FRESHWATER FISH: HARVEST TECHNOLOGY

R. L. Welcomme
RRAG, Imperial College, University of London, UK

Keywords: Fishing methods; Nets; Traps; Trawls; Seines

Contents

Summary

Many types of fishing gear have emerged over the centuries and a vast range of gear now exists to exploit inland waters. The choice of gear is conditioned by many factors including the characteristics of the water to be fished, the target species, the season of the year, the value of the fish caught and the cost of the gear. Fishing gears fall into three main categories: passive, in which the fish comes to the gear, active, in which the gear engulfs the fish, and other methods. Passive methods include gillnets, setlines, and a range of traps with accompanying barriers and fences. Active methods include trawls, seines, lift nets, scoop nets, and cast nets. Other methods include rod and line, projectiles, poisons, explosives, electricity and fish parks and holes. Fishing gear is made more effective by technologies for fish detection and transmission of information on fish movements. Fish technology has important consequences for management. Certain types of gear cause damage to the environment and fish stock and are normally banned. Other forms of gear require assignment of fishing rights, ownership and access to protect the investments made in their construction. Most fisheries rely on a range of fishing gears operated by different strata of society. Conflicts between these various sub-fisheries need to be taken into account when formulation fishery regulations.

1. Background

Mankind made the change from hunting to farming animals some 7000 years ago. In this way access to a much greater supply of food was possible than from hunting natural wild stocks. In the case of fisheries this transition is still occurring. Aquaculture now accounts for about 20% of the total production of aquatic organisms and about 65% of total inland production. This means that there is still considerable reliance on traditional methods for the capture of fish in the natural waters of the world. While fish farming will grow rapidly in importance, it appears that there will be a place for commercial fisherman for a great many years in the future.

To many eyes the methods and equipment used by fishermen appear crude and unsophisticated; in fact, so far as modern commercial fishing is concerned, the opposite is true in most of the world's important fisheries. Technology, sophistication, complexity, and investment in vessels and equipment, together with techniques of finding and bringing fish to port, are showing rapid growth. Increasing investment in research and development is continually improving the efficiency of operation and

conditions under which fishermen work. These advances in technology have been so successful that they have led directly to the over exploitation of many marine and inland stocks. They have also created serious over-capacity in many fisheries.

For a fishery to be successful it must be economically viable within the structure in which it operates. If a fisherman does not achieve sufficient financial reward for his efforts then he cannot continue fishing.

By extension any technological development that does not contribute to a profit is unlikely to be of benefit to the fisherman or to be used by him. However, in some fisheries such as those of inland floodplains the costs of fishing are so low as to permit the fishery to continue at low levels of individual catch.

Many different methods of fishing and types of fishing gear for catching commercially important freshwater organisms have emerged over the centuries. Their continued use and development to meet local conditions in many parts of the world has led to the sophistication of today's operation.

The fact that many gears remain rooted in tradition and use simple materials does not imply that the fishery is unsophisticated. Very often the sophistication lies in the deployment of the gear, which may be conditioned by deep knowledge of the behavior of the target species.

2. Choice of Fishing Method and Gear

Many factors enter into the choice of the method and gear used to catch a particular species in a particular area. Principally, the choice will depend on:

- The depth of water
- The characteristics of the bed of the lake or stream if gear is to be worked in contact with the bottom
- The species being fished
- The season of year and the flow regime in the case of rivers
- Individual value of the species to the fisherman

2.1 Depth of Water

The various types of fishing gear are designed to be operated within particular depths of water, typically: at the surface of deep lakes, on the lake bed in shallow areas, or between surface and bottom where depth is not too great. Depth of water will therefore exert considerable influence on the choice of suitable gear.

2.1.1 Characteristics of Lake and River Bed

Some types of fishing gear, particularly those that rely on their movement over the bottom, are susceptible to damage from hard, uneven or rough lakebeds, and it is often impossible to use them due to the unsuitability of the bottom topography. In many cases static gear can be placed on the bed of lake or river with little problem.

2.2 Species being fished

The various species of commercially important aquatic organisms have differing habits, movements, and reactions to stimuli; freshwater shrimps and most mollusks are found living on or in the lake or riverbed as are a wide range of fish species. Demersal species of this type are usually caught by fishing gear worked on the lakebed.

Pelagic species may be found anywhere between the bed and the surface, and these are normally taken by fishing gear that is not in contact with the bottom. In certain circumstances, such as during spawning, fish tend to congregate in shallow waters and may be caught by various types of fishing gear used in conjunction with light.

The distribution and movements of each species are controlled by external factors such as water temperature, salinity, and flow regime. They are also conditioned by behavioral factors including spawning habits, location of available food resources, and avoidance of stressful environments. Many species cope with seasonal changes by migrations of long or short duration between spawning, shelter and feeding habitats.

Some fish congregate in dense schools so that during migration, spawning or shoaling they can be taken in bulk. Other species, such as freshwater shrimps and many demersal fish, are more loosely distributed, and yet others will often be found singly or in small, scattered groups.

2.3 Season of Year and the Flow Regime

Seasonal migrations are highly significant for fisheries. In rivers the movements of species along river channels and between the river channels and adjacent floodplains provide increased opportunities for capture due to the predictability of the event and the high concentrations of fish sometimes observed. Events in lakes where fish ascend inflowing rivers to spawn and in the sea where anadromous and catadromous fishes move between the salt water and freshwater environments present similar opportunities.

2.4 Value

Fish are recognized by societies as having different characteristics in terms of keeping quality, taste or some other cultural criterion that endow them with very different values. Furthermore the same species of fish may be of high, medium, or low value depending on the way in which it is processed and marketed.

Examples of high individual value are normally large, firm fleshed with good keeping qualities. Small species, which rot rapidly at the high ambient temperatures of the tropics, are generally less appreciated. The lowest valued are fish used primarily for reduction into animal feeds, such as pet foods or fishmeal.

The type of fishing gear used must also take into account the use and value of the individual fish. For example fishing with individual hook and line can be economically viable in the case of the large salmon of high individual value or for subsistence

fisheries by individual fishermen, but would be inappropriate for the capture of fish for bulk processing into meal.

2.5 Economic Considerations

In addition to the technical factors economic considerations are of prime importance. It must be possible, using the method selected, to catch and bring to market sufficient quantities of fish as to provide a viable operation economically. If several techniques appear technically acceptable, the one estimated to provide greatest economic return is the usual choice.

3. Principal Types of Gear

In some cases the gear will be towed by the vessel, in some it will be used to encircle a school of fish, while in others the gear is static, being left in one place for a while and then retrieved together with its catch. Static and some types of active gears may also be used from dry land without the use of a boat. Several methods of fishing utilize gear that can be operated anywhere from the bottom to the surface, i.e., in "mid-water," in other methods, use of the gear is restricted by its design and present techniques of operation to near the surface, or on the bottom. The principle types of gear used in inland waters are set out in Table 1:

STATIC GEAR	Gill nets Long lines Traps Brush parks Fish holes Poisons Lift nets
MOBILE GEAR	Trolling Harpooning Pole and line Cast nets Dip netting Electric fishing
TOWED OR DRAGGED GEAR	Trawling
ENCIRCLING GEAR	Purse seining Beach seine

Table 1. Principle methods of fishing in freshwaters.

In marine fisheries the most important commercially used methods are purse seining, and trawling. Such highly mechanized methods are rare in inland waters where there is a much greater dependence on static gears such as gill nets or barrier traps, and small individually operated active gears such as cast nets.

3.1 Static Gear

The effectiveness of static methods depends on fish moving to the gear. They are therefore particularly appropriate for the capture of species during their seasonal migrations. Such methods are also useful in areas where underwater obstacles obstruct more active methods of fishing or floating mats of vegetation at the surface. Static gears may be purely passive or baiting can enhance their performance.

There are many methods of constructing and working static gear depending on the traditional arrangements evolved to suit particular fisheries. It is possible only to describe some of the more common techniques here. More detailed descriptions are available in Brandt, 1984 for all types of fishery and in Welcomme 1985 for river fisheries

3.1.1 Gillnets

The gillnet is a large wall of netting (see Figure 1) which may be set either just above the bottom when fishing for demersal species, or anywhere from mid-water to the surface when pelagic fish are being sought.

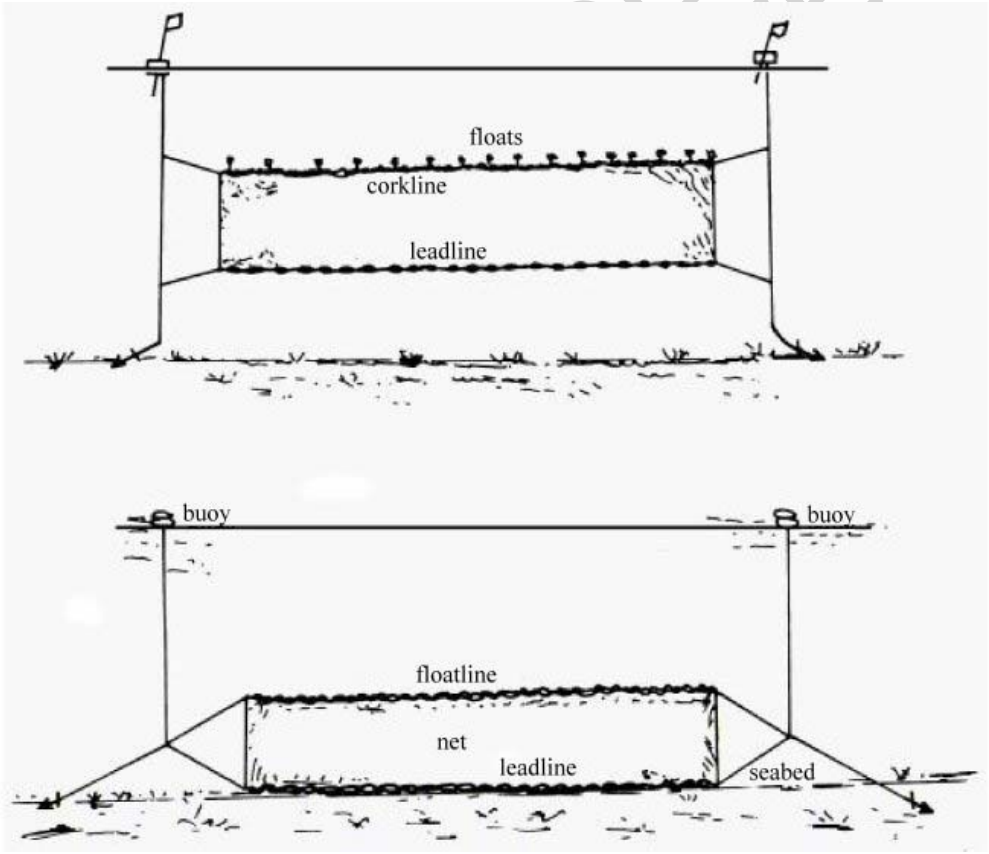

Figure 1. Diagram of a surface-set and bottom set gill nets.

When working inshore in relatively shallow water, the nets are usually set and anchored in position, but an alternative is the drift net, which is free to move according to tide and wind conditions. Drift nets are also used in rivers where they and the mother craft float downstream with the current.

The gillnet may consist of one sheet of twine in which the fish are trapped by their gills as they try to swim through, or several sheets of various mesh sizes in which they become entangled (tangle nets). The rigging of the gear varies widely, but two common arrangements for set gillnets are illustrated in Figure 1.

The top of the net is seized to a float or cork-line and the bottom to a lead line. The combined action of the floats and weights maintains the vertical stretch of the net.

With bottom gillnets, sufficient weight is used to keep the lead line on the bottom, while the buoyancy provided by the floats is sufficient only to maintain the vertical stretch. In the case of a mid-water gillnet on the other hand, sufficient floats are used to overcome the weight of the lead line that is used to maintain the stretch.

Lines from cork-line and lead line at each end of the net are connected to lines running from anchors at the bottom to surface buoys that show the location and extent of the gear and are used in hauling.

Several gillnets, each several hundred feet in length, may be set end to end in "fleets," and rather than being set in a straight line may be placed in hooked or curved formations. Usually, however, this is only possible in waters subject to little, if any current.

3.1.2 Long Lines

Long lining is used to capture demersal or pelagic fish. The gear is rigged to suit the species sought and the area fished; it is of particular importance in harvesting fish of high individual value, but is also widely used by subsistence fisheries.

The basic method involves setting out a long length of line, to which short lengths of line carrying hooks are attached every two to six feet (see Figure2). Lines may also be set bank to bank across river channels.

The line may be un-baited and operate by snagging or foul hooking but more commonly is baited. The line is inspected periodically, captured fish removed, the hooks re-baited, and the line reset.

Typical arrangements for bottom long lining, and sub-surface or pelagic long lining are shown in Figure 4. There are wide variations in the dimensions, rigging and operation of the gear depending on the area, species and local tradition, so that it is possible only to describe common arrangements and techniques.

3.1.3 The Mid-water Long Line

With this arrangement, the long line is maintained at its desired depth below the surface by regularly spaced lines running up to surface buoys. These mark the set and are of assistance in the hauling operation.

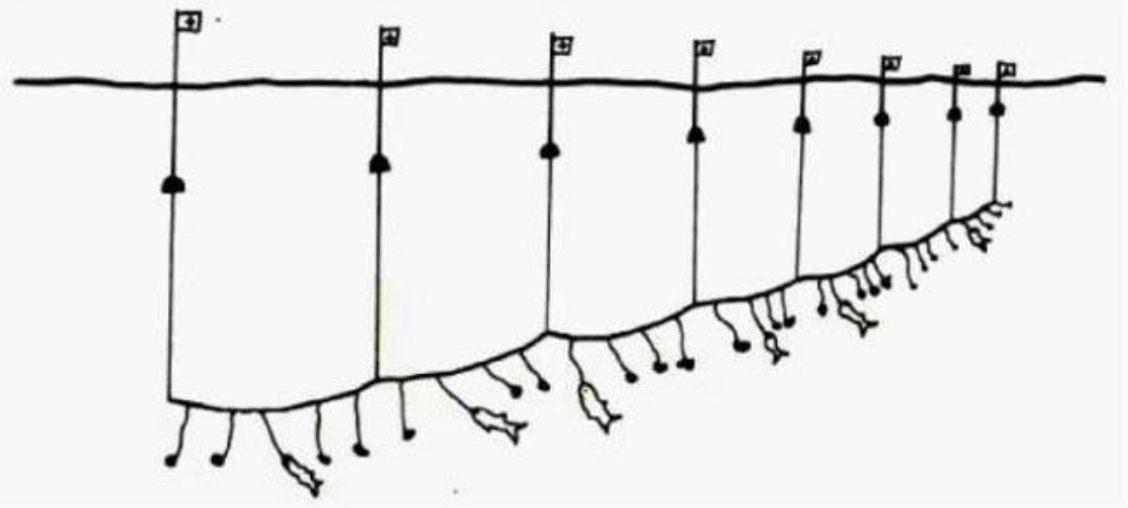

Figure 2. Configuration of bottom set long line.

3.1.4 The Bottom Long Line

The long line, with its baited hooks, lies on or near the bottom and is maintained in position by anchors at each end. The anchors may be buoyed at the surface and have markers to show the location of the set although they are often concealed to avoid retrieval by other fishermen. Alternatively, in rivers, the line may be set bank to bank and fastened to trees or specially located stakes. The lengths of line carrying the baited hooks may be spliced into the main setline at their required intervals. Alternatively, the baited lengths of line (gang lines or ganging/s) may be attached to the setline by snap-on connectors at stoppers.

The line and hooks vary in size depending on the species being sought; the main set line may be rope or wire, and the ganging may vary from light rope to chain.

-
-
-

Bibliography

Brandt A., von (1984). *Fish Catching Methods Of The World.* 3rd edition, 418 pp. Blackwell's, Oxford, Surrey, Fishing News Books. (Compendium of fish catching methods of the world).
Welcomme R. L. (1970). *Les Moyens De Peche Dans Les Eaux Continentales Du Dahomey, Etudes Dahomeyéennes*, **17**, pps. 5–35. [Compendium of fish catching methods of Benin in West Africa.]
Welcomme, R. L. (1985). *River Fisheries. FAO Fisheries Technical Paper* **262**, 330pp. [Basic textbook on fisheries ecology of rivers.]

Welcomme R. L. (In press). *Evaluation Of Tropical Brush And Vegetation Park Fisheries Fisheries Management and Ecology.* [Reviews the performance and management of brush park fisheries.]

Biographical Sketch

Robin Leon Welcomme was born in London England in 1938. He was educated at Birkbeck College, University of London and later obtained a PhD at Makerere College, University of East Africa for a thesis on the effects of climatic change on the biology and ecology of certain fishes of the Lake Victoria basin. He began his scientific career in 1963 as a Scientific Officer at the East African Freshwater Fisheries Research Organization, Jinja (Uganda) and was later employed as Fisheries Biologist in Benin, West Africa. Until 1971 He then took up employment as a Fishery Resources Officer in FAO, Rome (Italy). He was promoted steadily to achieve the rank of Chief, Inland Fishery Resources and Aquaculture Service, and became Secretary of the European Inland Fisheries Advisory Commission as well as Technical Secretary to other regional fishery bodies until his retirement from the Organization in 1997. Dr. Welcomme is now a Senior Research Fellow, Renewable Resources Assessment Group, T. H. Huxley School of Environment, Earth Sciences and Engineering, Imperial College, London where he continues his work on inland fisheries management, on river fisheries and inland water biodiversity. In his career Dr. Welcomme has published Approximately 110 scientific works including 4 books. He has traveled to and worked in over 70 different countries both advising member governments and local institutions on conservation and sustainable development of fisheries resources in rivers, lakes, and associated wetlands. He has also organized numerous meetings of commissions, working parties and technical networks particularly in Europe, Africa, and Latin America.