Gillnets: Gear Design, Fishing Performance and Conservation Challenges

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PAPER

Gillnets: Gear Design, Fishing Performance and Conservation Challenges

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ABSTRACT

Worldwide, the gillnet is one of the most important fishing gears for harvesting a variety of species in the sea and in freshwater. Gillnets are efficient, catching a diverse range of species, and are highly size selective. However, gillnets have limited species selectivity and sometimes catch non-target species; birds; and megafauna species including cetaceans, turtles, and sharks. Lost gillnets often continue to fish, a situation called "ghostfishing", wasting valuable resources. This paper describes basic components of a gillnet and its fishing mechanisms, and reviews catch efficiency, selectivity and related conservation issues.

Introduction

A gillnet is a wall of netting which hangs vertically in the water column with weights along the bottom and floats along the top, intercepting fish as they move around on fishing grounds. In principle, a gillnet is an invisible panel of mesh that fish swim into without noticing. Once in the mesh, fish are often caught behind the gill cover and cannot back out, hence the term "gillnet".

The gillnet fishery in the Northwest Atlantic can be dated back to the mid-1800s. In the early days gillnets were constructed of natural fiber such as cotton. The invention of synthetic materials and their application in fishing nets in the 1950s and 1960s can be considered a revolution in fishing gear technology. During the 1960s, most natural fiber gillnet materials were replaced by synthetic fiber (mainly nylon) in the Western world due to the large catch increase and the almost maintenance-free nature of the material (Carr et al., 1992; Gabriel et al., 2005).

Classification and Description

The Food and Agricultural Organization of the United Nations (FAO) classifies fishing gear into nine main types plus miscellaneous gears (Nedelec and Prado, 1990). Each of the nine gear types is further divided into sub-types. Gillnets and entangling nets are combined into one gear type with five sub-types and two miscellaneous types (Table 1). Set gillnets and driftnets are two major sub-types in this category. Groundfish gillnets used in the Northwest Atlantic are considered "set gillnets".

Set Gillnets

Set gillnets are anchored or weighted to the bottom and are relatively stationery. They are simply called "gillnets" in eastern Canada and the northeastern United States. A typical groundfish gillnet is 91 m (50 fm) long, with mesh sizes ranging from 140 to 203 mm (5½" - 8"). Larger mesh sizes of greater than 305 mm (12") are used for skates and monkfish. Set gillnets are set on the bottom for groundfish species, and midwater or near the surface for pelagic species such as salmon, herring and tuna.

Drift Gillnets

Drift gillnets are also called driftnets. These nets are not fixed to the bottom and literally drift with the current, catching fish while drifting. Driftnets may be tied to the vessel which also drifts with currents since it is difficult to anchor surface gillnets in deep waters Driftnets are commonly used in high sea fisheries, such as oceanic squid, tuna and salmon. High sea driftnet fisheries are highly industrialized and large in scale.

Trammel Nets

There are three layers of nets in a trammel net. The middle net has a smaller mesh size while the nets on two sides have larger mesh sizes. Fish swimming into the net push the

TABLE 1

International Standard Statistical Classification of Fishing Gear (ISSCFG). Classification of selected important gear types. (Nedelec & Prado, 1990).

GEAR CATEGORIES	STD ABBREV.	ISSCFG CODE
SEINE NETS		02.0.0
TRAWLS		03.0.0
DREDGES		04.0.0
GILLNETS AND ENTANGLING NETS		07.0.0
Set gillnets (anchored)	GNS	07.1.0
Driftnets	GND	07.2.0
Encircling gillnets	GNC	07.3.0
Fixed gillnets (on stakes)	GNF	07.4.0
Trammel nets	GTR	07.5.0
Combined gillnets-trammel nets	GTN	07.6.0
Gillnets and entangling nets (not specified)	GEN	07.9.0
Gillnets (not specified)	GN	07.9.1
TRAPS		08.0.0
HOOKS AND LINES		09.0.0

Footnotes

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small mesh net through the large mesh netting; this forms a pocket where the fish is trapped and retained.

Fixed Gillnets

In tidal and shallow water areas, gillnets may be hung onto stakes to form a wall or "fence". This is particularly effective in rivers where strong currents would distort the geometry of a typically constructed gillnet.

Combination Gillnets

Gillnet webbing of different mesh sizes may be rigged together to form one gillnet to target different species and sizes in mixed fisheries. Gillnets and trammel nets may be combined to achieve the same effect. Combined gillnets are often used as sampling gears for resource surveys and for studying selectivity of gillnets of different materials and constructions.

Anatomy of a Gillnet

A gillnet is a sheet of webbing strengthened by frame ropes, with floats and weights affixed to expand the web in the vertical direction. Multiple gillnets are typically tied end-to-end to form a string of nets that is fished as a single piece of gear. Ropes are attached to the end gillnets to facilitate retrieval. Buoys and highflyers are used to identify locations of either end of the string. An artist's impression of a set gillnet is shown in Figure 1, with the major components labeled in the inset.

Headrope

Headrope is also called the headline. The headrope is the rigging found on the top of the gillnet. Floating polypropylene is usually used as headrope with floats attached to it. In some gillnets, such as those for deepwater Greenland halibut (*Reinhardius hippoglossoides*) off Labrador, no floats are used (CFCL, 1994). In these nets, large polypropylene ropes (c. 16 mm or 5/8" diameter) provide enough floatation to lift the headrope off the seabed. Foam-core float ropes are used in some fisheries, eliminating the need for additional floats. The webbing is hung to the headrope by a hanging twine which is stitched to the headrope at regular intervals.

Footrope

Footropes are usually made of leadropes (lead weights inside a braided synthetic sleeve). Before the leadrope was invented, stone, clay, porcelain, lead, or cement block was used as weight for the footrope. The leadrope may be strengthened by a supporting rope to increase strength and prevent breakage. The bottom of the webbing is attached to the footrope by another hanging twine.

Webbing

Modern gillnet webs are made of nylon materials. The most common form of gillnet web is monofilament, although mutlifilament and multi-monofilament webs are also widely used in some parts of the world. Webbing is described by mesh size, twine diameter, twine construction and color. Usually half mesh selvage made of stranger materials is used on the top and the bottom of the web.

Bridles, Buoy Lines and Markers

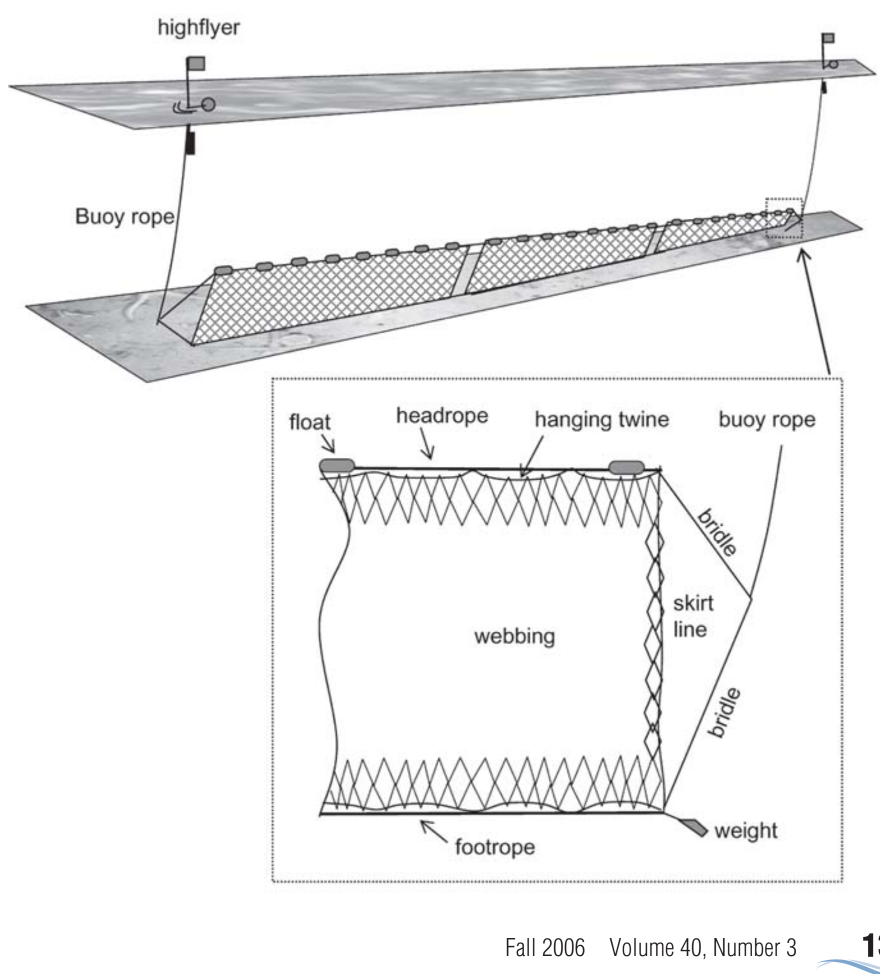
Bridle lines connect the headrope and footrope and join to the buoy rope. Buoy ropes connect the net and the surface marker which consists of a highflyer and a mark buoy. In New England, usually from four to twenty nets are tied together to form a string (Williamson, 1998), but in deepwater fishery for Greenland halibut off Labrador, it is quite common to have fifty nets in a string (CFCL, 1994). In some fisheries, it is required that both ends of the gillnet string be marked.

Other Accessories

Depending on fishing area, jurisdiction and the type of fishery, a gillnet may require attachment of identification and ownership tags, pingers, weak links, breakaway swivels, radar reflectors, or acoustic gear-finding transmitters. There may be specific requirements on the size, strength and density of ropes (Frady, 2006), as well as the maximum number of nets allowed.

FIGURE 1

Schematic illustration of gillnet while fishing. Inset: an anatomy of a gillnet.



Capture Mechanisms and Key Design Considerations

Four basic mechanisms of fish capture by gillnets can be identified: gilling, wedging, snagging and entangling (Hovgard, 2000).

- **Gilling** - caught with the mesh behind the gill cover,
- **Wedging** - caught by the largest part of the body,
- **Snagging** - caught by the mouth or teeth, or other part of the head region,
- **Entangling** - caught by spine, fins or all parts of the body as a result of struggling.

Visibility (or invisibility) of the net is the most important aspect in gillnet design and operation. Whether the net is visible and to what extent, is determined by the fish's visual characteristics, material of the net, light level, water clarity, and relative position of the fish to the net. Visibility of the net is reduced when there is low contrast between the net and its background. Smaller diameter materials are less visible. Night time hours, periods with no moon, high latitude winter days, deep water, and turbid water (near estuaries, tidal area with muddy bottom) all contribute to lower visibility of the net. In clear waters of shallow depth, visibility of net is related to the color of the net against background and changes with viewing angle (Wardle et al., 1991). Net colors were considered an important factor by Hampley (1975) in his review on gillnet selectivity as well as by Jones et al. (2004) who surveyed color use in various fishing gears.

Mesh size of a gillnet determines, to large extent, the species and size of fish caught. Baranov's theory of geometric similarities (Baranov, 1948) states that gillnet selectivity is only dependent on mesh size and fish size. He predicted that very few retained fish would have their length differing from the optimal length (model length) by 20%. Baranov's theory of geometric similarities is, however, considered to be an oversimplification (Hamley, 1975).

The hanging ratio is another factor for design consideration. Hanging ratio is the ratio of rope length (headrope or footrope) to the stretched length of the net it is attached to. Hanging ratio is expressed as a decimal or percentage. Different hanging ratios change the shape of the mesh and affect slackness (Figure 2). A slackly hung net (small hanging ratio) usually results in more fish being entangled rather than being gilled.

Catch Efficiency of a Gillnet

For gillnet fisheries, fishing efficiency is generally defined as catch per net per specific soaking time (eg. a day). There are many factors which affect fishing efficiency. Fish availability and behavior, mesh size, net depth, webbing material, and hanging ratio are among important factors.

Fish Availability and Behavior

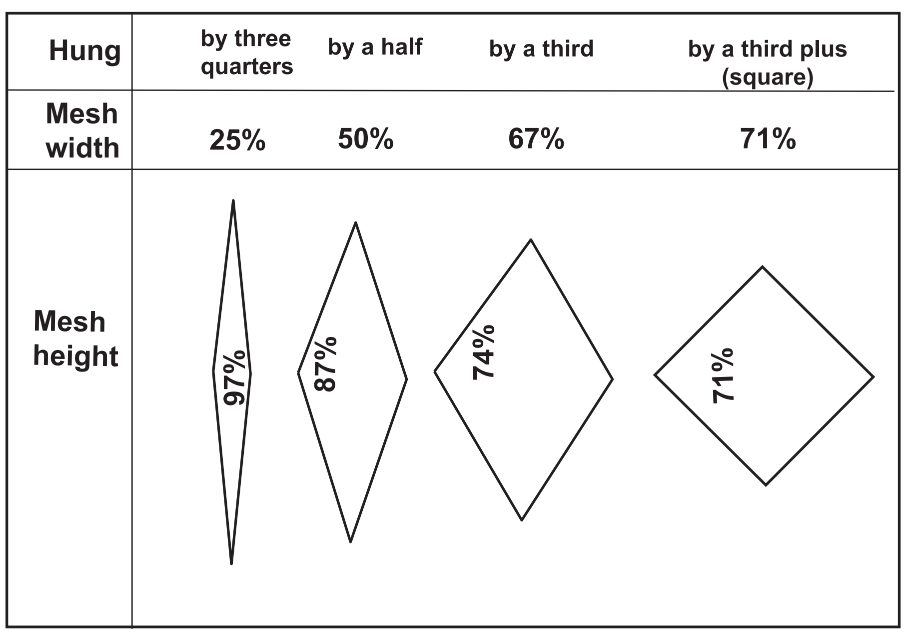
Fish availability, density and mobility are important factors influencing fishing efficiency (Laevastu and Favorite, 1988; Dickson, 1989). Movement of fish increases the encountering probability of fish with gillnets (Rudstam et al., 1984; He, 2003). This is especially important for the set gillnet which is anchored on predicted fishing routes or foraging grounds and relies on the movement of fish to encounter the net. Certain environmental factors such as low temperature affect swimming speed and mobility of fish (He, 1991; 1993; 2003) and can affect fishing success. Based on the rate of movement of winter flounder (*Pseudopleuronectes americanus*) at different temperatures, He (2003) postulated that a gillnet set in water at 4.4 C would have more than 10 times the potential fishing area than that at -1.2 C, both set for 24 hours. Size-related swimming speed of fish may result in gillnets selecting for larger sizes (Rudstam et al., 1984). Angelsen (1981) reported that more male spawning cod and halibut than females are caught by gillnets because they are more active on spawning grounds.

Mesh and Twine Size

Mesh size is a very important design feature for determining fishing success. Comparative fishing trials using gillnets of 127 and 140 mm (5" and 5.5") on the south coast of Newfoundland targeting redfish resulted in 3.6 times more fish caught in the smaller mesh size nets (Brothers and Yetman, 1982). However, catch rates of Greenland halibut increased with larger meshes (Yetman and Staubizer, 1991; Melindy and Flight, 1992). Gillnets with 203 mm (8") mesh size caught 38% more fish in weight than those with 140 mm (5.5") mesh size (Melindy and Flight, 1992). The increase in catch rates was due to the increase in the size of fish caught for the larger

FIGURE 2

Hanging ratio of a gillnet explained.



mesh nets as the average weight of fish caught in the large mesh nets was 3.5 times heavier than the small mesh nets.

Thinner twines generally produce larger catch, as they are less visible and more easily to entangle fish due to their increased softness (Hansen, 1974). Hovgard (2000) reported a Danish study which indicated 2 to 3 times more catch of European dab (*Limanda limanda*) using 0.16 mm than 0.28 mm monofilament twines. Gabriel et al. (2005) suggested that thinner twines may result in decreased detection of the net by fish's lateral system. However, thinner twines are more easily damaged which may result in increased costs and down time and more frequent replacement of nets.

Net Depth

The depth of the net is the vertical distance between the headrope and the footrope. It is usually described by the number of meshes in depth (MD). Height of the net, however, is often less in fishing conditions as a result of current action and accumulation of catch, which tends to depress the headrope height (Stewart, 1988). Fishing efficiency of the gillnet in relation to net depth varies with the species of fish targeted. For those fish that stay close to the seabed, such as flounder, a high net would not increase catch efficiency (He, 2006). In cod gillnets, an extra 10 meshes of webbing (35 MD) caught significantly more cod than the standard 25 MD nets (Yetman, 1989). Similarly, 8 MD experimental gillnets caught significantly less cod than the regular 25 MD net in the Gulf of Maine (He, 2006), while the catch efficiency for flounders (mainly American plaice, *Hippoglossoides platessoides*) was similar. Nets with vertical tie-down lines connecting the headrope and footrope (tie-down nets) have lower vertical height and more slackness, and were reported to catch more flounders and other bottom-dwelling animals (eg. lobsters) but less cod when compared with the standard cod net (He, 2006).

Webbing Material

Monofilament nets are less visible and generally produce larger catch than multifilament nets (Larkins, 1963, 1964; Pristas and Trent, 1977; Collins, 1979). Larkins (1964) reported that the monofilament nets in a monofilament/multifilament string caught 1.9 to 4.1 times more salmon than the multifilament nets in the same string in the Pacific coast.

Hanging Ratio

Comparative fishing trials between gillnets of different headrope hanging ratios indicate the optimal hanging ratio varies by target species. Tests of nets with hanging ratios of 0.5 to 0.7 indicated that the best hanging ratio for cod was 0.6 instead of traditional 0.5 used by Norwegian fishermen (Angelsen et al., 1979). For European dab, however, nets with a hanging ratio of 0.2 caught more fish than that of 0.6 by a factor of 2 (Hovgard, 2000).

Selectivity of Gillnets

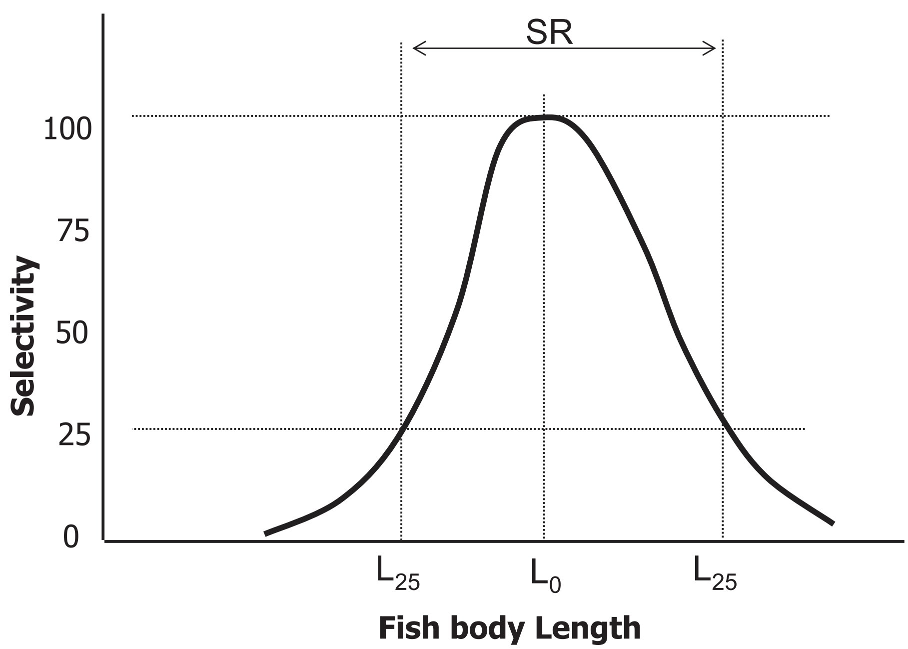
The selection of fish by a gear is the "process which causes the catch of the gear to have a different composition to that of the population" in the area (Wileman, et al., 1996). Selectivity is the quantitative assessment of this selection process based on biological sampling obtained in the field. Gillnet selectivity processes, mechanisms, and analyses are reviewed by Hamley (1975) and Hovgard (2000). There are two basic shapes which represent selectivity curves for fishing gears: sigmoid and bell-shaped curves. Gillnet selectivity curves are usually bell-shaped (Figure 3) and may have two or more peaks reflecting different means of capture. Gillnet selectivity is usually described by the modal length (L_0), the selection range (SR), and the selection factor (SF) which is the ratio of L_0 to mesh size. Several factors affect selectivity of gillnets, including mesh size, webbing material, hanging ratio, and twine size.

Mesh Size

Mesh size is the most important factor determining gillnet selectivity. Larger meshes generally catch larger fish for all species. While surveying young cod in Greenland waters, Hovgard (1996) found that more cod were caught by gilling as mesh size was increased. Size distribution was changed from no conspicuous peaks, to two peaks, to a single peak as mesh size was increased from 33 to 66 mm (1.3" to 2.6"). Comparing gillnets of 180 and 220 mm (7.1" to 8.7") mesh sizes in the

FIGURE 3

Selectivity curve of a gillnet and associated selectivity parameter. L_0 - the modal length, L_{25} - the 25% retention length, SR - selection range.



Barents Sea for Greenland halibut, Nedreaas et al. (1993) found that the model length was 55 cm for the smaller mesh size compared with 66 cm for the large mesh size. Regulating mesh size to reduce undersized fish has been a common management measure in many fisheries. In the New England multispecies gillnet fishery, the minimum mesh size is 165 mm (6.5").

Webbing Material

Generally speaking, smaller twines have a poor size selective property (larger selection range) due to elongations when a fish forces through the mesh (Hansen, 1974), and easier entanglements which result in a wider size of fish being caught. A monofilament gillnet has a better selective property for cod than both multifilament and multi-monofilament nets because monofilament twines are more rigid than both multifilament and multi-monofilament twines (Stewart, 1987). A larger percentage of fish are gilled in monofilament gillnets than nets made of multifilament and multi-monofilament, which tend to result in tangling.

Hanging Ratio

Slackly-hung gillnets with low hanging ratios result in more fish being entangled rather than gilled, which results in poor size selectivity (Hamley, 1975; Angelsen et al., 1979; Stewart, 1987). When studying tilapia, Hamley (1975) obtained a size range (90% of catch) of 18 to 23 cm in a tightly hung net, but 8 to 22 cm in a slackly hung net.

Species Selection and Bycatch Reduction

Gillnets have poor species selective properties, catching a wide range of species. Primary measures to reduce bycatch species and undersized fish are the use of suitable mesh sizes and fishing at selected locations. Use of tie-down nets or nets with less meshes in the vertical direction (lower headline nets) reduced catch of cod and spiny dogfish (He, 2006) without reduction in flounder catch. A gillnet design with Norsel lines to raise the web 0.5 m above the seabed reduced bycatch of red king crab (*Paralithodes camtschaticus*), but also reduced targeted cod (Godoy et al., 2003).

Comparison with Other Fishing Gears

Gillnets generally catch large fish compared to other gears, if the proper mesh size and netting materials are used. Several comparative fishing trials have indicated better size selectivity for gillnets than for other fishing gears. When fished simultaneously on the west coast of Greenland, gillnets caught more large Greenland halibut than longlines (Boje, 1991). Even though both gears caught fish of the same peak length of about 70 cm and had a similar length range of 45 to 115 cm, longlines caught a larger proportion of fish between 50 and 65 cm, while gillnets caught a larger proportion of fish between 65 and 85 cm. Cod on the Flemish Cap are fished by several fishing fleet sectors using trawls, gillnets and longlines. Boje (1991) reported seven fleet sectors as identified by gear (trawl/mesh size, gillnet, longline) and by country (flag). Average weight of cod caught by different fleet sectors and their share of the cod catch in 1991 is shown in Table 2. The Portuguese gillnetters caught the largest cod with an average weight of 2.5 kg, while the Spanish freezer trawlers caught the smallest cod with an average weight of 0.4 kg. Lowry et al. (1994) compared gillnets and trawls with the same mesh sizes ranging from 105 to 130 mm targeting Baltic cod, and found that gillnets caught fish with peak lengths 7 to 16 cm longer than fish caught with trawls using the same mesh size. Nedreaas et al. (1996) and Huse et al. (1999) compared 220 mm mesh size gillnets with a 135 mm codend mesh size trawl and #12/0 EZ-baiter hook longline targeting Greenland halibut in the Barents Sea off northern Norway. They found gillnet catches were composed of mostly mature females of large size while the trawl and longline had a much lower percentage of large mature females. The average length of gillnet fish was 65.9 cm, while the longline caught fish was 59.6 cm and the trawled fish was 50.1 cm. Comparison of three gear types targeting cod and haddock also showed similar results (Huse et al., 2000).

TABLE 2

Size of cod (*Gadus morhua*) caught by different fleet sector on Flemish Cap in later 1980s (Boje, 1991).

Sector	Mean weight(Kg)	Catch share(%)
Spanish pair trawler	1.3	23
Spanish freezer trawler	0.4	1
Portuguese freezer trawler	0.9	4
Portuguese gillnetter	2.5	23
Longliners	2.3	27
Other freezer trawlers		1
Non-NAFO trawlers		21

Conservation Challenges

While gillnets are considered one of the best gears in terms of size selectivity, species selectivity is quite poor, catching various species and sometimes entangling marine megafauna and protected species (Northridge, 1984; 1991; Pol and Carr, 2000). Another conservation issue related to gillnet is ghostfishing of lost gillnets (Breen, 1990).

Bycatch of Birds and Mammals

Bycatch of sea birds and entanglement of marine mammals by gillnets have resulted in their negative image in the public. Seabird bycatches are common in almost all gillnet types, especially those set near the surface, adjacent to bird colonies, and in shallow waters (Lien et al., 1989; Forney et al., 2001). Prior to the early 1990s in Newfoundland waters, both groundfish gillnets and surface gillnets entrapped seabirds during the brief capelin spawning season when intense inshore feeding by birds and peak commercial fishing activity coincided. The greatest bycatch of birds by fishing gears was near bird breeding colonies; with diminishing bycatch as distance from the colony was increased (Lien et al., 1989). Murres (*Uria aalge*) were most often caught in monofilament groundfish gillnets, while

Atlantic puffins (*Fratercula arctica*) were more often caught in surface gillnets for salmon.

Melvin et al. (2001) tested a modified salmon gillnet with the top part of the webbing made of highly visible white multifilament twine. This modification reduced bycatch of common murre and Rhinoceros Auklet (*Cerorhinca monocerata*) by 70-75%. Other means to reduce bycatch of birds in gillnet fisheries include time and area closures and the use of pingers.

Interactions between marine mammals and gillnets have resulted from two major gear components: buoy lines and nets. These interactions have resulted in animal mortality and severe damage to fishing gear (Lien et al., 1989; Northridge, 1984; 1991). An annual average of 24 humpback whales (*Megaptera novaengliae*) was entrapped in Newfoundland groundfish gillnets between 1978 and 1987 (Lien et al., 1989). Carretta et al. (2005) reported marine mammal, sea turtles and bird mortality in the California driftnet fishery for swordfish and sharks between 1996 and 2002 with a variety of mortality rates for different species. Bycatch of marine mammals by large-scale driftnets resulted in a ban of driftnet fishing in the high seas with United Nation's Resolution 44/225 passed in 1989.

Mortality of harbor porpoise (*Phoceena phocoena*) in the Gulf of Maine and Bay of Fundy groundfish gillnets resulted in successful research and subsequent implementation of the use of acoustic pingers in the fishery (Kraus et al., 1997; Trippel et al., 1999). The 10 kHz pinger was able to reduce porpoise catch while maintaining target species catch of cod and pollock (*Pollachius virens*). Trippel et al. (1996) found that the majority (96%) of porpoise bycatch was in the upper two-thirds of the gillnet. For some bottom-dwelling species such as flounder, the height of the net may be reduced without affecting the catch of the target species (He, 2006). A reduced height gillnet may have a positive effect on reducing porpoise bycatch in the gillnet fishery. Use of the barium sulphate ($BaSO_4$) material within monofilament nylon increases reflectivity of the net (Cox and Read, 2004; Mooney et al., 2004) and has reported to reduce harbor porpoises (*Phocoena phocoena*) and seabirds (shearwater *Puffinus spp.*) without reduction in target species (cod, haddock and pollock) (Trippel et al., 2003). In addition, uses of stiff ropes, neutrally buoyant or sinking ropes, weak ropes or weak links are required in New England gillnet and pot fisheries to reduce interaction of fishing ropes with large marine mammals (Frady, 2006).

Ghostfishing

Gillnets can become lost due to adverse weather or sea conditions, or by conflict with other fishing gears or vessel traffic. Some derelict gear may continue to fish after being lost (Breen, 1990). This phenomenon is referred to as "ghost fishing." Fishing gear intentionally abandoned or otherwise disposed at sea, has a similar effect on animals and the environment. Gear designs to reduce fishing capacity of lost gear are called "de-ghosting" technologies. A recent review by Matsuoka et al. (2005) provided comprehensive accounts on the subject.

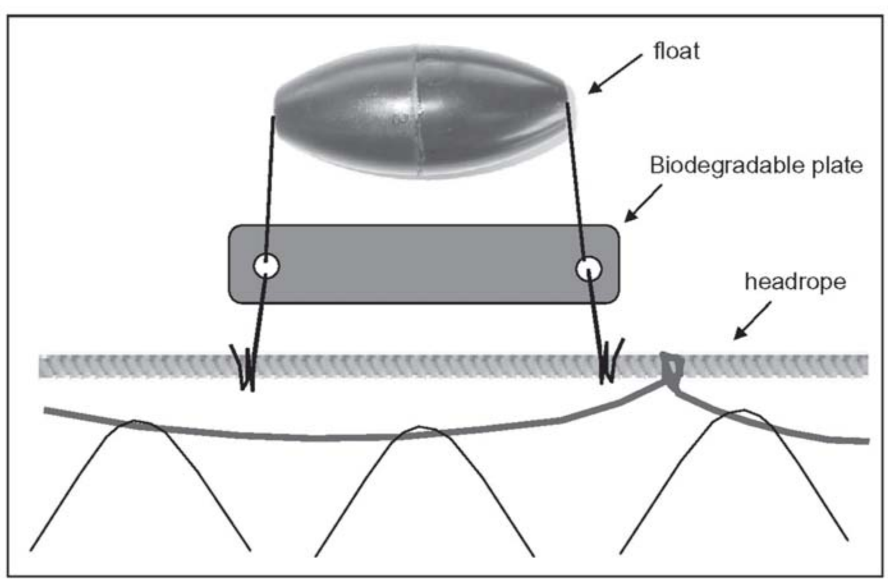
Canadian Fisheries Consultants Ltd. estimated that around 5000 gillnets were lost annually in the Atlantic Canadian waters (CFCL, 1994). There are also concerns that the problem of gear loss may be aggravated by the increased use of gillnets in deep waters and in more hostile sea conditions. Cooper et al. (1988) conducted video camera surveys by a remotely-operated underwater vehicle in the Gulf of Maine and estimated that there might be 2497 nets (each 91 m in length) on the 64 nm^2 area of the traditional gillnet grounds on Stellwagen Bank and Jeffreys Ledge, equivalent to 39 lost nets per nm^2.

With the introduction of synthetic materials in gear construction, these lost fishing gears may continue to fish for several years before they become inactive. Gillnets deliberately set over wrecks in UK coastal waters fished for at least two years (Revill & Dunlin, 2003). When lost gillnets are retrieved, they often contain large amounts of fish and shellfish. Direct observations on lost gillnets or simulated "lost" gillnets confirm that these nets did continue to fish (Carr et al., 1985; Cooper et al., 1988). It was estimated that lost salmon nets might fish for two years for fish, and six years for crabs (High, 1985). Gillnets lost in shallow waters tend to become overgrown by algae. Since these algae laden nets are more visible, their fishing capacity is correspondingly reduced. Fishing capacity is decreased to about 15 to 20% of the normal net in the first a few weeks (Carr & Cooper, 1988; Revill & Dunlin, 2003). However, shallow water is usually rich in marine life so catch rates can still be considerable.

Prevention of ghostfishing may include prevention of gear loss, lost gear retrieval and de-ghosting technologies. The use of degradable material which causes the lost gillnet to lose floatation could reduce the vertical profile

FIGURE 4

Degradable plastic panel. Redrawn based on Carr et al. (1992).



and hence fishing capacity. Carr et al. (1992) tested degradable plastic plates for attaching floats to the headrope of gillnets (Figure 4). The gear was set to simulate ghost fishing for a period of 220 days. Two types of degradable plastic plates were used. Divers made underwater observations to check net profiles and catch. Only two of the 20 degradable attachment panels partially degraded after 220 days. No significant differences in catch were observed between sections of the net rigged with degradable float attachments and those with regular rigging. Though there was a report of degradable fishing nets being developed in Japan (Anon., 1993), commercial application of degradable net has not implemented.

Conclusion

The gillnet is a very size selective fishing gear, landing only a narrow range of fish sizes. Size selectivity is closely related to mesh size, and changes with type of webbing material, twine size, and hanging ratio. There are two conservation challenges facing the gillnet fisheries: 1) species selectivity including bycatch of marine mammals, sea birds and turtles, and 2) ghostfishing of lost fishing gears. Research to mitigate conservation challenges has shown progress, but more work is needed.

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