues to this day.

Over-harvesting of certain species can lead to a reduction in its biomass, which in turn can lead to invasive species taking over an ecosystem. This has led to management schemes for harvesting living resources being set up in the Southern Ocean. The **Convention for the Conservation of Antarctic Marine Living Resources** (CCAMLR), an agreement signed by 32 countries under the Antarctic Treaty System (ATS) in 1982, regulates the commercial harvesting of Antarctic marine living resources through the CCAMLR Ecosystem Monitoring Program (CEMP). The purpose of the CEMP is to detect and record any changes in the critical components of the Antarctic marine ecosystem, use them as a basis for conservation measures and determine whether changes in commercially harvested species are a result of over-fishing or if they occur naturally.

CCAMLR is currently creating a representative network of marine protected areas (MPAs) throughout the Southern Ocean to help preserve the Antarctic marine environment (the environmental protocol to the Antarctic Treaty allows for the creation of protected areas in the Southern Ocean). The planned network includes representative areas from each of the mini-ecosystems that exist within the Southern Ocean.

In November 2009, CCAMLR declared its first MPA to preserve foraging areas and unique oceanographic features. It covers more than 90,000 km^2 and is located near the Antarctic Peninsula at the South Orkney Islands. CCAMLR also placed new regulations on krill fishing, requiring that harvesting areas be spread out in order to reduce their impact on ecosystems.

Despite efforts to regulate harvesting of living resources in the Southern Ocean to make sure populations aren't overharvested, illegal, unregulated and unreported (IUU) fishing remain a chronic problem. Continued monitoring and policing of the waters of the Southern Ocean is needed to make sure living resources are harvested responsibly and the delicate marine ecosystems of the Antarctic remain healthy so that its resources can continue to be available to future generations.

SHEET N°17

GLOSSARY :

CAFF: Conservation of Arctic Flora and Fauna Working Group of the Arctic Council.

Carbon sink (syn. CO_2 sink): n. Ecology. – A reservoir where carbon dioxide (CO_2) is stored. CO_2 usually moves from the atmosphere to the ocean, vegetation, the ground or underground. If there were no CO_2 sinks, the concentration of CO_2 in the atmosphere would be higher and the greenhouse effect more pronounced.

FAO: Acronym for the "Food and Agriculture Organisation". Amongst other tasks, this UN organization evaluates the world situation in fishing and aquaculture over time. (www.fao.org).

Nutrients: n. Biology. – Nutritious substances that are rapidly assimilated by planktonic flora and fauna.

pH: (Acronym used in chemistry) - pH stands for the "potential of Hydrogen". The pH scale measures the acidity or alkalinity of an aqueous solution. It is a logarithmic scale with dimensionless units ranging from 0 (strong acid) to 14 (strong base), with pure water being pH neutral at 7 (sea water is naturally slightly alkaline). The pH scale approximates the negative logarithm (base 10) of the molar concentration of dissolved hydrogen ions (H^+) in the aqueous solution.

Photic zone: n. Ecology. – Area of the ocean's surface where light is able to penetrate, making photosynthesis possible. Photic zones may extend to a depth of 200 metres in a best-case scenario, although it is generally shallower in high latitudes, where the angle of the sun is less direct. In terms of biology, the photic zone is the richest in planktonic species, coral, small invertebrates and fish of all kind.

Phytoplankton: n. Biology. – Organisms, usually single-cell, capable of producing photosynthesis. Found in the surface waters of marine environments (photic zone lit by the sun), phytoplankton is at the base of the entire marine food web.

Primary production (of phytoplankton): n. Biology . – The amount of organic matter produced by photosynthesis. Primary production is measured in tons of dry matter per hectare per year.

Pteropod: n. Zoology. – Marine organism with a soft body, belonging to the gasteropod family (which includes snails).

Zooplankton: n. Zoology. – Group of animal microorganisms living suspended in water.

WEB :

Discover the video on "Which animal species are endangered in the Arctic?" and the animation on "Polar flora and fauna" on EDUCAPOLES, the educational website of the International Polar Foundation (IPF) :

http://www.educapoles.org

Other websites containing interesting information related to this subject:

http://www.ccamlr.org/pu/e/gen-intro.htm

http://www.arctic.noaa.gov/reportcard/biology.html

http://www.arcticbiodiversity.is

http://arctic-transform.org/download/FishBP.pdf

http://www.epoca-project.eu/images/RUG/oa_guide_english.pdf

http://climate.nasa.gov/videos/ESW/The_Oceans_Green_Machines_640x480_captions.mov

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