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Lecture Notes

Part 1

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FISHING PRACTICES IN THE CONTEXT OF CLIMATE CHANGE

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Introduction

Fishing provides major source of food for the humanity and provides employment and economic benefits to large sections of the society. As a source of food it contributes about 20 percent of animal protein supply. At present the total world capture fishery production is around 95 million tonnes. About 70 percent of the production is directly utilised for human consumption while the balance 30 percent is reduced into fishmeal and used in animal feed production.

Fishing is an ancient occupation and has been in practice since the Palaeolithic period. About 200 million people are either directly or indirectly involved in fishing in the world. Fifty million people of whom 12.5 million are fishermen and their family members directly depend on fishing for their livelihood. An additional 150 million people are involved in shore-based support activities, processing and marketing of fish and fish products. Fishing contributes significantly to foreign exchange earnings of many developing countries.

Fishing vessels

The world fishing fleet numbered about 3.8 million vessels in 1995. About one-third of these were decked vessels, the remaining two-thirds were un-decked vessels, generally less than 10 m in length. There is great diversity in fishing vessels operating around the world that may range from a 2-metre dugout canoe to factory trawlers exceeding 130 metres in length, where trip durations range from a few hours to over a year.

Introduction of the use of ice and refrigeration machinery has greatly increased the ability of the vessels to handle, process and store fish in good condition onboard. Technological developments, such as hull design optimisation, improvement in engine performance including turbo charging, hydraulic hauling machinery, improved navigation equipments, fish finding electronics had major effects on the efficiency and profitability of fishing vessels. The introduction and widespread use of the outboard engine has greatly changed small-scale fishing operations in developing countries.

Major developments have taken place in fishing vessels in craft materials, hull optimization, engine performance, propulsion systems, gear and catch handling deck equipment, onboard pre-processing, processing, preservation and packaging systems, and energy conservation. In modern large fishing vessels, the command console resembles the aircraft cockpit. The navigation controls and main displays are shown on monitors in front of the control position and increasingly these are shown on one large integrated display. Navigation instruments, fish detection devices such as sonar and radio communications are the important instruments used in fishing vessels.

In India, 2,38,772 fishing craft of various sizes and classes are under operation, consisting of 58,911 mechanized boats, 75,591 motorized craft and 104,270 non-mechanized craft (CMFRI, 2005). About 49.7% of the mechanized vessels are trawlers, followed by gillnetters (24.1%), dol netters (15%), liners (2%) and purse seiners (1.7%) and others (7.6%). A few deep-sea fishing vessels of more than 20 m overall length are operating along the east coast based at Visakhapatnam, targeting shrimp resources in the north-east coast. Mechanised fishing sector produced 66% of the marine landings, followed by motorized sector (27%) and artisanal sector (7%) during 2003. While the landings from mechanised sector increased from 1.33 million

tonnes in 1991 to 1.66 million tonnes in 1996, that of non-mechanised sector decreased from 0.42 million t to 0.27 million t. The landings from motorized sector during this period remained more or less the same, fluctuating between 0.33 million t and 0.46 million t.

Fishing gear materials

Traditional fishing gears used in earlier years were less effective with low productivity. They were made of natural fibres such as cotton, manila, sisal, jute and coir. As these materials are vulnerable to bio-degradation, they have relatively short service life and incur high cost for maintenance. In recent decades major advances have taken place in fibre technology along with introduction of modern materials. With the introduction of man-made synthetic fibres in India in the late 1950s, natural fibres used for the fishing gears have been substituted by these synthetic materials due to their high breaking strength, high resistance to weathering, low maintenance cost, long service life and better uniformity in characteristics. Most important synthetic fibres used in fisheries are polyamide (PA), polyester (PES), polyethylene (PE) and polypropylene (PP). Other synthetic fibres, which are less widely used and generally restricted to Japanese fisheries, are polyvinyl alcohol (PVAA), polyvinyl chloride (PVC) and polyvinylidene chloride (PVD). The introduction of synthetic materials with high tensile strength has made changes in the design and size of fishing nets. Earlier, nets were fabricated manually, which was laborious and time consuming. In recent years, machine made nettings are used almost exclusively.

Fishing gears

A wide array of fishing gears and practices ranging from small-scale artisanal to large-scale industrial systems are used for fish capture. Over the years, traditional fishing gears have been upgraded and more efficient fishing systems have been introduced. Most important among these fishing gears are trawls, purse seines, lines, gillnets and entangling nets and traps. Among the most significant developments which affected the historical evolution of fishing gear and practices are (i) developments in craft technology and mechanisation of propulsion, gear and catch handling, (ii) introduction of synthetic gear materials, (iii) developments in acoustic fish detection satellite-based remote sensing techniques, (iv) advances in electronic navigation and position fixing equipment, and (v) awareness of the need for responsible fishing to ensure sustainability of the resources, protection of the biodiversity and environmental safety and energy efficiency.

Fishermen use several fishing gears and methods that are appropriate for the species and environmental and ground conditions. Fishing gears whether primitive or sophisticated use five mechanisms in the capture process viz., gilling and tangling (e.g. gill nets and trammel nets), trapping (e.g. traps, pound nets), filtering (e.g. trawls, seines and other net fishing systems), hooking and spearing (e.g. hook and line, harpoons), and pumping (e.g. fish pumps).

Fishing gears are classified based on the principles of capture, design and technical features and operational methods. FAO defines and classifies the main categories of fishing gear as follows:

- Surrounding nets (including purse seines);
- Seine nets (including beach seines and boat, scottish/danish seines);
- Trawl nets (beam, otter and pair bottom trawls, otter and pair midwater trawls);
- Dredges;
- Lift nets;
- Falling gears (including cast nets);
- Gillnets and entangling nets (including set and drifting gillnets; trammel nets);
- Traps (including pots, stow or bag nets, fixed traps);

- Hooks and lines (including handlines, pole and lines, set or drifting longlines, trolling lines);
- Grappling and wounding gears (including harpoons, spears, arrows, etc.);
- Stupefying devices

In the past, technological development of fishing gear and methods was aimed at increasing production, by increasing efficiency of the gear systems. However, in the present situation of overfishing, increased awareness of the environmental and ecological impacts of fishing, the fishing gear development is focused on development of responsible fishing gear systems with improved size-selective and species-selective properties, decreased impact on the environment and non-target resources, and sustainability of fish stocks.

Among the great variety of harvesting systems available around the world, the most significant in commercial fisheries are purse seines and trawls, followed by lines, gill nets and entangling nets and traps.

Surrounding nets are roughly rectangular walls of netting rigged with floats and sinkers, which after detection of the presence of fish are cast to encircle the fish school. Surrounding nets are generally operated in the surface layers. Purse seines are the predominant type of surrounding nets, in which the bottom of the net is closed after encircling the fish school, by a purse line. Mini purse seine or ring seine used in the traditional motorized sector belong to this category. Seine net is a long wall of netting supported by floats and sinkers, which are operated by surrounding areas of water with potential catch. They are usually operated in the coastal or shallow waters where bottom or surface act as natural barriers. Trawl nets are conical bag nets with two wings and a codend where catch is concentrated, operated by towing from one or two boats. Based on the position in water column where they are operated, trawls are classified into midwater trawls or bottom trawls. Gill nets are entangling, rectangular walls of netting kept erect by means of floats and sinkers and positioned in the swimming layer of the target fish, which catch the fish by holding them in the mesh by gilling or entangling.

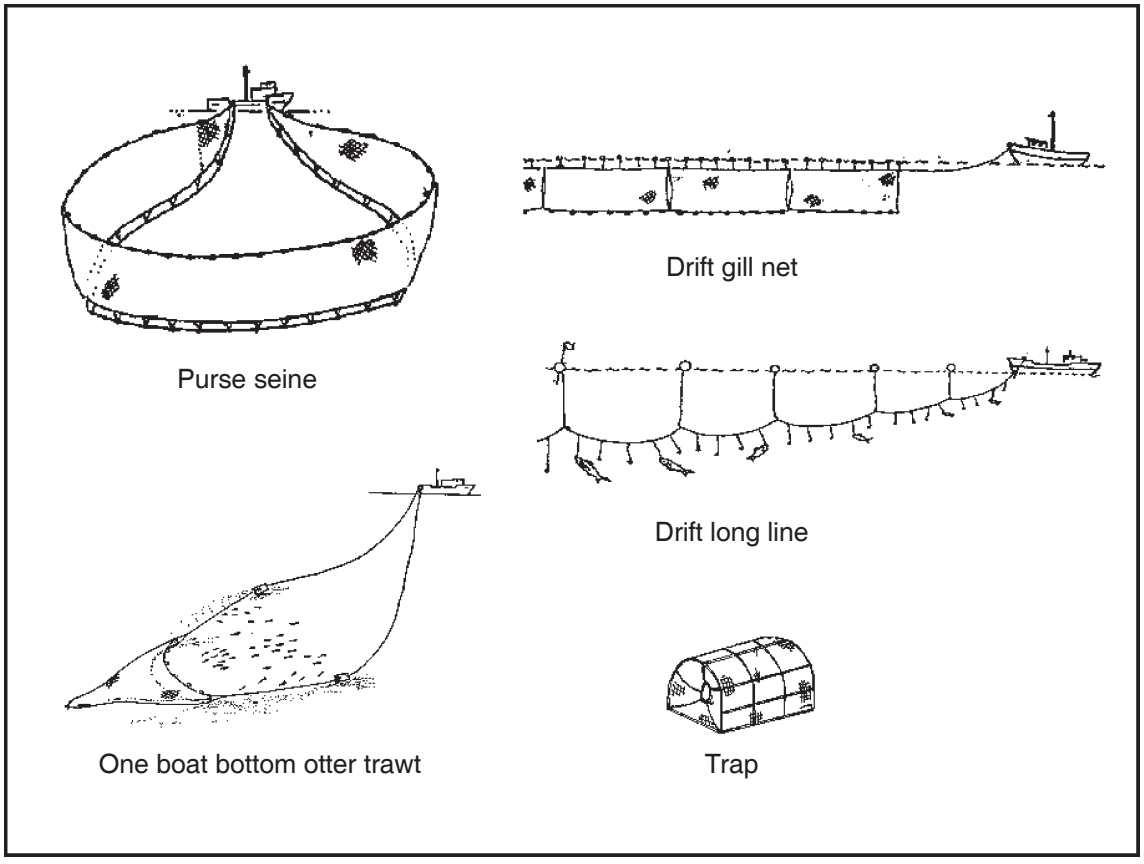
GPS, acoustic fish detection and satellite-based remote sensing techniques

Development of Global Positioning system (GPS), acoustic fish detection and satellite-based remote sensing techniques has enormously increased the precision and efficiency of fishing operations. The most well known and widely used instruments for fish detection are echosounder and sonar. Echosounders are used for (i) depth recording for navigation purposes and position fixing; (ii) ground or sea bed discrimination i.e., to distinguish soft mud, sand, gravel and rock bottom conditions; (iii) determination of sea bed contour; (iv) location of wrecks and hazardous areas; and (v) location of fish and determination of its depth of occurrence. Technological advances in electronics and research into underwater acoustics have led to tremendous improvements in echo sounder and sonar and made them more reliable and affordable. Sonar is an indispensable tool for detection of schools, during aimed midwater trawling and purse seining.

Progress in the satellite-based remote sensing techniques, which use sea surface temperature and ocean colour to identify areas of potential fish abundance also greatly reduces the search time, as near-real time information is communicated to the fishermen. Indian National Centre disseminates PFZ Advisories for Ocean information Services (INCOIS, Hyderabad) (autonomous body under Department of Ocean Development), on Tuesdays, Thursdays and Saturdays to around 200 nodes covering the entire coastline of India.

Responsible fishing

Until the Second World War, when fishing pressure was of moderate intensity, fishery resources were widely believed to be inexhaustible. Dynamic developments in the harvest and post-harvest technology of fish took place in the post-war era. Introduction of powerful and highly efficient fish harvesting systems and fish detection methods, and an uncontrolled expansion in fleet size fuelled by ever increasing market demand for fish brought about increasing pressure on the world fishery resources. Unmistakable signs of



A few major fishing gears

overfishing and negative impacts on the ecosystems have increasingly manifested in the recent years, highlighting the need for scientific management of the world fishery resources in order to ensure their long-term sustainability and availability to the future generations. The FAO Code of Conduct for Responsible Fisheries was adopted in October 1995. The Code covers conservation; management and development of fisheries; capture, processing and trade of fish and fishery products; aquaculture; fisheries research; and integration of fisheries into coastal area management. Responsible fishing would ensure the long-term sustainability of the resources, minimise negative environmental impacts and protect biodiversity.

Climate change and fishing practices

Climate change strongly influences the distribution and abundance of fishes (Wood and McDonald, 1997; Brander et al., 2003; Hobday et al., 2006). Global climate change results in latitudinal shift in ocean temperature (Bakun, 1990), which is predicted to drive species ranges toward the poles (Parmesan and Yohe, 2003). Where dispersal capabilities are limited, as for example due to physical barriers, and when habitats are unsuitable, widespread collapses of fish stocks may occur. Changes are also expected in growth, survival, reproduction, or responses to changes at other trophic levels (Beaugrand et al., 2002; Beaugrand et al., 2003). These changes may have impacts on the nature and value of commercial fisheries. Species-specific responses are likely to vary according to rates of population turnover. Fish species with more rapid turnover of generations may show the most rapid demographic responses to temperature changes, resulting in stronger distributional responses to warming (Perry et al., 2005).

While the principles of capture and the prevailing gear systems will continue to persist in the changing fisheries scenario, design requirements of craft and gear, operational and gear handling parameters may require significant changes to suit the emerging non-traditional fish species and shifting traditional fish stocks. Small-scale fishing will be more significantly impacted due to shifting of traditional fish stocks compared to large-scale fleet operations that can follow the shifting fish stocks.

Climate change is projected to result in irreversible changes in rainfall, ocean and wind currents and increases in mean sea level, which may strongly impact on small-scale fishing operations. Intensity of cyclones and storms may increase with global warming, making fishing operations a riskier occupation.

References and further reading

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