FISHING GEARS AND FISHING METHODS

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ABSTRACT

Critical issues on fishing gear and fishing method of the world are re-appraised with particular reference to the Nigerian fishing industry. The adaptability, selectivity and seasonality of both passive and active fishing gears to aquatic environment, fish species and time of the year are re-examined. Furthermore, new innovations (mechanization) to improve the efficiency of gears and thus the fishery are addressed in the light of rapid socioeconomic changes within the fishery industry. Included along with miscellaneous fish viewing and fishing methods are eleven illustrative figures on fishing gear technology and fishing methods.

INTRODUCTION

Fishery management requires a good knowledge of fishing gear. There is great divergence in the efficiency of different forms of fishing gear, in their adaptability to certain conditions, and in their desirability for specific job.

Traditional fishing arts have been developed over the years to adapt to local body conditions; the species of fish desired and targeted size. The most successful fishing methods of an area or a region are those that have stood the test of time.

This paper will describe some of the traditional fishing gear and fishing methods employed around the world. Their advantage as well as disadvantages shall be given adequate consideration. From experience with fishing gear and literatures on the subject, there has been a continuum in development of fishing gears, with evolution resulting from modernization factors. The adaptation of new technologies could help small scale fisheries increase their catch, but the introduction of any new fishing technology always demands good rational management and regulation. Vessels must also march with new fishing methods and gear. As gears become more complex, it may require updating of vessels in size, power and design.

CLASSIFICATION OF FISHING GEAR AND FISHING METHODS

Passive Gears

Passive gears are stationary gears. It does not have to be dragged, pulled or towed to capture fish. Hook and lines, traps, wires, gill nets among others affectively fish by themselves. The catch is recovered by simply removing the gear from the water after a time period. No energy is expended on towing, pulling or dragging of gear.

Hooks and lines: This is the simplest gear employed for fishing. The requirements are line and baited hook. Hooks vary enormously in shape, size, type of point, thickness of wire and type of end of the shank (Fig. 1a). The line is cast into the water where the fish supposedly are; the fish swallows the bait and is hauled in. In Nigeria, the line is wound around a stone and thrown from the bank/shore into the water (Read *et al.,* 1967). The stone acts as a sinker. Hooks and lines fishing is inexpensive and easy. The catch is often alive and of high quality. The type of fish capture depends on the size of hook and the type of bait. A wide variety of sizes and type of hooks and lures (bait) can be used, allowing vary selective fishing. In spite of these merits, line fishing is labour intensive. A vary

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limited number of fish can be captured per line. Furthermore, the fish may select against the lure/bait provided.

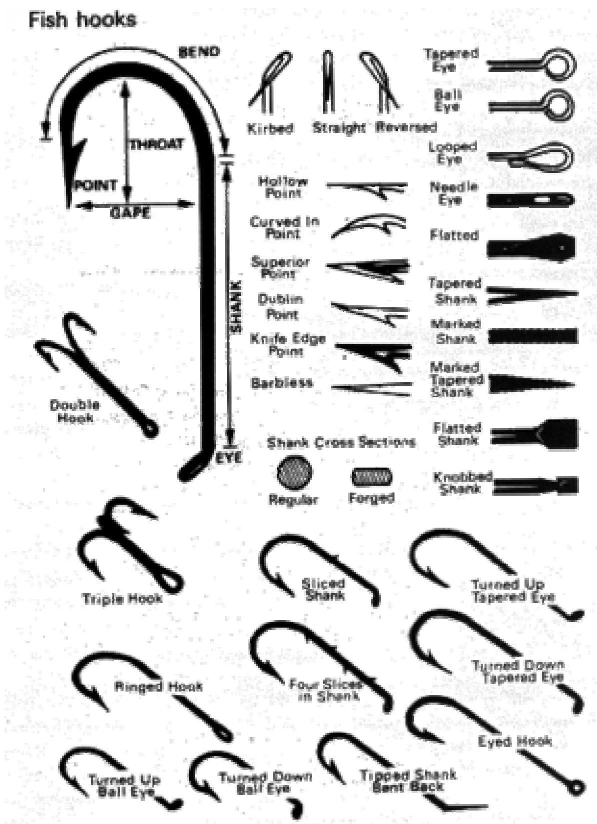

Fig. 1a: Hook types employed in hook gear fisheries (Cole and Rogers, 1985)

Set lines: The use of set lines increases the number of lines deployed without requiring the constant presence of the fisher. Fishing role can be contended in shallow waters or on the beach. In the ocean, set lines may be suspended from the surface; such lines must be checked regularly because predators may devour the fish caught if the lines are not promptly recovered.

Long lines: are adaptations of the older hook and line in which the main line or ground line is horizontal and carries many short vertical gangling each with a baited hook. In laying the line, one end is anchored to the river or ocean lake bottom and its position marked by a buoy. The liner sails along a straight course running out the full length of the line along the bottom, and the other and is marked by a second buoy. As the line is laid the hooks are baited. A long line may be nearly a mile in length. Each line is often left on the river, lake or sea bottom for few hours before hauling (Fig. 1b). As the line is brought aboard, the fish are removed from the hooks and the line carefully coiled for use again. Apart from bottom fishing, they can be used at the surface, suspended in the water column (Fig. 1c) or fixed near the bottom. Japanese and Italian fishers use surface long line to capture tuna, shark and bill fish (Ben-Yami, 1980). Subsurface and bottom-set long lines are used to capture cod, grouper, snapper drum bream, halibut, haddock, hake and flatfish. An alternative to bottom-set long lines is vertical fish stick. This device is hung from a surface float just off the bottom. It has rigid branch to allow multiple hooks without snagging (Fig. 1d). Fishers can use local materials to fabricate this gear.

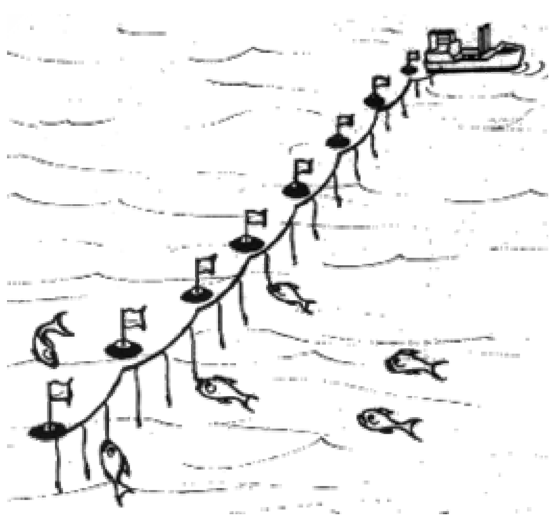

Fig. 1 b: Long line of baited hooks (BOSTID, 1988)

Long line fishing methods offer a number of advantages. They involve low capital and energy investments and labour-intensive operations. Species and size can be selected by the position of the hook in the water column, the hook size and the bait type and size. Long line fishing is often practiced by canoe fishers.

Long line fishery, although advantageous in terms of catch, the technique is often laborious because usually each hook has to be individually baited, and captured fish recovered from the hook. The un-baited snagging and entangling long line; mari-mari (Fig. 1e) are laid in the deeper portion of channels where big fish are accustomed to rest (Welcomme, 1985). Furthermore, it may be difficult to store long lines and their catch on a small vessel. If the line becomes caught or entangled on the sea-bad, its

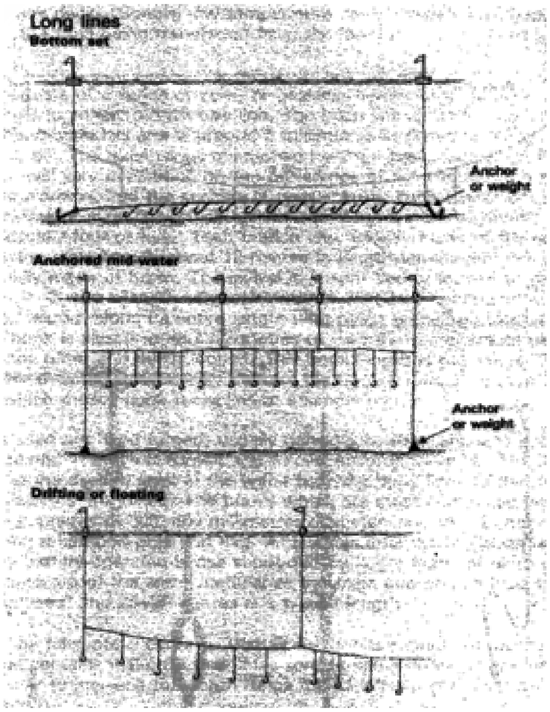

Fig 1c: Various ways of deployment of long line (Cole and Rogers, 1985)

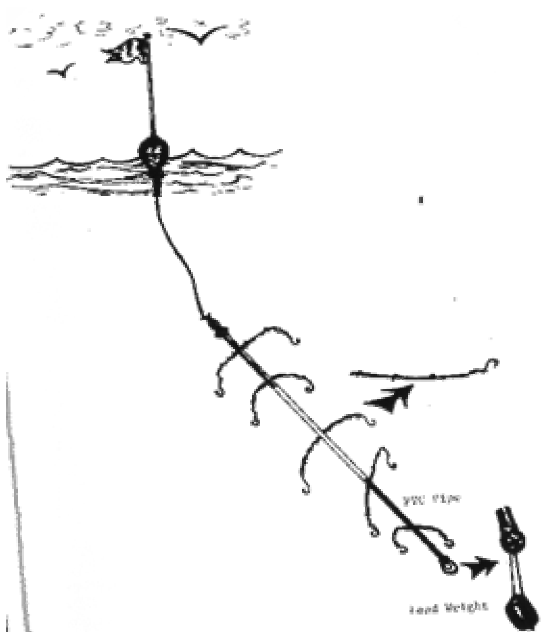

Fig. 1d: Vertical fish stick (BOSTID, 1988)

recovery may take many hours; or the line and its catch may be lost, unless expensive mechanized equipment is employed. Modernization in long line fishery generally involves mechanization of hauling. If available, hydraulic or electrical devices offer better control, lower maintenance, and variable power. Simple mechanical hauling techniques can increase the range and depth of long line fishing. Manually operated reels can be constructed of local materials and used to reduce the effort needed to handle gear. A vehicle wheel (from a bicycle or automobile) can be fitted with handle and mounted on the boat to create a simple roller, which facilitates handling lines.

Maze Gear

Consist of equipment for leading fish into a situation or enclosure from which they cannot escape or from which the avenue of escape is not readily apparent. Maze gear includes many varieties of fishing pots, fyke nets, trap, pound nets and tidal weirs among other modifications.

Pot gear and traps: are portable traps that fish enter, usually through a small opening, and with or without enticement by bait. Pots are most effective in capturing slow-moving creatures that exist for the most part about, or just above the river, lake or sea bottom. The pot gears are usually small enough so that a large number can be piled on the deck of a small boat, and light enough so that they can be readily hauled aboard. Pot gears are either half round, rectangular, cylindrical, conical, etc and are made of different materials such as chicken wire gauze, strips of raffia palm, broom sticks, bamboo, cane sticks among others (Reed *et al*., 1967, Ectcheri and Lebo, 1982 and Welcomme, 1985). Traps often have one or two chambers with funnel-shaped non returnable valves. Apart from the presence of chambers and funnel, there is a door for that recovery of captured species (Fig. 2). The operation demands the weighing down of the trap with few bricks, concrete, flat stone (sinkers) and buoy line is attached to a corner at the chamber end. Baits are kept on a hook or in a mesh bag attached to the centre so that it hangs in the chamber. In Anambra and Cross river systems conical traps are often baited with palm fruits, dead toads, meat scrapes, cassava etc to lure in the fish. The buoy line has a small float attached about 2 meters from the pot to keep the line from becoming cut or entangled on the rocky bottom. The surface end of the line is attached to a small buoy. The disadvantages of pot gears are; handling is difficult and manual hauling is arduous. A major disadvantage of this technique is the high loss of pot gear due to theft, storm damage,

Fig. 1e: Mari-mari [foul-hook long line] (Reed *et al.,* 1969)

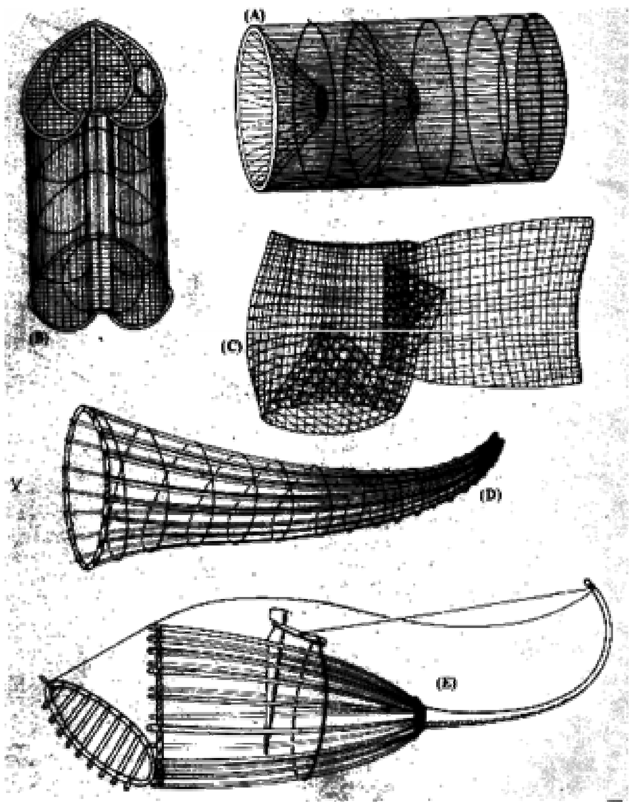

Fig. 2: fish traps from tropical rivers. [a] cylindrical drum trap - worldwide, [b] vertical slit trap – Asia, [c] folded woven trap –Niger river, [d] funnel trap worldwide and [e] spring trap – Niger river (Welcomme, 1985)

degradation of materials and the inability to locate the gear once it is deployed without the buoy line. A lost trap may continue to operate (ghost fishing) thus depleting the fish resources.

Electrical, mechanical, and hydraulic hauling techniques are also modernization that may be employed.

The use of mangrove roots, branches and submerged vegetation to cover trap provides attractive shade and shelter for some fish species. The '"curiosity trap" used throughout the Caribbean, has curved surfaces which seem to attract snapper, grouper, and other bottom dwelling fish species. Variation in material and design of fishing pot gear and traps exist throughout the world. In Niger, Anambra and Cross River basins, conical traps are made with broom sticks, slashes of raffia palm and cane sticks among others (*Reed et al.,* 1967). Caribbean Island fish traps in-corporate exterior funnels leading into a cone shaped interior funnel that is often turned to prevent escape. In Hawaii a trash can is used to catch deepwater shrimp. The bottom is cut out of a 10-gallon trash can and is replaced by a ¾ inch nylon fish net funnel, which serves as the entry. A part of the lid is also cut out and replaced with ½ inch wire mesh (BOSTID, 1988). Earthenware pots with handles (Italy, Malta) or without handles (Japan, Korea) are employed as fishing traps for octopus. Sections of PVC tubes are used by the Japanese as octopus pots. An equally effective pot can be made from old tires. The tires are cut in the rims and the rims laced together with wire, and a circular wooden disk nailed to one end. Tire pot gears are extensively used in Venezuela (BOSTID, 1988).

Metal traps are employed in the USA. Corrosion is always a serious problem with metal traps. One solution is to use marine mesh, which combines the strength of steel wire with the durability of plastic. Such traps are often very bulky and expensive (AGFSC, 1986).

Weirs, trap net and fyke nets: Fyke nets are essentially shallow-water gear for they are difficult to set effectively in deep waters. The Fyke nets are used extensively in river and shallow coastal water fishery. Weirs and Trap Net (Fyke) are best adapted for use in fair current conditions sometimes used without any wings or leaders (Von Brandt, 1984).

The simplest form of fyke is merely a long net bag with a rectangular opening, such side lashed to a stake. If there is a current flowing into the opening, such a net may take a number of

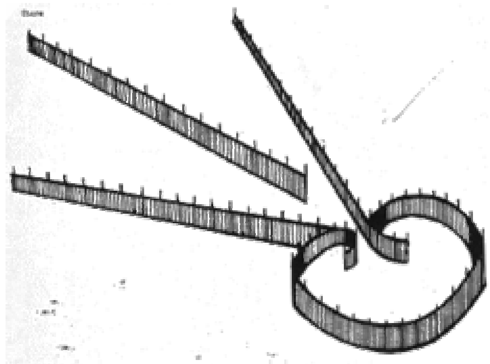

Fig. 3a: Bamboo stake trap set facing the shore. Wings of the trap guide fish to the centre where they are netted (BOSTID, 1988)

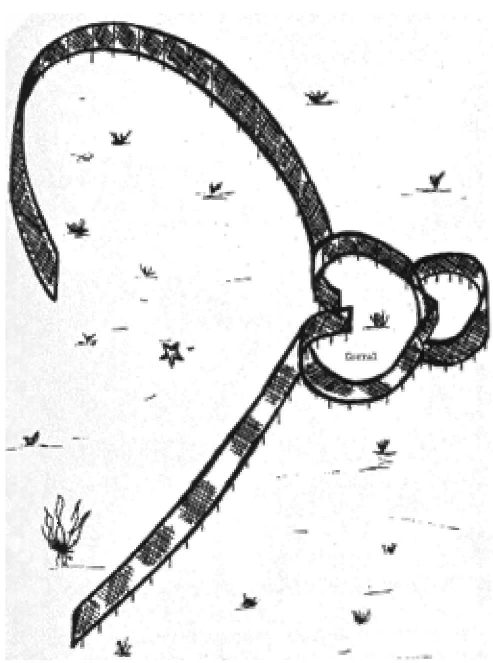

Fig. 3b: Fyke trap with netted coral (BOSTID, 1988)

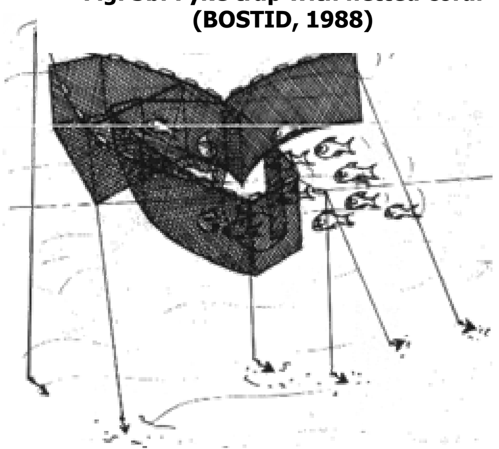

Fig. 3c: Floating fyke net trap (BOSTID, 1988)

different species. The fyke usually has short, vertical, net wings set obliquely on either side of the mouth of the bag. As fish, moving with the current strikes these wings; they are deflected toward the mouth of the net. In swift currents the wings or leaders are short and the bag very long so as not to offer too much resistance to the water current (Fig. 3a). However, fykes are also used in many shore fisheries, especially for taking flounders and bottom fishes. In such situations, very long wings can be used since the currents are fairly slow. The wings are often heavily leaded on the bottom and have cork or glass floats on top. Instead of stakes the net is set with anchors. Fyke nets have a number of advantages that favour their use in developing countries. They may be constructed of local materials and little or no energy is used in fishing. Where seasonal runs occur the catches can be enormous. Indeed, these traps are the only means to intercept large schools without a costly investment in vessels. The fish are alive at capture and therefore in excellent condition. During installation, a great deal of labour is required. These traps are limited to physically suitable areas and to local and seasonal fish behaviour. Furthermore, the traps often show tremendous diversity in design. In Southeast Asia, large bamboo weirs are used. The bamboo stake traps consist of long fences of split bamboo fastened at intervals to large wooden poles driven into the sea bottom. Long wings guide the fish into the heart-shaped center of the trap where they are harvested with net. It is usually set with the open end toward the shore line thus very effective for catching fishes migrating along the shore line (BOSTID, 1988). In the Caribbean, a simple fyke net is used in shallow shelf area. The length of the wings depends upon the characteristics of the region, but generally the maximum depth is about 4 meters. One of the nylon mesh wings runs from the shores to the corral (heart, chamber) opening to intercept the migration path of the fish. The other wing is semicircular, to prevent their escape and direct them into the corral. From the corral, a narrow opening leads into the smaller holding pool or crib with a net floor to make fish recovery easier (Fig. 3b).

In Japan, a floating fyke net trap is employed. A floating net cage is anchored over the shallow shelf. One wing extends up to hundreds meters to the coast and the other to the deeper waters. Schools of fish are again directed by the wings into the cage. Depending on its placement their floating trap catches demersal as well as pelagic fish species (Fig. 3c).

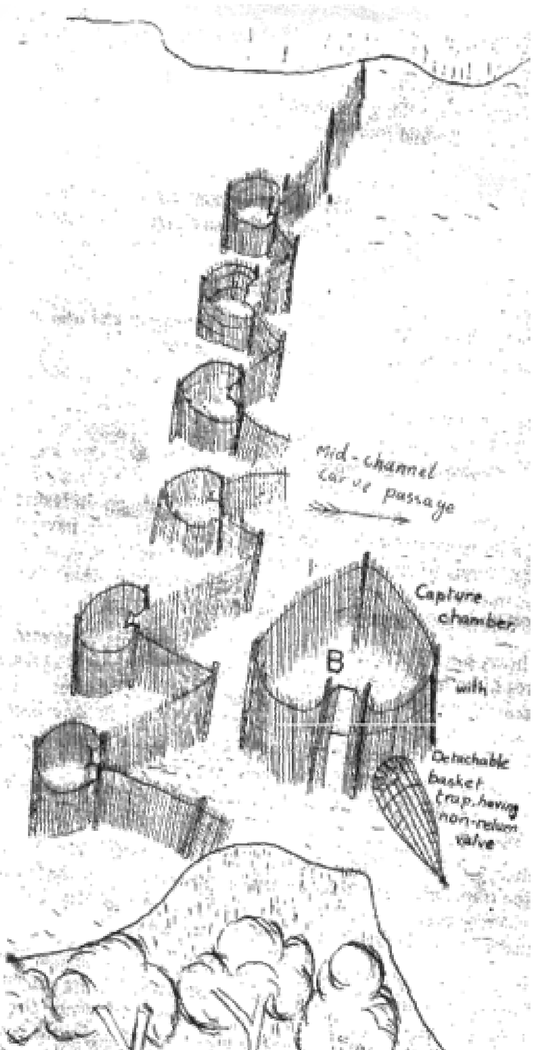

Fig. 3d: Cross river fish fence (Reed *et al.,* 1969)

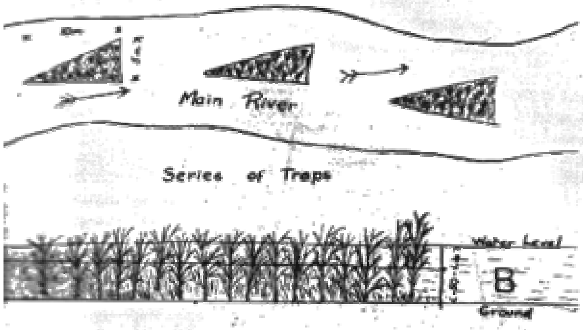

Fig. 4: Fish shelter, B is the side view (Reed *et al.,* 1969)

Fish fence: Fish fence are made up of sticks tired together by traditional fibers. Often traditional mats are employed in fish fencing. In Cross river, the fence usually stretches the main channel leaving space of few meters width in the centre to allow canoes and river boats passage. The catching chambers always point down stream, so they could theoretically catch almost all fish which move upstream. Often attached to catching chamber are detachable large conical traps with non returning valves (Fig. 3d).

The fisher detaches these traps to collect his catches. Fish fencing within the Cross River basin is seasonal and often used for few months of the year when the current is very slack and the water shallow. They are usually erected in March each year and dismantled in May. The most common fishes captured by this gear are: *Labeo, Citharinus, Distichodus* and Catfishes. When the water begins to rise in mid May, the fish fence give the best results but about a week or two later, the currents becomes so strong that the traps are either dismantled or abandoned.

Fish shelters: Fish shelters are made up of triangular plot of branches staked firmly in the river bed and with the apex of the triangle downstream. Each fish shelter may be about 10 meters long and 4 meters across the base (Fig. 4). These shelters attract small fish, which in turn entices large predators. Prior to the raiding of the fish shelter for fish, scraps of food, mostly kitchen waste, are placed amongst the branches. A day preceding the raid, fish fence is set around the fish shelter, thus encircling the fish. Fishers than wade inside, remove the branches; reduce the area of the enclosed space by gradually shifting the fence until the fish become penned in a small space where they are captured with clap nets. The fish shelter is later rebuilt. In Nigeria, the chief operators of fish shelters are the Ijaws, Aimu, Nupe and Ibo fishers (Reed *et al.*, 1967).

Entangling Nets

Entangling nets are not walls, placed transversely to the path of migrating fish. The bottom of the net is weighted with sinkers while the top is supported by floats. A single-walled net (gill net) is used to gill fish, while a triple walled net (trammel net) entangles them (von Brandt, 1984).

Gill nets: A gill net is an upright wall of fiber netting. In the gill net, the fish becomes caught by the mesh of the net in trying to swim through. Usually if the mash is the correct size for the size of fish sought, the fish is able to get its head through a mesh but its body is too large, and when the fish attempts to free itself, the twine slips under the gill cover, preventing escape (Stewart, 1982).

Many fish will be caught around the middle of the body and some may be caught by the twine entangling the maxillary bone of the jaw or the teeth. Gill nets vary in size of mesh in accordance with the size of individual or species sought. The twine also varies in size and strength, although in general, the larger-sized mesh is made of heavier nylon twine. The ordinary gill net consists of a single wall of web kept vertical in the water with sinkers and floats (Fig. 5a). The webbing is hung to a cork line at the top, and a lead line at the bottom. A loosely hung net is more efficient.

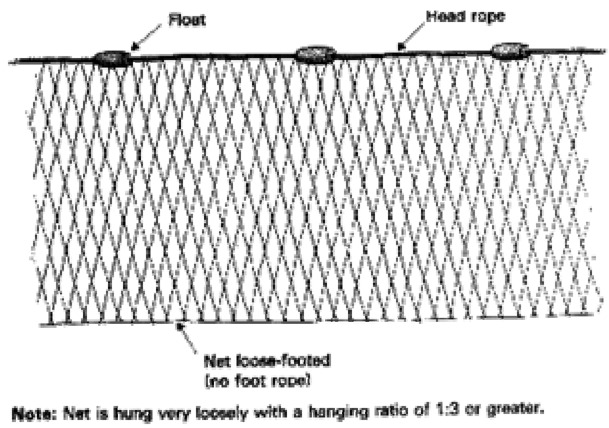

Fig. 5a: A single-walled net (gill net) (Cole and Rogers, 1985)

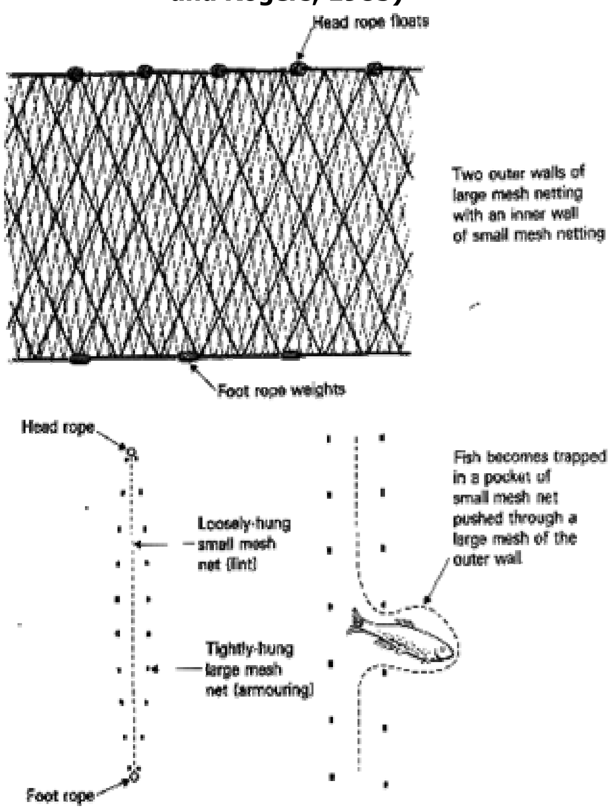

Fig. 5b: A triple-walled net (trammel net) (Cole and Rogers, 1985)

Set gill nets: These are stationary gill nets fixed in position at strategic places where fish may be suspected to pass through. The nets are usually held in position by anchors or stakes. These nets are effective for mid water and demersal fish. Visuality of gill nets by fishes during the day makes them less effective thus are usually fished at night (von Brandt, 1984). In some rivers, the turbidity of the water often renders them effective in daylight. Likewise in waters with many phosphorescent organisms, gill nets sometimes may not fish effectively when it is dark but may take fish in twilight. Most of the night catches are often dead, some rotten or even eaten by predators before the nets are hauled in the morning. Set gill nets are the most effective gear that can be fished throughout the year for most type of species. The amount of catch by set gill net is a factor of the length, width and mesh size of the net. In the lower Niger basin, set nets are of various lengths (21.8 – 45 meters), width (1.82 – 3.2 meters) and mesh size (5 – 10 centimeters) are common. In Anambra river, set gill nets with more 6.9 – 7.6 cm mesh size seemed to have recorded more catch than other mesh sizes.

Trammel nets: Trammel nets have three panels of netting suspended from a common row of floats and attached to a single bottom line (Fig. 5b). The two outside walls of netting have mesh larger than the targeted fish and the interior netting has a smaller mesh size. The inside net hangs loosely between the two outer nets. A fish striking from either side passes through the large mesh outer panel, strikes large mesh panel, forming a sac or pocket in which the fish is trapped (BOSTID, 1988). A trammel net is often fished by drifting. The nets may be used at the surface, mid-water, or at the bottom. A fisher may choose to anchor his net or allow it to drift. In intertidal areas, the nets may be driven into the bottom and the fish collected at low tide. Taiwanese fishers ties scare ropes around their bodies and swim as a group toward a fixed net. Fish in the swimmers path are frightened into the net (Cole and Rogers, 1985).

To be most effective, a net should be invisible to the fish. In the past, cotton nets were dyed different colours to match the background of the aquatic environment. Nowadays, transparent monofilament nets are mainly used for entangling nets, though more visible but softer continuous filament nylon nets are still popular in some fisheries. Monofilament fibers are less elastic and stiffer than continuous multifilament nylon fibers. Thus, although the former are more efficient in catching the fish, the later holds them better. The great advantage of entangling nets is their selectivity. The way the net is hung and its depth determine the species of fish captured. The shape and size of the mesh also select fish species of a specific size, fish whose girth is smaller than that of the mesh opening are able to swim through. Even a lone fisher can manually deploy a gill net or a trammel net from a small craft. Floats are sinkers can be made from local materials such as bamboo, bottles, cement, or stones, although manufactured equipment might be more efficient (BOSTID, 1988).

Entangling nets cost more than hooks or traps. They required a high degree of maintenance, and picking the fish out of the net is labour intensive. Since the fish are usually dead when harvested they are of lower quality.

Ghost fishing with nets made of synthetic fibers is a problem. If lost, the nets continue to trap fish, because the fibers are not biodegradable. To avoid this, the twine (gangling) holding the main netting to the floats should be made of natural fibers (cotton) which will degrade as soon as the net is lost.

Lift nets (Atalla): Lift nets are lifted from water at the moment when the sought-after fish have gathered over them. These nets can be installed on canoe (Fig. 5c) or on the shore of the rivers, lakes, lagoons and estuaries. Atalla fishing for fingerlings is common among the Ijaw, Aimu, Igbirra, Igala, Ibo and Urhobo fishers. The construction and size of the lift nets vary. Essentially, it consists of a square bamboo frame-work on which is mounted small mesh-sized netting material. The frame has a device that enables it to be hinged onto the canoe side. On the opposite corners of the squared frame are ropes used for having the net out of water. The atalla is lowered from the side of canoe into the water for sometime before raising it perpendicularly for the fish to fall into the canoe.

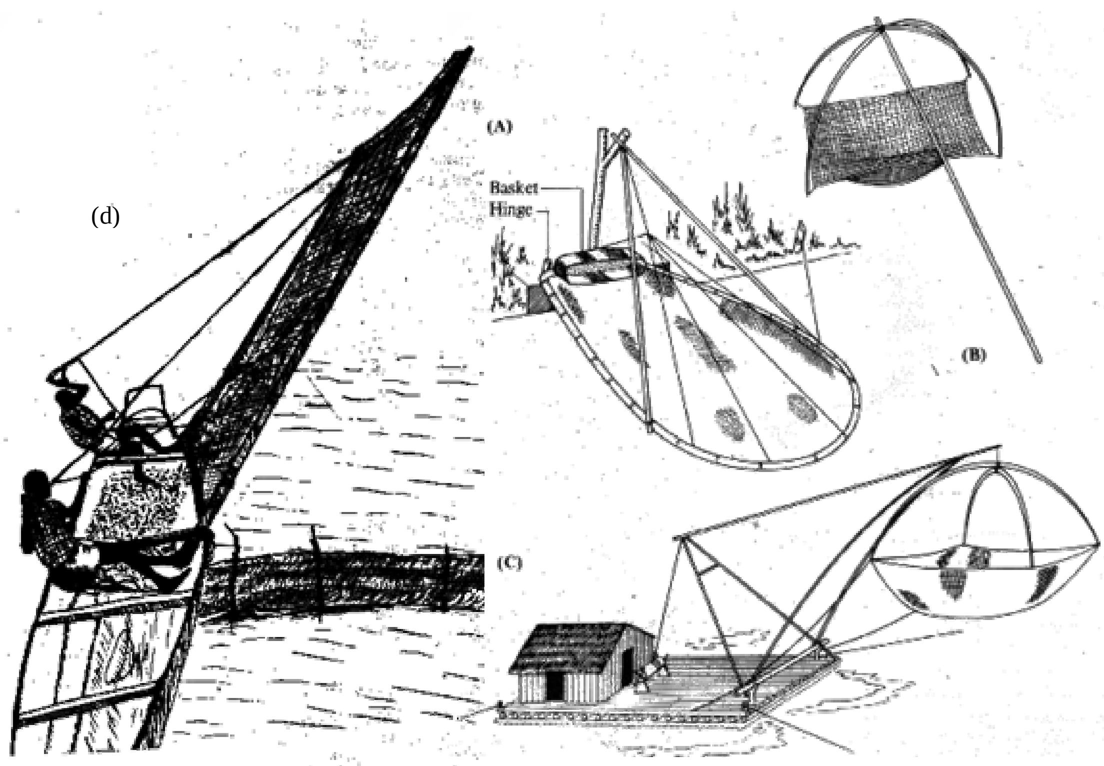

Fig. 5c: different types of lift net (atalla). [a] bank mounted lift net – Niger river, [b] hand held lift net – Bangladesh, [c] raft mounted lift net – Mekong and [d] canoe mounted lift net – Anambra river (Reed *et al.,* 1969; Welcomme, 1985)

The significant thing about the gear is that very small mesh size nets (less than 10 mm) are generally used (Awachie and Walson, 1978). As a result of the small mesh-sized netting, the atalla catches large quantities of fries, fingerlings and young fish of different species, a situation which evokes the emotion of people that the atalla may cause some damage to the fisheries with no regards to it use in collecting fingerlings of desired species for stocking of ponds. Seasonality has been reported for atalla. It operates best between 6 am to 3 pm and between late October to early January at Lokoja (Reed *et al.,* 1967). Operation of atalla is tedious, lifting power may be provided by pulleys or weighted levers.

In South India, lift nets are operated off the beaches and lifted with counter weights. At night, lamps are hung from the crossbars to attract fish. In the Caspian Sea, Soviet fishers use small circular lift nets equipped with underwater electric lamps to catch anchovy. A large variation of lift net is called a blanket net. Operated from the ship’s side, it can almost be as wide as the vessel’s length. Four-boat lift nets are common in Scandinavian and South East Asian fisheries (BOSTID, 1988). In lake Tanganyika, lift nets are suspended from hauling ropes at the four ends of a catamaran. The net is shaped like an inverted pyramid and has a stretched depth of 12 m. Kerosene lamps are used to attract fish over the net opening that is suspended between the two hulls. Lift nets can be cost and labour effective when set under specific conditions or when attracting fish with light. The catch is alive and, therefore, of good quality.

This fishing technique, especially in combination with light attraction, could be used in many areas either for consumable fish and fingerlings for stocking of ponds or baiting of hooks.

Active Gears

Active gears has to be moved, dragged, or towed in order to capture fish. They usually require engine-propelled boats and usually involve additional investment over passive or stationary gears.

Trolling: Trolling lines are simple hooked that are trailed from a moving vessel at a controlled depth (Fig. 6a). Bait may be artificial or natural and attracts predator fish that see what appears to be a smaller fish thrashing and turning in the water. In India, the lure may be nothing more than a colourful piece of cloth, a small bunch of feathers, or a piece of skin from the baitfish. The trolling line must be carefully adapted to local conditions and fish species and size. The use of outriggers can increase the number of lines that can be trolled and help keep them from becoming entangled (von Brandt, 1984).

Trolling offers numerous advantages to small-scale fisheries. Multiple trolling can be performed from a reasonably small canoe (Fig. 6b). Changing sinker weight allows fishing at graduated depths. Bait can be made of local materials and easily changed for the targeted species. The use of artificial bait avoids the capture or purchase of live bait.

Trolling is also an excellent auxiliary fishing method that can be used as the vessel is going to or returning from other fishing grounds. Eligible areas include inshore or offshore waters and target species may be pelagic or demersal. The introduction of trolling does not require high skills or a large investment in gear. Little labour is necessary in this fishing art.

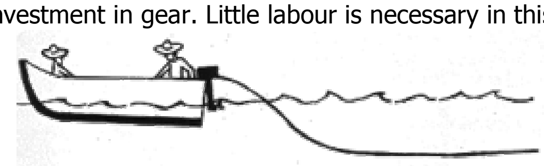

Fig. 6a: Single line trolling (BOSTID, 1988)

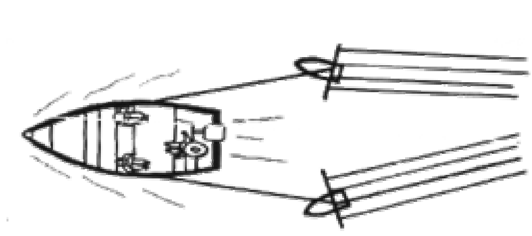

Fig. 6b: Multiple lines trolling (BOSTID, 1988)

A number of innovations can make trolling more efficient and save labour. Simple hand and electric reels can make work easier and allow more fish to be caught at a given time.

Large and small umbrella rigs permit the fishers to have several hooks on a trolling line. For many species umbrella rigs are more attractive than conventional lures, perhaps because multiple lures create the illusion of a school fish. The number of lines a vessel can troll can be increased by towing two smaller boats to spread the lines over a large area (BOSTID, 1988).

Depressors are used by Japanese fishers for mid-water trolling. These are flat, small boards weighted with lead at the front edge. The depressor itself is towed by a line attached near its front edge. Besides submerging the line, the board also wobbles, so that the hook jumps or jigs. When a fish takes the hook, the board tilts and rises to the surface.

Another trolling variation, the fish kite, is popular in Micronesia, Melanesia, and Indonesia. The kite is flown up to 100 m behind the boat, and it tail line carries a ball of cotton or a piece of shark skin continuously bobs on the surface of the water and induces garfish to snap at it.

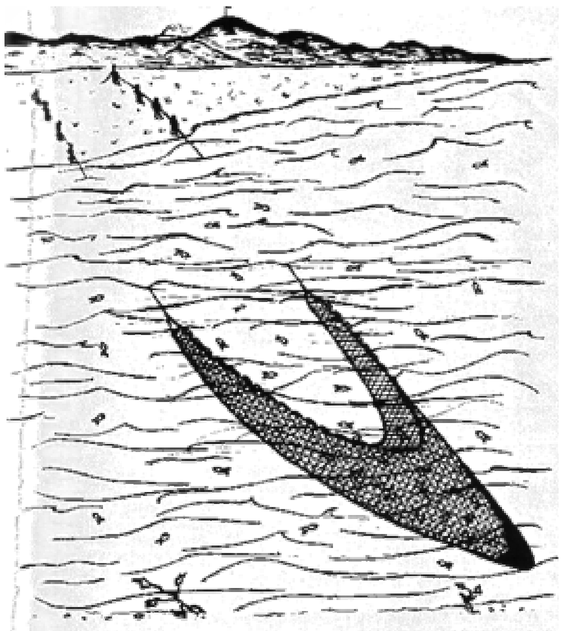

Fig. 7a: Beach Seines operated from the shore (BOSTID, 1988)

Fig. 7b: Beach Seines operated from a boat (BOSTID, 1988)

Seining: Seines are long nets with meshes small enough to prevent the desired fish from gilling. They are generally set in a semicircle and dragged over a smooth bottom by means of long ropes (Sweeps). In this way, the fish are herded into the net and hauled onto the beach or on board. (Andreav, 1962).

Beach Seines: Beach seines are especially appropriate for catching seasonal pelagic species as they feed near the shore. They are most often set from the boat. One fisher remains on shore with one end of the net, while the rest of the net is set in a curved path and brought back to the beach. Once the second drag line is delivered to the sore (beach), the hauling begins (Fig. 7a). The bottom and water surface act as natural barriers for the fish encircled in the net. The wings may often be hundred of meters long. Large beach seines, however, are costly, and their use is restricted to large stretches of smooth, shallow bottoms with fairly mild surf. The net is species-indiscriminate and may catch juveniles of large sized fish. Small two-man beach seines are often used for catching live baits and small pelagic fish (Fig. 7b). Beach seines have the potential for increase motorization and mechanization. Shore-anchored pulleys, tractors, jeeps or even animal traction could be used to make hauling easy. In Nigeria, large beach seine net are frequently used in the rivers and swamps during the dry season, chiefly by Nupe fishers who name them *esako*, meaning large (Reed *et al*., 1967).

Boat Seines: Boat seines are set and hauled from a boat. One end of the seine is anchored and the fisher sails in a circle, releasing the net, and returns to the anchor. The net is then hauled into the boat (Fig. 7c).

With small seines, this fishing technique can be used by small vessels without mechanization almost anywhere there is a smooth bottom. The high skill involved in net design and the cost of it construction are liabilities.

Boat seines have the potential of bringing small-scale fisher to previously unexploited resources. However, the introduction of modern technologies (such as motorization of boats, rope and net haulers, storage of nets and cables on reels among others) would enlarge the area covered and increase the catch, but involves capital investment and an increase in running costs.

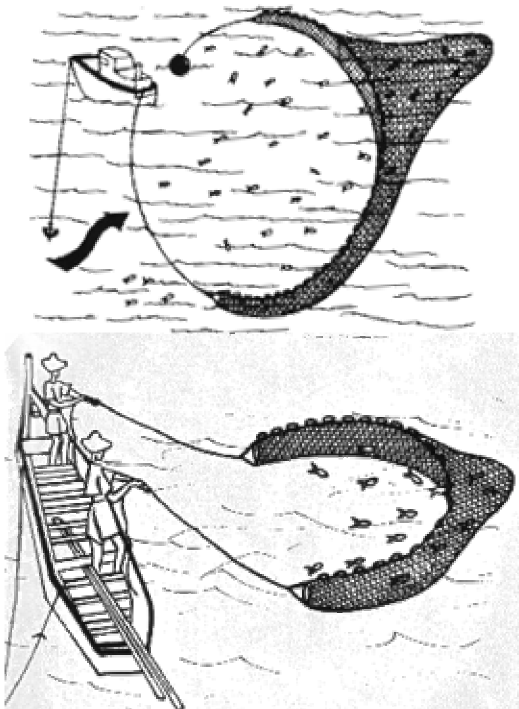

Fig 7c: Boat seine nets [i] large, use by anchoring one end of the seine [ii] small, operated from the boat by two fishers (BOSTID, 1988)

Purse Seines and Ring Nets: Purse seines are characterized by a line at the bottom of the net that is used to close off the escape route (Fig. 7d). The purse seine set with one or two boats are called ring nets. Light may also be used to attract the target species. Purse seines are highly mobile and can capture whole or large school of pelagic species that gill nets and beach seines could not. Commercial models of this gear are very effective in fishing for clupeids, salmon, tuna and other marine fishes (BOSTID, 1988). A fine-meshed purse seine has been used to capture young sockeyes at lakes of British Columbia. Many other freshwater surface pelagic fishes can be taken in this manner, as practiced, for example in lake Kariba on the Zambezi river and elsewhere in Africa and southeast Asia. In California, a sardine purse seine may be 500 meters long, 62 meters deep at the bag end, with wings 70 meters deep next to the bag and 48 meters deep at the free end. Hauling can be manually or mechanically, and the catches are usually alive.

Nevertheless, purse seines are costly and required highly skilled operators. Purse seining with boats (ring netting) enables small, artisanal fishing craft to take advantage of this flourishing method.

Jigging: The jiggle technique involves mainly catching fish by impaling them with special hooks. In jigging, the line must be jerked to pierce the fish. Generally, the sharp hooks are weighted so that when they are pulled up; there will be enough momentum to penetrate the fish skin (BOSTID, 1988). In some cases, regular weighted hooks are jigged manually or mechanically to attract fish attention to the bait. Special reels can be used to impart a jiggling action to the line. Puppers or jigs are especially used to catch slow-moving fish in their spawning site. Jigs are also widely used throughout marine fisheries. The Norwegian Jukes-line catches cod by jigging. Special hooks are used in east Asia and the Mediterranean to jig squid. The potential exist for significant expansion of fish jigging by light attraction.

Jigging is a low-cost, low–energy technique that does not require baits. The live catches are brought into the boat. At the same time, it is labour intensive and time consuming, unless relatively expensive jigging machines are employed. Jigging requires knowledge of the local area to determine where and when it can be used.

Clap nets: Twin clap nets are probably the most common and widely use fishing gear among the Hausa's fishers. They vary in size, the ones being used by men are 2 meters across the mouth, and smaller ones are used by women and children. The twin clap nets are made up to two semicircular wooden frames (Reed *et al.,* 1967). Attached to the frame is 10 to 30 mm mesh size netting material (Fig. 8). The fisher upon seeing the fish dives and claps the fish using the twin clap nets (one held in his right hand and the other in his left hand). Clap nets are commonly used in dry season to catch fish in isolated pools or swamps. Large numbers of fishers often concentrates on one pool at a time and systematically catch most of the fish therein. Such fishing excursions are often arranged in the form of festivals, the most famous of which is held each year Argungu on river Sokoto. Clap net are inexpensive and labour intensive. The catches are always alive and of good quality. Visibility of the fish by the fishers restrict it use to relatively few water bodies.

Cast nets: Cast nets are conical-circular nets, the edge of which is weighted with lead while the conical end is tied to a throwing/hauling rope (Fig. 9). The throwing rope also serves as hauling rope. The net is of various sizes, depending on individual's preference and fisher's ability to manipulate the

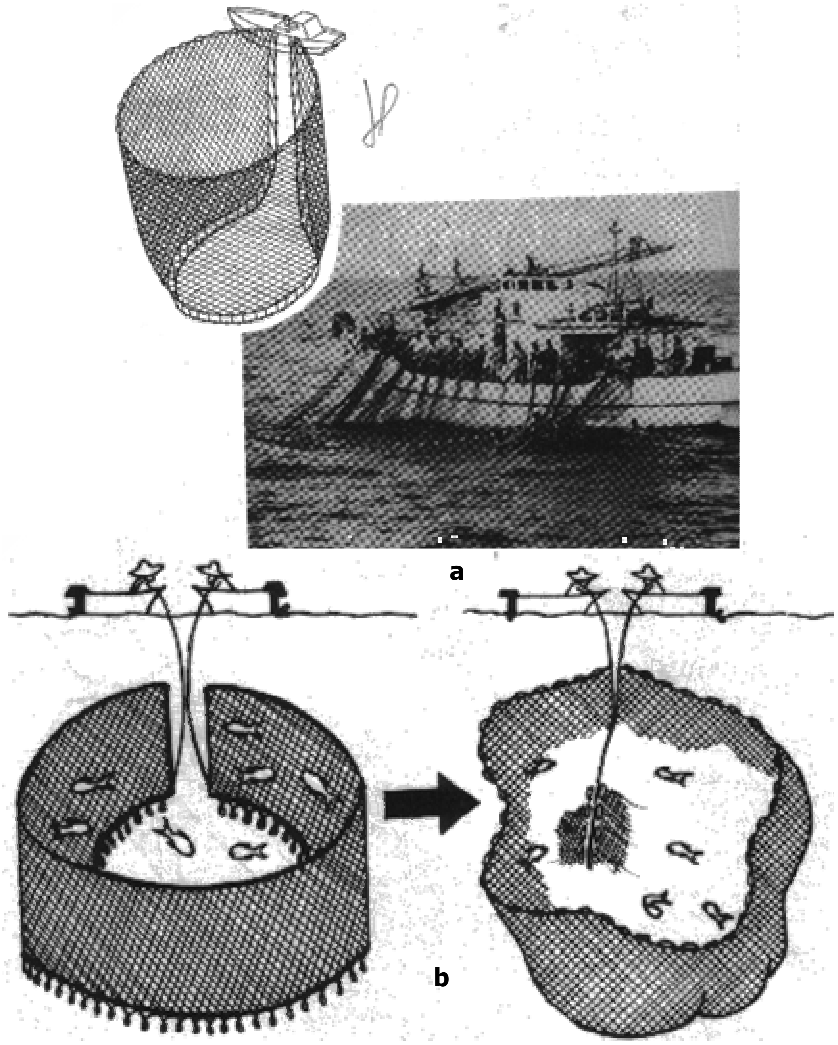

Fig. 7d: Purse Seines and Ring Nets [a] operated from a boat [b] operated from two boats (BOSTID, 1988)

net. In the Anambra and Niger river systems, lengths of 3.8 - 8.9 m and mesh sizes of 3.8 - 8.9 cm are in use. When the net is thrown on the water surface, the lead on the outer edge sink rapidly and the edge line is drawn together, thus enclosing the fish. Fish are either gilled or entangled in the folds or pockets of the net's perimeter. Cast nets are very popular gear which can be used throughout the year. Cast nets catch fish from the pelagic to the benthic section of the water body. In northern Nigerian fisheries, the cast net catches more fish than any other single type of fishing gear. They are more effective than any other type of net for catching the tilapias which avoids most gear, and for the catching of juvenile *Citharinus* which inhabits or are swimming near the surface in small schools during the receding flood (Reed *et al.*, 1967). The major limitation is that they are effective only in open waters devoid of obstacles, and it requires skill to manipulate them in such a way that they unfold in a circular form when thrown on the water surface.

Drift gill nets: Drift nets are mobile gill nets which are normally left to drift freely with the current. By adjusting the number of floats and sinkers the net can be made to sink to a desired depth. In operation a large surface float (Calabash) is attached to one end of the net and the other end is fastened to a canoe which drifts along slowly for a long distance with the net before the net is hauled with the catch into the canoe (Fig. 10). Drift nets are effective in rivers devoid of obstacles and are most often used when the floods are receding and during the dry season when the water level is low and the water current not fast. Near Lokoja they are commonly used June and July to catch *Hyperopisus bebe* and in New Bussa area during the month of August.

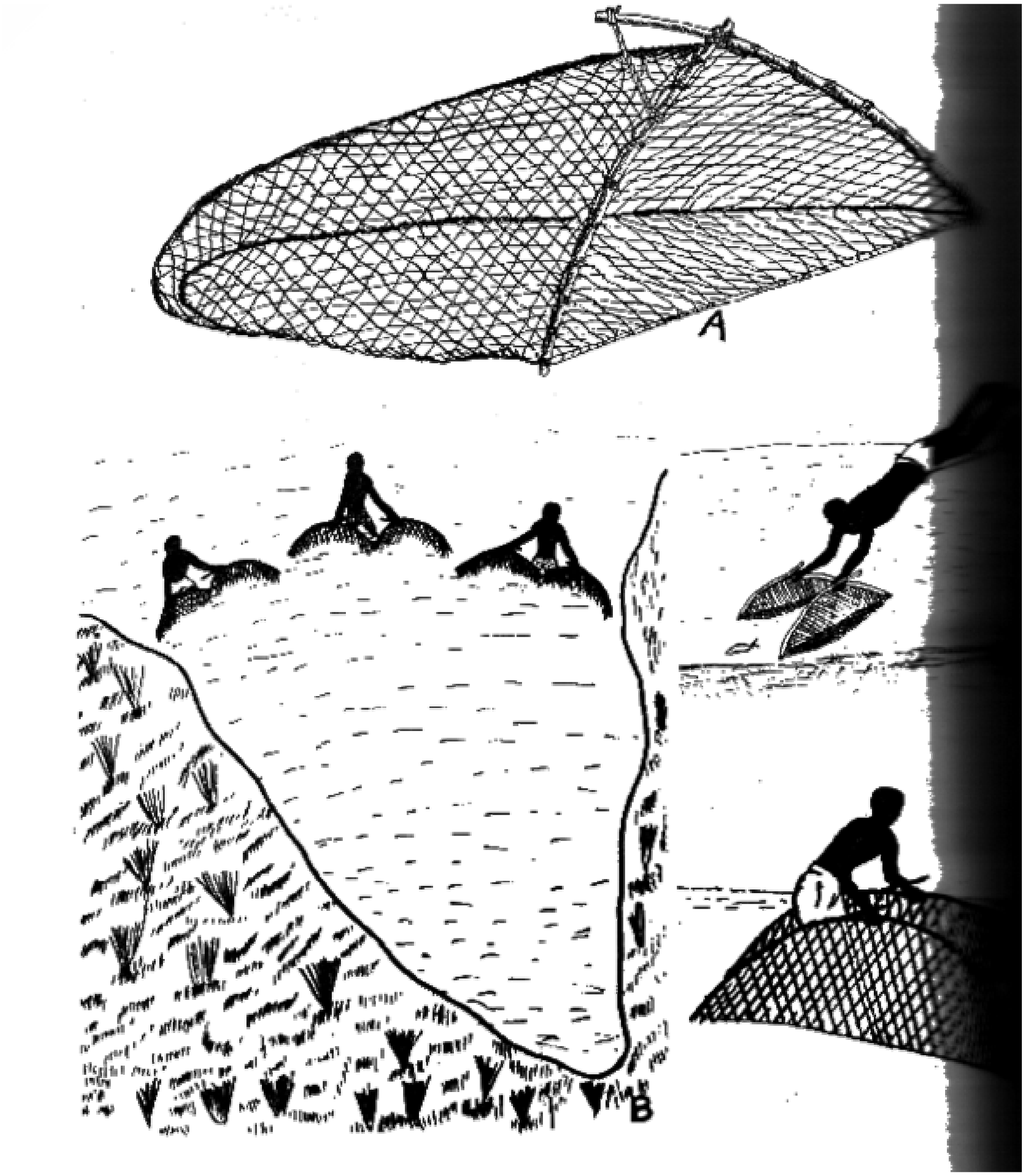

Fig. 8: Clap nets showing how it is operated (Reed *et al.*, 1967)

Trawl Nets and Trawling

The beam trawl: The beam trawl is a tapering bag of netting which can be towed over the sea bad. The mouth of the bag is held open by a long beam, metal runners. The upper leading edge of the bag is attached too a strong head-rope lashed to the beam. The under part of the bag, which drags over the bottom is attached to a considerably larger ground-rope (Fig. 11a). As the trawl is towed, the ground-rope trails behind the head-rope so that fish disturbed on the bottom by the ground-rope are already enclosed under the upper part of the net. The hind part of the trawl net trappers to a narrow sleeve of stronger finer-mash netting known as the cod end, within which the captured fish accumulated. The rear of the cod end is tightly closed by a rope, the cod line. When the trawl net is hauled up to the vessel and the catch released, by untying the cod line, letting the fish out of the bag. (Brabant and Nedelec, 1983). Beam trawls are the simpler trawls and are used primarily to capture flatfish and shrimp. Smaller beam trawl about 2 meters in length, are used with rowboats in

Portuguese rivers. Although small beam trawls might be used by artisanal fishers, they obviously lack the fishing spread of larger trawls which require power and mechanization.

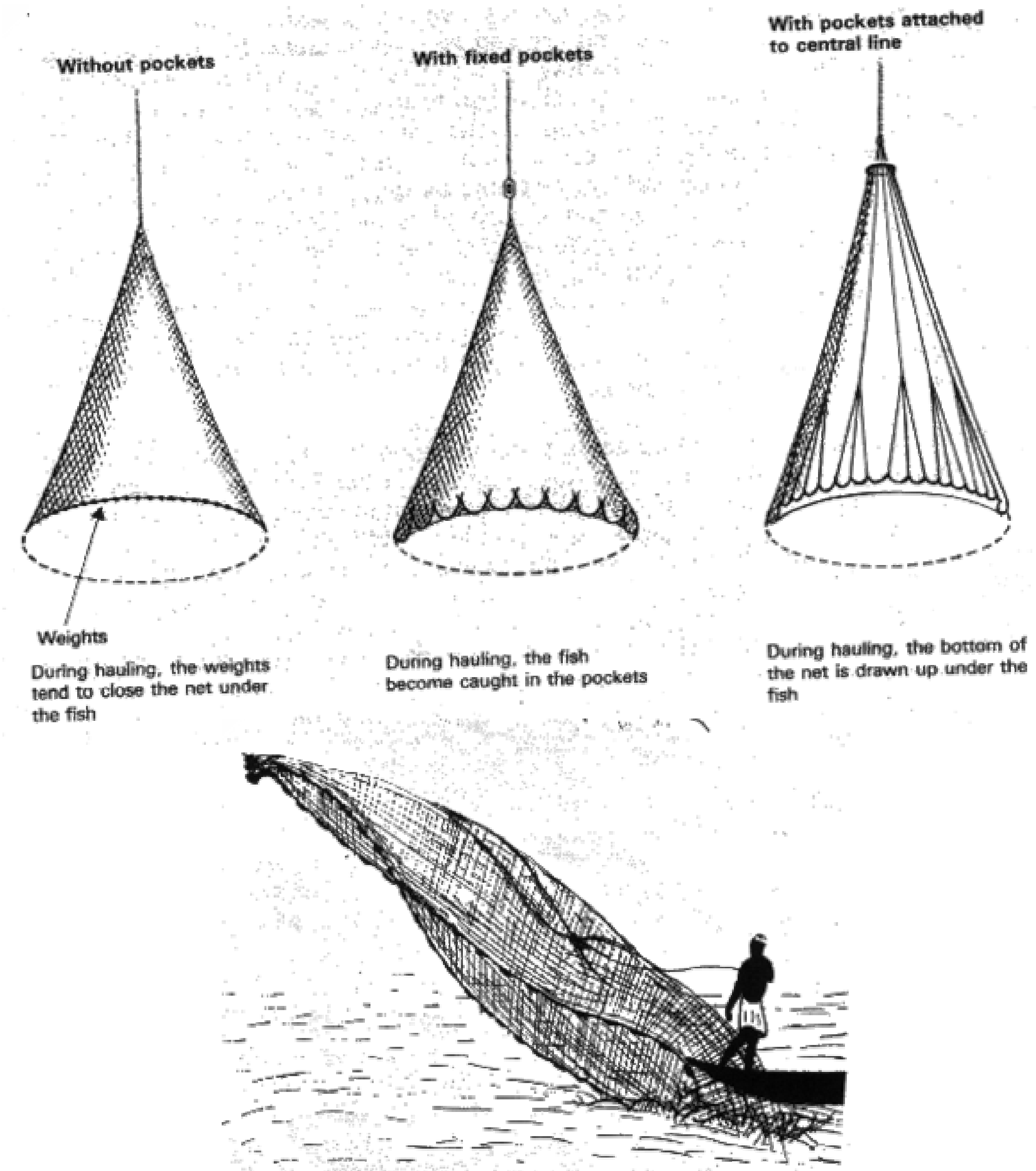

Fig. 9: Cast nets showing types and how it is operated (Reed *et al.,* 1967; Cole and Rogers, 1985).

The otter trawl: The otter trawl has a bag of netting resembling that of a beam trawl net generally in shape, but are considerably larger. Otter trawl nets are the major nets used for demersal fishing. The sides of the bag are extended outwards by the addition of wings of netting to larger, rectangular, wooden "otterboards". The otterboards are towed by a pair of very strong steel cabins, the warps, which are attached to the otterboards in such a way that the pressure of water causes the otterboards to diverge as they move, pulling the mouth of the net wide open horizontally (Fig. 11b). The under-edges of the otterboards slide over the seabed and are shod with steal for protection. The head-rope., to which the upper lip of the trawl net is laced, is usually about 30 – 40 meters long, and bears numerous hollow metal floats which keep it a few meters above the bottom. Sometimes, elevator boards, known as 'Kites' are fitted to the head-rope to increase the gape of the net. The lower lip and ground-rope are longer, 40 – 60 m, and trail well behind the head-rope during trawling (Tait, 1982).

The ground-rope is a heavy, steel wire rope carrying on its central part a number of large steel bobbins, 60 cm in diameter, and on its lateral parts several large rubber discs. These help the otter trawl to ride over obstructions on the seabed. The deck of a trawler carries powerful winch for winding the warps, and the net may be operated either from the side or the stern depending on the design of the vessel. For shooting and hauling the trawl, the side of the trawler carries pair's of strong gallows supporting the blocks over which the trawl warps runs.

When shooting the trawl the vessel moves ahead as the warps are laid out until the otterboards are submerged and the net overboard. The two warps must be of equal length to ensure correct opening of the net. When the trawl strikes the bottom, the drag on the net slows the vessel and the subsequent speed of trawling. Generally, the speed of trawling, depends upon the power of the ship, but is usually about 3 knots. The length of warps is adjusted to about three times the depth of the water, and on the side trawlers they are braced at the stern to keep them clear of the propeller. The strain of towing is taken up by the winch brake (Tait, 1982).

When the net is to be hauled, the trawler continues ahead as the warps are wound-in by the winch. The cod end usually comes up to the surface with a rush, suspended 1 m above the deck and the cod line is untied and the fish discharged on the deck. The deck is usually divided into fish pounds and the fish-room floors which is usually covered with ice. Before storing, the fish are gutted and heads removed from the larger species such as cod, saithe, and haddock. The livers are often kept and boiled down on board in large steam vats to extract oil (Tait, 1982). Fish is a rapidly perishable commodity and deteriorates fairly quickly even when stored in ice. In ice it can be kept in quite good condition for about a week, but stales within a fortnight. This effectively limits the duration of fishing for distant water trawlers rely solely on ice for preservation. Some improvement in the period of effective preservation in ice is obtainable by the addition of antibiotics, but the most notable advance in fish preservation has been the development of deep-freezing techniques. Preservation by freezing has advantages in addition to making possible longer fishing voyages in distant water, of regulating the market supply of fish.

The Spanish trawl (pareja): The Spanish trawl (Fig. 11c) is a very large net, similar in general principle to otter trawls but has no otterboards, the mouth of the net being held horizontally by the lateral pull of the warps, one of which is attached to each vessel. The net has a wide sweep and great catching power, the head-rope sometimes being as much as 100 m length. The mesh is constructed of lighter materials than the otter trawl and generally produces a catch in ratter better condition. In spite of its great size, this trawl can be towed by a pair of relatively low powered vessels. The Spanish trawl can be operated in deep water down to 600 m on the continental slope.

MISCELLANEOUS FISH VIEWING AND FISHING METHODS

Direct sensing: Direct sensing of fish by sight, literally means fish watching from above the water's surface, or beneath it. Direct sen**s**ing is useful for identification and in some situations can be used for estimating of fish abundance. It is also useful for observation of the gear performance and fish behaviour in relation to the fishing method. Fish watching can be improved by using Polaroid eyeglasses or binocular field glassed above the water, and diving gear beneath it. Visual observation of fish from above the water may be facilitated by the use of observation tower to extend the areas of vision and reduce daytime gore interference. Turbidity of inland waters greatly limits application of direct observation. However, headwater streams and biologically young oligotrophic lakes are less turbid. Furthermore, human tolerances also limits its application; as a result, knowledge gained by direct observation may be defective or meager for night time., uncomfortable climatic or weather conditions, and for water containing vicious animals (such as crocodiles) or parasites (such as the trematodes causing achstoromiasia, including the dread bilharziasis limit the application of direct observations.

Diving gear may be a simple facemask or goggles, or for prolonging observation periods, an air-breathing tube (snorkel) may be added. Insulation of the body by wet-or dry-type diving suits extends the usefulness of diving methods into very cold water. Improved underwater lights have increased nighttime observations: submersed floodlight aid direct observation from above.

Underwater observation chambers may provide maximum comfort and now range from simple, fixed tanks entered from the surface, through stationary self contained completely submersed laboratories to self-propelled miniature submarines developed from all types of submersibles. It is now possible to collect data and samples of both living and non living environment.

Remote sensing: Visual observation can be supplemented, augmented, or replaced by several methods of remote sensing. Photography can be adapted to record visible contacts with fish, either when done by the observer, or when done automatically or remotely. Television application to data has provided useful information on the performance of submersed fishing gear. Both underwater photography and television are of course, limited by turbidity.

Methods of remote sensing of fish range from primitive trout wire sensing (a practiced hand on a fine heavily-weighted wire can recognize its contacts with fish as it moves slowly through a school), through echo sounding (vertical sound signals), echo ranging (direction variable-sonar), light beam interruption (electronic-eye), or light wave-length absorption (infrared sensing) to highly sophisticated hydro-acoustic data acquisition device have been employed in the assessment of fish stock. Although for most applications such sensing requires accompanying identification of the fish species involved, it can also be used to determine the abundance of ecological groups of species: e.g. fish concentrating at the surface or in the thermocline, middle zone, bottom, and littoral zones. Locating fish for capture on the basis of their thermal preference using a "thermometric fish finder" have also been reported, while the refinement in the applications of acoustic telemetry to fish have enabled the extension of capabilities of tracking individuals within populations to monitoring physiological parameters including body temperature and heart beat among others. Other miscellaneous fishing methods such as the use of scoop nets and landing nets (fixed or variable opening, operated in shallow waters or form boats); drive-in-nets (not specified else where); gathering with hand or with simple hand implements (with or without diving equipment), pole lining, fish pump, eclectic fishing, poisons and explosive has been properly documented (Tait, 1982; von Brandt, 1984).

Fish pumping: Several techniques to harvest shrimp from ponds and raceways are utilize by commercial shrimp farms located throughout the world. Commonly, farmers drain their aquaculture systems and collect shrimp in basins, nets, mesh bags or baskets as water passes through the drain. Other methods for partial harvest include cast netting or trapping the shrimp as water exits the pond gates during receding tides. Recently, modified mechanical pumps have proven to be very effective at harvesting shrimp from ponds and raceways. Some commercial farms now use mechanical pumps to reduce the time and labor required for harvesting of shrimps. At the University of Florida shrimp demonstration facility (IFAS/IRREC), protocols have been established for effective use of a fish pump to harvest juvenile and adult Pacific white shrimp, *Litopenaeus vannamei,* from ponds and raceways. These protocols can reduce time and labor costs, improve product quality and can be used with other aquatic organisms (Ohs *et al.,* 1995).

Conclusion: Fishing gear subsiderization and mechanization, fishing gear regulation and adaptable fishing craft development are areas of limitations among other *vis-à-vis* the development of the Nigerian capture fisheries sector. The introduction of fishing gear and methods to an area whether these methods are technically new or simple are not without danger to both the community and the aquatic ecosystem. In this regards, the fishing arts developed within a region may usually be the best suited fro the species and sizes desired, given the prevailing aquatic conditions, community and economic structure. The issue of gear regulation become appropriate considering the dangers of fishing out our aquatic ecosystem, although this is often traditionally rejected thus in areas with such regulation, often impossible to implement.

In Nigeria introduced new gear for enhanced capture may be too costly for the local fisher to sustain unless credits and increased subsidies are made available.

The various departments of fisheries both in ministry of Agriculture as well as the World Bank founded ADPs should ensure that credits and subsiderization of fishing gears are always maintained.

Currently, most of the Nigerian waters are over fished. Upgrading the gear and making it more efficient increases the risk of further depleting the fish stocks. Therefore, the introduction of new gear and fishing methods should be accompanied by proper monitoring and protection of the aquatic resources. In this regards, the establishment and funding of a functional monitoring/surveillance unit within the fisheries department is most appropriate. Component members of the proposed unit may include those from the judiciary, the water police, the custom and exercise, the Navy and Fisheries experts. Their duties being enforcement of regulations, punishment of defaulter and protection/conservation of the aquatic resources for the optimal sustainable benefit of man.

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