Relative Abundance, Absolute Abundance and Density

Relative abundance is the ratio of abundance between two or more locations or species or size classes. If catchability is equal between the entities that are being compared, then relative abundance can be calculated from catch-per-unit-effort, without knowing what the catchability is. If catchability differs due to gear differences, habitat differences, or species differences, then this must be taken into account.

Absolute abundance is the number of fish present in a specific area.

Density is the number of fish present in a unit of area or volume. Knowledge of catchability is necessary to calculate absolute abundance and density. There are three general techniques that are commonly used to estimate catchability:

- Mark-recapture methods,
- Depletion methods, and
- Known catchability, or calibrated methods.

In **mark-recapture methods**, a known number of individuals are marked in some way and released into the population at large. (Population is defined here as the fish of a particular species occupying the area of interest, not in the genetic sense.) The population is then sampled and its size is estimated from the ratio of marked to unmarked individuals.

Depletion methods observe the rate at which catches decline with successive sampling. This provides an estimate of catchability that can be used to estimate the size of the population.

Calibrated methods, based on detailed knowledge of gear efficiency/catchability, use a pre-determined formula to estimate abundance from the catch that results from a unit of sampling effort.

There are assumptions with respect to catchability (among other things) for each of the methods of estimating absolute abundance or density. Mark-recapture methods assume equal catchability of marked and unmarked fish.

Most depletion methods assume equal catchability between successive samplings, although if sufficient sampling runs are completed some methods can estimate catchability for each run from the catch data.

Calibrated methods assume that catchability is the same as during the calibration studies. These assumptions are critical to the accuracy of the estimates. There is a large volume of literature dealing with methods of estimating abundance that should be consulted by anyone that needs to have a thorough understanding of these issues.

GEAR REVIEWS

1. Gill Nets

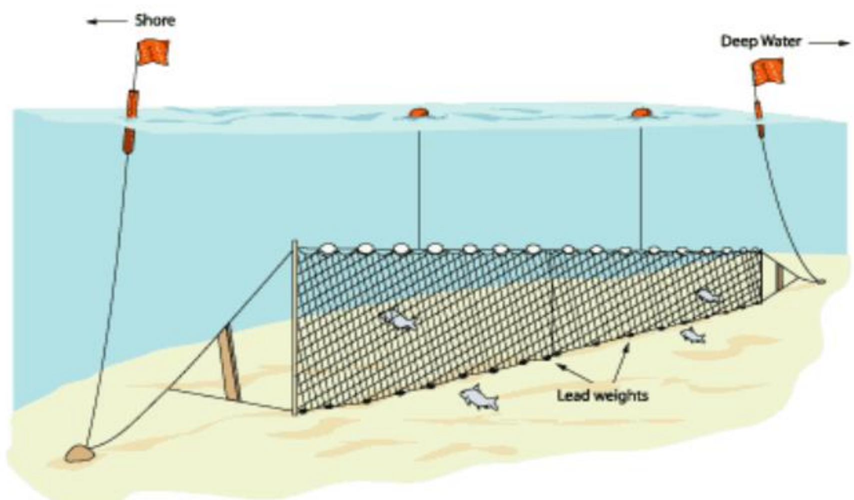

Fig – 4.2

- ***Description and method of use***
  Gill nets consist of mesh with square openings fastened to a positively buoyant line at the top, often referred to as the float line, and a negatively buoyant line at the bottom, often referred to as the lead line because lead has traditionally been used to weight this line. Gill nets are typically stretched between two fixed points (although drift nets are used in marine fisheries) (Fig.1). They are set by attaching one end to an immobile object such as an anchor or a tree along the shoreline and then moving away from that point while paying out the net. Once the other end it reached, it too is attached to an immobile object such as an anchor. The net is left in place and fish are captured when they swim into it. Gill nets are most often set with the lead line resting on the bottom, the float line floating above it, and the mesh stretched between the two. By adjusting the relative buoyancy of the float and lead lines, however, it is also possible to set gill nets that float at the surface and to suspend them at various depths. Gill nets can also be set vertically, a technique

that is sometimes used to assess the depth distributions of fish. If boating conditions are favourable, gill nets can easily be set and lifted by two people from a small boat (Fig. 2) Fish are caught in gill nets when they become wedged in the openings in the mesh or become entangled in it. Consequently, the size of the openings, commonly referred to as mesh size, is a critical parameter affecting efficiency. Mesh size is usually measured and described as ***stretched mesh***, which is equal to the sum of the lengths of two sides (the distance between two opposing corners of a square when it is stretched into a straight line). Mesh size can also be described by the length of one side of the square. This is referred to as ***bar mesh***. Thus, for a given square, the stretched mesh size is twice the bar mesh size. Most individual gill nets contain only one mesh size. Often several nets are joined together into what is referred to as a ***gang***. Gangs can contain nets of different mesh sizes and often resource agencies use specific combinations of mesh sizes for index or inventory work. There are also gill nets designed specifically for scientific purposes that contain a range of mesh sizes in a single net. Gill nets are also described in terms of their length, the distance or the number of mesh openings between the float and lead lines, and the material that the mesh is made of. Most gill nets today are made of monofilament nylon, but older nets were made of cotton and multi-filament nylon. An example of a net description would be *a 100 metre long by 40 mesh deep, 10 cm stretched mesh monofilament gill net*.

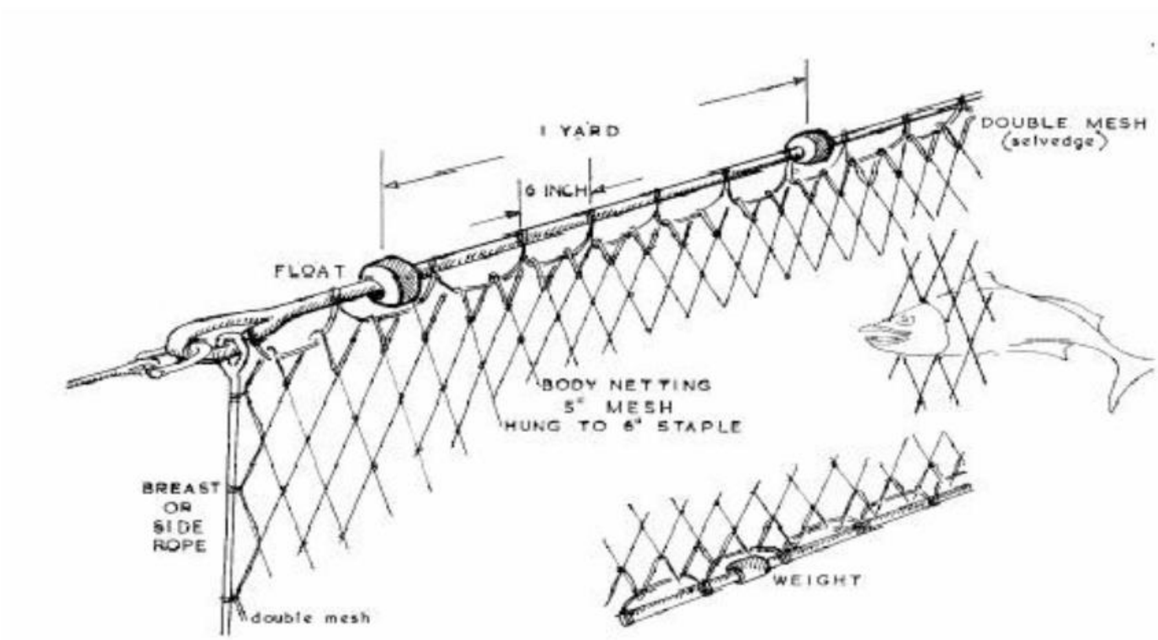

Fig -4.3

- ***Habitat considerations***

  Gill nets can be set wherever there is sufficient unobstructed depth for the lead and float lines to fully separate. Emergent and floating vegetation, and brush, trees and other obstructions near the surface can preclude their use. Gill nets tangle on any rough object, so retrieving them can be difficult and result in damage to the nets in habitats where there is a lot of wood or other debris, as is often the case in reservoirs where forests have been flooded or in areas where logs have been stored.

Gill nets cannot be set perpendicular to strong currents, but may be set parallel to them. Even in relatively gentle currents, however, debris can accumulate in gill nets, decreasing their fishing efficiency and increasing their water resistance. In rivers, the accumulation of fallen leaves is often a problem in autumn. Gill nets can be set over any substrate, although efficiency is probably reduced, especially for benthic species, when the substrate is very uneven (i.e., boulders). Visibility plays a role in catch efficiency, so light and turbidity can affect catch (Berst, 1961; Hansson and Rudstam, 1995), as can net colour (Jester, 1973, 1977). Efficiency can decrease with time set if the nets become fouled with algae or debris (Hamley, 1975).

Fig - 4.4

- ***Selectivity/Efficiency***

  Gill nets are highly selective and there is a large body of literature addressing the relationships between mesh size and fish size. There are two aspects to the selectivity of gill nets. First, like all passive gear, their efficiency is directly related to the probability that a fish will encounter them. Gill nets are not effective for catching sedentary fishes. Catchability increases as movement of the target species increases. In addition to behavioural differences (sedentary versus roaming), distance traveled can be influenced by swimming ability, which, for a given species, is often related to size. Consequently, some researchers have used fish size to estimate the relative probability that fish of various sizes will encounter the nets (Rudstam et al. 1984; Spangler and Collins, 1992).

Seasonal differences in fish movement can be very important in determining the likelihood of encounter. Changes in movement in response to weather, or any other stimulus, can influence encounter probability. There is a high encounter probability for gear sets along spawning migration routes during spawning season.

The second aspect of catchability in gillnets is the probability that a fish that does encounter the net will be retained. Gill nets capture fish by three principal methods, **wedging, gilling and tangling** (Baranov, 1914). **Wedged fish** attempt to swim through an opening in the mesh and are eventually prevented from swimming further by the mesh that encircles their body. **Gilled fish** are not necessarily tightly held by the mesh around them, but are prevented from backing out of the opening because the strands lodge under their opercula. **Tangled fish** are held by mesh that is tangled on various parts of their bodies such as fin spines, pre-opercles, maxillaries, and teeth.

Gill nets can be highly selective with respect to fish size, particularly if wedging is the principal means of retention. McCombie and Berst (1969) examined the relationship between mesh size and fish girth. The fact that few fish are captured whose maximum girth is less than the mesh perimeter is not surprising, as we would expect that they could swim through the mesh. The fact that the maximum girth is often larger than the mesh perimeter reflects a number of factors: the fish is not always caught at its point of maximum girth, the mesh can compress the body of the fish as it struggles, and nylon thread is somewhat elastic.

The relationship between fish girth and retention means that changes in girth due to gravidity or other factors can influence the length of fish that are captured by a given mesh size. Several authors have investigated the difference in size and selectivity between fish that are wedged and fish that are tangled. Not surprisingly, fish caught by tangling tend to have a wider range of relative girths than those caught by wedging (McCombie and Berst, 1969; Hamley, 1975; Hovgård, 1996; Hansen et al. 1997).

The third aspect affecting gill net selectivity, retention, is influenced by the material that the mesh is made of. In the 1930s, cotton thread, which was softer and more elastic, replaced linen thread in the construction of net twine (Pycha, 1962). In the late 1940s and early 1950s, net manufacturers switched from cotton twine to multifilament nylon twine (Pycha, 1962; Hamley, 1975). Monofilament nylon is the predominant mesh material used today. Understanding the effect of changing mesh construction on catchability has been important for interpreting long-term catch/effort data series that are based on more than one mesh type. Consequently this topic has received considerable attention. Pycha (1962) found that multifilament nylon nets were 2.25 – 2.8 times as efficient as cotton nets in capturing lake trout. Henderson and Nepszy (1992) reported that catches were larger in monofilament gill nets than in multifilament gill nets for 16 of the 23 species caught, with a maximum efficiency increase of approximately 3 fold.