Industry Considerations and Action

Mark Minton[1]

[1] Western Pacific Fishery Management Council, 1164 Bishop Street, Suite 1400, Honolulu, Hawaii 96813

1.0. Introduction

More than 170,000 people work as commercial fishermen in the United States. In 1998, U.S. commercial fishermen landed about 9.2 billion pounds (4.2 million metric tons) of fish and shellfish at U.S. ports, valued at approximately $3.1 billion. An additional 400.8 million pounds (181,800 metric tons) were landed outside the United States. Purse seine nets and trawl nets accounted for more than 70 percent of the total catch. Among the other fishing gear used were longlines, gillnets, set nets, trolling gear and pots. American consumers spend almost $50 billion each year for fish and shellfish products. Thousands of businesses located throughout the United States, produce, process and distribute seafood products. These firms contribute more than $25 billion to the U.S. Gross National Product (National Fisheries Institute 2000).

There are an estimated 15 to 17 million recreational fishermen in the US. In many fisheries, recreational fishermen harvest as many or more fish than commercial fishermen (e.g., bluefish, red drum, striped bass, summer flounder, and winter flounder, Spanish mackerel, spot, spotted seatrout). In 1994, recreational landings of finfish, from Maine to Texas and Oregon to California were over 173 million fish weighing almost 200 million pounds. In 1997, nearly 17 million recreational fishermen made 68 million marine fishing trips to the Atlantic, Gulf, and Pacific coasts. The estimated marine recreational finfish catch was 366 million fish or roughly 423 million pounds (NMFS 2000). It has estimated that the recreational boating and fishing industries may put as much as $60 billion annually into the U.S. economy (Recreational Fishing Alliance 2000).

While plastics were first developed in the 1860s, they did not begin to replace natural fibers in fishing gear construction until the 1940s. Shortages of materials such as rubber during World War II led to the rapid development of plastics. By 1964, the majority of nets manufactured in Japan, one of the major suppliers of nets to American fisheries, were constructed of plastics (Uchida 1984).

Synthetic fibers have led to significant technological advancements in fishing gear design and construction. Modern fishing gear, constructed of synthetic fibers is cheaper, more durable, lighter, stronger and more efficient than most traditional gear. While synthetic fibers have led to immeasurable benefits to society, there have been associated costs.

Because they are resistant to degradation, synthetic fibers persist longer than natural fibers in the marine environment. Once lost in the ocean they have the potential to continue to fish and adversely affect the environment. Known impacts of lost and discarded fishing gear include the entanglement of marine life (i.e., fish, mammals, sea turtles and seabirds),

navigational hazards to vessels and habitat impacts. Because they are relatively inexpensive, synthetic fishing nets may provide an economic incentive to fishermen to discard damaged or worn nets and line instead of investing the time and energy to repair them.

An estimated 80 percent of the marine debris found in the ocean originates from land-based sources (Faris and Hart 1995) and 20 percent originates from maritime sources. Plastic production pellets, transported by merchant ships to manufacturing sites where the are melted down and made into various plastic consumer goods are found throughout the World's oceans.

Commercial fishing gear accounts for approximately 5 percent of the total debris found in the ocean (O'Hara et al. 1988). Other maritime sources of marine debris include merchant ships, recreational boats, cruise ships, military vessels and offshore oil rigs. Research has shown that the type and source of plastics vary by geographic location. While in most instances the predominant plastic debris was packaging (bottles, bags and lids), in Alaska it was fishing gear, such as webbing, rope and floats (Faris and Hart 1995).

Because lost and discarded fishing gear has a great potential to impact marine life and habitat, its reduction is a high priority. Prevention is the key to the solution of this problem. Participation and input by the fishing industry is critical to developing reasonable solutions. The fishing industry has participated in a number of previous marine debris and derelict fishing gear conferences and will participate in this fourth international conference.

2.0. Background Information

A. Fisheries operating in the Pacific

The Pacific Ocean contains some of the world's most productive fisheries. A number of small and large scale fisheries operating around the margins of the Pacific employ a variety of gears and methods to target a wide range of species. Principal gears include bottom and mid-water trawls, gillnets, pelagic longline, demersal longline, troll gear, hook and line, traps and purse seines. The trawl fisheries of the northeastern and northwestern Pacific are among the largest fisheries in the world and take large volumes of gadoids (pollock and cod), sebastes (rockfish) and various flatfish.

High seas fisheries in the Pacific target schooling pelagic species, such as tunas and squids. Tunas are taken predominantly by purse seine vessels which target skipjack and juvenile yellowfin tuna and other small tunas for the canning industry. Larger, adult albacore, bluefin, yellowfin and bigeye tunas are the principal targets of longliners, which in some cases also target swordfish. Other open ocean pelagic fisheries include albacore trollers and pole-and-line vessels fishing for skipjack. Squid are caught on the open ocean using light attraction at night and squid-jigs.

Major trawl fisheries, both domestic and international, occur in the North Pacific. Generally trawl fisheries may be classified as either bottom or midwater trawl. Bottom trawls are cone-shaped nets that are towed on the bottom. Two cables are used to tow the net and retrieve it. Large rectangular doors attached to the cables keep the net open while deployed. Large circular

rollers, called “rock-hoppers” attached to the nets foot rope are used to fish on hard, rocky bottoms.

Mid-water trawls also employ cylindrical shaped nets. Mid-water trawls are generally towed at various depths above the bottom. Table 2. summarizes the US domestic fleet operating in the Gulf of Alaska and Bering Sea.

Table 1: Fleet sizes of US Vessels operating in the Gulf of Alaska and Bering Sea (1998)

Vessel Type	Gear Type	Vessel Size	Fleet Size
Trawl catcher processor	Trawl	>125 feet	51
Trawl catcher	Trawl	50-150 feet	230
Longline catcher processor	Demersal longline	>100	43
Longline vessels	Demersal longline	-	2,000
Pot catcher processor	Traps	-	7
Pot vessels	Traps	-	800
Set net vessels (salmon)	gillnet	-	4,000
Seine vessels	seine	-	1,000

Source: NPFMC 2000

Gillnets are widely used throughout the North Pacific including Canada, Japan, Russia and the United States. Uchida (1984) provides a thorough review of existing fisheries. Gillnets are constructed of monofilament line and typically have a float lead lines. Typically a number of nets, or “panels” are joined together. Gillnets may be anchored to the bottom of the sea with the use of weights or allowed to drift. Fish are captured as they attempt to swim through the net.

In the early 1980s many of the Asian distant water fleets including Japan, Korea and Taiwan begin to use large-scale drift gillnets in the North Pacific to catch salmon, tuna and squid. Vessels involved in the fishery typically would set up to 40 miles of net per night. The United States and Canada expressed concerns about the amount of salmon being intercepted on the high seas by this fishery, thus depriving domestic fisheries the opportunity to harvest these fish. In addition, large numbers of other marine life were inadvertently captured and kill by the fishery including marine mammals, sea birds and sea turtles. In 1991, the United Nations General Assembly, in response to mounting international pressure, adopted a Driftnet Resolution calling for a global moratorium on large-scale high-seas driftnet fishing effective December 31, 1992.

Major longline fisheries exist in the Pacific. Table 1. summarizes existing pelagic longline fleet sizes currently operating in the Central Pacific. The US domestic longline for swordfish in the North Pacific is a relatively new fishery. The introduction of chemical light sticks in the late 1970s revolutionized the industry. Lights are attached by rubber bands or line clips to the branch lines above the hook. The light sticks produce a chemical luminescence for up to 24 hours. The lights are available in a variety of colors and are thought to attract either the bait upon which swordfish prey, or the swordfish themselves.

Table 2: Fleet Sizes of Pelagic Longlines, Operating in the Central Pacific (1997-1998)

Nation	Fleet Size
China	110
Japan	1,573
Korea	148
Taiwan	1,674
United States	125

Source: WPFMC

Major trap fisheries exist in the North Pacific for king, tanner and dungeness crab. The traps used in these fisheries are typically large (8" x 8'' x 3") constructed of iron rods covered with some type of netting. Large numbers of traps are set in the crab fishery. Traps are typically set individually with one to multiple buoys to mark their location. Traps are also used to target some species of fish such as cod.

The use of free floating, fish aggregation devices (FADs) by purse seiners operating in the eastern, central and western Pacific is another source of derelict fishing gear. Purse seine vessels set either on free swimming schools of tuna on the surface of the ocean during the daylight hours or on schools found associated with drifting logs or man-made rafts. Just before dawn. The increasing use of drifting fish aggregation devices (FADs) is a relatively recent development in the fishery. In the Central Western Pacific, the US fleet made 90% of sets on untethered FADs in 1999 up from about 30% in the previous year (Coan et al. 1999). These FADs are roughly 2 m x 2 m rafts with a radio beacon for tracking and recovery. Netting, often worn out purse seine nets, are suspended beneath the FADs to create habitat and attract fish.

Recreational fisheries are another source of lost fishing gear present in the ocean. Recreational fishing is a highly popular pastime throughout the Pacific. In Hawaii, large amounts of light gauge, monofilament line lost by recreational fishermen is found on beaches and coral reefs. Monofilament fishing line presents an entanglement threat to various marine life including sea turtles. The line may get wrapped around the turtles flipper and restrict its movements and ultimately may sever the appendage. In Hawaii in recent years the rate of stranded turtles having some sort of recreational fishing equipment around them has increased from about 5 percent to about 15 percent (Laurs 2000). In 1999, 43 of the 299, or 15 percent, of documented turtle stranding the turtles had recreational fishing hooks in them. 20 of the 43 turtles strandings related to recreational fishing were dead when recovered. The remaining 23 turtles were entangled in monofilament line (Laurs 2000).

B. Causes of gear loss

Fishing gear is lost at sea through a number of ways. It can be lost inadvertently during the course of normal operations or, in some cases, through deliberate disposal. The following section briefly describes some of these pathways.

Bottom trawls may become snared on underwater hangups including rocky bottoms and the wrecks of sunken vessels. When fishing in areas of high relief bottom, nets must be constantly inspected and repaired as they are damaged in the course of normal fishing operations. When nets hauled back with tears and rips they must be mended either by sewing in new meshes

or, when large sections have been badly damaged, entire new sections of net. As part of the mending process small sections of mesh are often cut out before sewing in the new webbing. Some of these damaged sections may be discarded, either unintentionally or intentionally.

Bottom trawls are occasionally lost entirely due to hangups on bottom features, such as ledges, pinnacles, rock piles and wrecks. Because of the substantial cost of replacing a net (~$30,000) vessels go to great lengths to recover a lost net. One method used is towing a grappling hook over the spot where the net was lost until the net is recovered. Because of the potential damage to gear and the subsequent loss of fishing time, vessels typically mark the location of hangups and wrecks on their charts and plotters. Nets lost in this fashion likely remain entangled on the bottom.

While mid-water trawls are designed to fish up in the water column they can be fished at or near the bottom and therefore may potentially be damaged due to hangups, particularly in rocky or high relief areas.

Gillnets may be lost as a result of a number of factors, including net repair, interactions with mobile gear, entanglement on bottom features such as ledges and wrecks and storm events. While the use of high seas driftnet gills has been banned since the early 1990s, illegal vessels are still reportedly using driftnets to poach fish within the US Exclusive Economic Zone as well as on the high seas. Numerous documented cases exist of illegal driftnet vessels simply abandoning gear in the water once detected by surveillance aircraft in an effort to elude apprehension. The abandonment of illegal gear is another source of fishing gear entering the marine environment. Given the large amount of gear deployed, undoubtedly some was lost in the course of normal fishing operations. Due to the persistent nature of synthetic monofilament gillnets and the long residency time of gear once lost in the marine environment, there is likely large amounts of driftnet still circulating within ocean currents and large scale eddies.

In longline fishing, as the mainline is retrieved, the crew generally removes branch lines, buoy lines, lights and radio buoys, which are readied for the next day's set. Throughout the haul damaged sections of the mainline are replaced. The damaged sections may be unintentionally or intentionally disposed of into the ocean. Light sticks are also lost during the course of normal fishing operations. The light sticks are positively buoyant and of a shape and size that, if inadvertently lost from the branch line or discarded improperly, can create problems if ingested by marine mammals, seabirds or marine turtles. Naval and merchant marine shipping also reportedly use large quantities of light sticks.

Traps are lost through a variety of ways. In heavy seas it is not always possible to locate all the buoys marking the lobster pots. Major storm events can also lead to the displacement and loss of crab traps. Tides may run so strongly in areas that the buoys marking lobster and fish traps are submerged. Thus, vessels may not be able to locate and retrieve all the gear it set.

Vessels often operate at or near the edge of the ice front and may lose traps as the ice edge advances. The buoy marker lines may be severed by ice. Interactions with mobile gear such as trawls may result in traps being displaced and lost. It is estimated that trap loss in the North Pacific king crab and tanner crab range from 10 to 25 percent (Kruse and Kimker 1993; and

High and Worlund 1979 in Carr and Harris 1997). In Alaska, current regulations require that the trap escape panel be constructed of some type of biodegradable material to reduce the potential for lost traps to continue to fish.

As previously noted, interaction between different fisheries and gear types are another potential means by which fishing gear may be lost. In the case of areas where both fixed gear (i.e., trap and gillnets) and mobile gear (trawl) fisheries operate simultaneously, gear interactions result in the displacement and loss of fishing gear. Mobile fishing gear may displace lobster traps and damage gillnets. Fixed gear such as gillnets and traps may be displaced, damaged or destroyed by vessel traffic. Longlines may also be parted and sections lost if cut by the propellor of transiting freighters or vessels.

Purse seine vessels reportedly set large number of FADs, some of which are lost. Once lost FADs could be a marine debris issue if washed up on beaches or coral reefs. Purse seine nets are rarely lost during normal use.

Under extreme circumstances, vessel emergencies and matters of safety at sea may contribute to the discarding of fishing gear by vessels. Fixed gear fisheries such as the North Pacific crab fishery operates under some of the most inclement weather conditions found anywhere on earth. In heavy seas and arctic conditions stacked crab pots may begin to "ice up" due to spray and sub-freezing temperatures. As ice accumulates on the stacked pots the vessel can rapidly become unstable due to the excess weight and ultimately, unless the situation is remedied sink with a loss of part or all the crew. Under such conditions crews often most "break ice," removing ice from railing, decks, superstructure and stacked gear. Under extreme conditions it may be necessary to jettison stacked traps to ensure the vessels stability and safety.

Non-compliance with existing domestic and international laws is another source of derelict fishing gear present in the ocean. As is the case under any regulatory regime, there is a some non-compliance. Despite MARPOL, fishing gear continues to be deliberately discarded by some unscrupulous vessels and crew. Enforcement alone will not achieve compliance with MARPOL Annex V. Industry education and outreach programs, such as U.S. Coast Guard's SeaPartners campaign are an important part of the solution.

C. Past Efforts

The International Convention for the Prevention of Pollution from ships at sea (MARPOL) was drafted and signed in 1973. MARPOL established specific guidelines governing the discharge of wastes by vessels at sea. It was amended in 1978 to include five annexes on ocean dumping. Annex V deals specifically with the disposal of plastics, including synthetic fishing nets by vessels. The Marine Plastic Pollution Research and Control Act (MPPRCA) of 1987 is the US domestic legislation that implements MARPOL Annex V in U.S. waters.

Under the MPPRCA, any vessel greater than 26 feet in length are required to prominently post a 4" x 6" MARPOL placard that explains the garbage dumping restrictions. Vessels 40 feet are larger are required to develop a written waste management plan that describes how the

procedures used by the vessel for handling the vessel's garbage in accordance with MARPOL Annex V laws. The plan also must name the crewmember in charge of carrying out the plan. In addition, vessels are required to maintain a detailed waste logbook that details the handling and disposal of plastics and other wastes. These records are to be maintained onboard the vessel for at least two years and are to be available to the USCG for inspection upon request.

Under MARPOL and the MPPRCA, it is illegal for any US vessel to discharge plastics in any navigable waters within the EEZ or on the high seas. Violations can result in fines of up to $50,000 for each incident. If criminal intent is proven, an individual may be fined up to $250,000 and/or imprisoned up to 5 years. If an organization is responsible, it may be fined up to $500,000 and/or six years imprisonment. One exception to the plastic disposal requirements of Annex V is the accidental loss of synthetic fishing gear incidental to its repair, as long as reasonable precautions to avoid such loss have been taken (Koehler et al. 2000).

D. Net Disposal and Recycling

Under MARPOL, all ports, terminals or marianas, whether public or private, are required to provide trash reception facilities for wastes generated at sea and are responsible for the handling and disposal of the wastes once received.

In 1987, the Port of Newport Oregon, with funds provided by the National Marine Fisheries Service, began a one-year pilot project to help provide fishermen with convenient refuse disposal facilities. Under this program recycling and re-use was encouraged, including a popular program that allowed fisherman to leave off unwanted trawl net for public re-use (as baseball backstops, gardening supports and erosion mats, jungle gyms and the like). The other goals of this project were to increase public awareness about the problems caused by marine debris and to evaluate the program so that other ports could benefit from the Port of Newport's experiences.

Due to the positive response from the fishing community to this program and with the aid of Saltonstall-Kennedy funds, the Pacific States Marine Fisheries Commission (PSMFC) took on similar disposal, recycling, and awareness projects in other ports in Oregon, Washington, Alaska and California. Gillnet recycling was initiated in Bellingham, Washington, and Cordova, Alaska under this program and trawl and seine net "public re-use" was encouraged in Seattle and Bellingham in Washington, and in Astoria and Coos Bay in Oregon. Gillnet recycling was further promoted by the PSMFC with a follow-up grant from the Environmental Protection Agency (EPA). Seattle, Bellingham, Anacortes and Everett, Washington, Astoria, Oregon and Cordova, Naknek, Kenai, Dillingham, and Petersburg, Alaska participated in this Program (Recht 2000).

The dockside recycling receptacles initially focused on bulky materials such as cardboard, wood (for re-use), metal and nets (for re-use) as well as oil. Later, paper, aluminum, and other scrap metal recycling was promoted in Alaskan communities involved in gill net recycling. These facilities not only provided convenient refuse disposal for the fishermen and provided a source of scrap materials, they helped gain the acceptance of the program by port officials by keeping port disposal costs down, especially in areas where recycling pick-up

services for oil, cardboard, and scrap metal exist kept logistics streamlined. In some areas, e.g. Alaska, where dump space is limited and the siting of new waste dumps costly, reduction in the amount of materials entering the waste stream was an additional benefit. However a belief that recycling should 'pay for itself', an unrealistic expectation, moderated some community's commitment to the programs (Recht 2000).

The recycling of gillnets has proven to be an economically viable operation and a benefit for the ports in several Alaska and Washington communities and thus has continued as a private enterprise relationship.

Though trawl net re-use is still promoted in a number of ports (e.g. Newport and Anacortes), no recycling has been workable, due to the low value of the polypropylene nets and the presence of gear such as chains and rollers, making the effort too labor intensive unless subsidized (Recht 2000).

Due to re-prioritization of policy objectives and programmatic goals (e.g., EPA focus changed from recycling promotion to pollution prevention), additional funding to help develop, streamline, and coordinate these projects was not available after the initial funding ran out. While many of the Port's involved in this project continue the programs initially established and while the private recycler also helps to promote the effort, additional funding would have helped strengthen industry and community involvement and buy-in into the program and expand opportunities in other ports (Recht 2000).

Skagit River Steel and Recycling, located in Burlington, Washington, is the only company currently involved in net recycling in the United States. This company works with ports in the Northwest and Alaska. The principal markets are in Hong Kong, Taiwan, China and Japan. Recently markets have begun to develop in the US.

The company deals almost exclusively with nylon nets: gillnet and driftnets. Past experience has shown recycling nylon seine nets can be economically viable. Many seine nets are coated to preserve and extend their life which complicates their recycling.

The synthetic materials used to construct trawl gear, polypropylene and polyethylene is problematic for recycling because they degrade. If some type of photo-degradable material is added to synthetic trawl materials, it would further make trawl nets more difficult to recycle. Skagit River Steel and Recycling currently does not handle trawl gear. The company did handled trawl nets in the past but stopped doing so because it lost money.

One of the major obstacles is the need for consistent support for net recycling at the local level, whether it is a fisheries organization or local government. Another problem is the plastics market is very fickle (Hendrickson 1999). The port of Newport, Oregon reportedly has made used trawl net available to the public for use in landscaping and for other purposes (Recht 1999).

Carr and Harris (1997) report that in New England changes in minimum mesh size requirements forced fishermen to buy new gear and dispose of old nets. Many landfills reportedly were not willing to accept the old gear for disposal (Carr and Harris 1997). Similarly,

in the central western Pacific problems with disposal of worn out purse seine gear has led to some nations refusing to dispose of these nets in limited land fill capacity (McCoy 1999). This presents a dilemma as to how to legally dispose of gear.

E. Industry Action

As noted, the MPPRCA requires all US vessels greater than 40 feet, including commercial fishing boats to 1) develop a written waste management plan that describes the procedures used by the vessel for handling the vessel's garbage in accordance with MARPOL Annex V laws, and 2) maintain a detailed waste logbook that details the handling and disposal of plastics and other wastes. These records must be maintained onboard the vessel for at least two years and are to be available to the USCG for inspection upon request.

In addition to compliance with MARPOL, the fishing industry has initiated a number of waste reduction programs and policies designed to prevent, reduce and re-use vessels wastes. Fishermen have taken a leading role in addressing the problem of marine debris and lost nets. The fishing industry has spent its own funds to produce educational materials such as posters and stickers intended to educate the public about the problem of marine debris. Fishermen have been actively involved in efforts to encourage ports to provide dockside waste disposal and recycling receptacles to facilitate the proper disposal of fishing gear (Leipzig 2000). The fishing industry has organized and funded at least one major conference examining the problem of lost fishing gear.

In Kodiak and Dutch Harbor, Alaska, the fishing industry works closely with port authorities to ensure proper disposal of damaged and worn nets and vessel wastes. Approximately 800 tons of net are land filled every year in Dutch Harbor and Kodiak. In Kodiak, nets disposed in the landfill are buried. In Dutch Harbor nets are stockpiled while efforts to arrange for barge service to make annual trips to recycling centers are pursued. Kodiak makes used nets available to the public for a multitude of uses, including erosion control, landscaping and pest control for gardens. The local Chambers of Commence have begun work on a feasibility study on burning used nets for power generation. In Kodiak, a program to recycle and re-use motor oil from vessels has reportedly resulted in savings of approximately $100 thousand a year on waste oil disposal. Some of the waste oil is used for heating purposes while the rest is recycled for re-use (Burch 2000).

Some industry trade associations and vessels operators provide new crewmembers orientations that include a review of the requirements of MARPOL and company waste disposal policies. Some employee contracts also stipulate that the individual agrees to abide by all relevant laws and regulations, such as MARPOL and the MPPRCA. Most vessel operators, whether formally or informally, provide new crewmembers an orientation and overview of the policies and procedures they are expected to follow including waste disposal.

Some US vessels operating in the North Pacific employ incineration as a waste management strategy. The Groundfish Forum is an industry trade association that represents 19 of the 25 head and gut (H & G) catcher-processor vessels operating in the North Pacific. The average length of these vessels are 140 feet. Some of the vessels incinerate wastes at sea,

including plastics. While most vessels employ burn barrels to incinerate wastes, a few vessels have incinerators on board. Incinerated ashes are brought to port for disposal (Henderschedt 2000).

The fishing industry in Washington State is involved in several ongoing initiatives to address the problem of lost fishing gear. Working with local dive groups, it has been involved in efforts to remove derelict gillnets from Puget Sound. A number of fishing vessel owners have donated their time and vessels as dive platforms to help remove these nets. Industry has initiated a program by which the location of lost nets in Puget Sound is provided to the Washington Department of Fish and Wildlife. The State reportedly is maintaining a database of this information and has produced maps showing the locations of nets (Zuanich 2000).

The participants of the North Pacific Rim Fishermen's Conference on Marine Debris (1987) drafted and adopted the "Fishermen's Pledge to a Clean Ocean." (Appendix 1). The pledge is a commitment to return all discarded fishing gear and other plastics to port and dispose of them properly; to make every effort to prevent accidental loss of fishing gear; to make an effort to safely collect lost fishing gear found at sea return it to port for proper disposal; to follow the marine debris regulations required by MARPOL Annex V; and encourage all fishermen to follow this example. This pledge was distributed to fishermen as a plaque suitable for mounting on a vessel's bulkhead.

Many Japanese longline vessels operating in the Pacific, which typically average between 150 to 180 feet in length, are equipped with incinerators. Items not suitable for incineration are bundled for disposal at port (Araki 2000).

Toppings et al. (1997) studied the waste disposal practices of fishing vessels on the East Coast of Canada in 1990 and 1991. Their study examines several industry actions and practices for managing wastes including damaged and worn gear. During the early 1990s, the Nova Scotia Maritime Fishermen's Union worked to encourage fishermen to bring their waste back to port. One of the major goals of this project, supported by Environment Canada, was to educate the fishing industry about the problem of marine debris. Another goal was to ensure that adequate disposal facilities, (e.g., barrels and dumpsters) were provided by various ports. In response, several Canadian fishing corporations reportedly initiated company policies prohibiting the discharge of their vessels' wastes at sea (Topping et al. 1997).

Toppings et al. (1997) reports that many of the non-US fishing vessels operating off the Atlantic coast, particularly large factory trawlers of the former Soviet Union, incinerate their wastes. The authors note that Canadian vessels do not incinerate their waste because they are smaller vessels and Canadian law requires expensive air pollution reduction control equipment for operations that incinerate their waste.

In 1992, the United Nation's Conference on Environment and Development introduced the concept of responsible fisheries. Subsequently, the Food and Agriculture Organization (FAO) of the United Nations elaborated the concept in the "Code of Conduct for Responsible Fisheries," which was adopted in 1995. Compliance with the Code is voluntary.

The FAO Code of Conduct proposes *inter alia* the following actions to prevent marine pollution:1) nations should introduce and enforce laws and regulations based on MARPOL; 2) fishing vessel owners and operators should fit their vessels with appropriate equipment as required by MARPOL and consider fitting a shipboard compactor or incinerator if possible to treat garbage and other shipboard wastes generated during normal vessel operations. In addition the Code of Conduct recommends efforts be made to develop new technologies, methods and materials to reduce the loss of fishing gear and reduce the impacts of lost or abandoned gear (FAO 1995).

The associated technical guidelines for responsible fisheries contain the following recommendations to reduce marine debris:

- Vessels should attempt to recover all lost fishing gear and when not possible, report the type, extent and position of the lost gear. In the event that any lost gear is encountered, it should be recovered if possible and returned to port. Again, if this is not possible the position and type of gear should be reported.

- Fishing gear should be marked in order to facilitate the identification of the owner

- Attempts should be made to reduce conflicts between active and passive gear.

- When a fishing vessel fouls or interferes with gear that does not belong to it, it should take all practicable measures to minimize the extent of damage caused to the gear.

- All ports should be maintained and managed in such a manner as to ensure compliance with relevant marine pollution laws, particularly MARPOL Annex V.

Some segments of the fishing industry have endorsed the concept and principles of responsible fisheries. The Responsible Fisheries Society (RFA), an industry trade association affiliated with the National Fisheries Institute (NFI), has developed and adopted the "Principles for Responsible Fisheries." These principles are intended to provide guidelines to fishing and seafood firms and organizations to ensure responsible use of fishery resources and protect the environment. The groups that have adopted them are reportedly developing specific action plans to implement them.

3.0 Summary of Recommendations from Previous Conferences

Beginning in 1984 there have been several conferences convened to examined the issue of Marine Debris including the issue of derelict fishing gear. These include the First International Conference on the Fate and Impact of Marine Debris, Honolulu, Hawaii (Shomura and Yoshida 1985); the North Pacific Rim Fishermens Conference on Marine Debris, Kailua-Kona, Hawaii (Alverson and June 1988); an Interagency Task Force on Persistent Marine Debris, established by President Ronald Reagan in response to a letter from 30 US Senators expressing concern about the growing problem of marine debris, published a report recommending various actions to address the problem (Cottingham 1988); the Second International Conference on Marine Debris, Honolulu, Hawaii (Shomura and Godfrey 1990); and the Third International Conference on

Marine Debris, Miami, Florida (Faris and Hart 1995). Each of these group efforts produced a number of recommendations to address the problem of marine debris. The following recommendations, relevant to the fishing industry, are drawn from the previous conferences. Table 3. summarizes these recommendations.

First International Conference on Marine Debris (1984)

1. Undertake efforts to advise user and interest groups of the nature and scope of the marine debris problem. Such groups should include the fishing and plastics manufacturing industries, merchant carriers, the military, appropriate international groups and the public.

2. Develop a means of identifying derelict gear through creation of a reference collection.

3. Obtain worldwide data on vessel disablement as a result of interactions with marine debris.

4. Develop alternative methods for both fishing and non-fishing activities to replace those methods that contribute significantly to the marine debris problem.

5. Investigate use of biodegradable materials in gear construction and the recycling of net materials.

North Pacific Rim Fishermen's Conference on Marine Debris (1987)

1. Tag fishing gear using the same technology as coded-wire tagged salmon.

2. Identify fishing gear and methods for which alternate materials or operating procedures may reduce their likelihood of becoming hazardous marine debris.

3. Assess the feasibility of and impediments to the recycling of waste fishing gear and other vessel-generated wastes.

4. Improve shore-side reception and management of vessel-generated wastes. In particular, to assist in the development of integrated waste management systems. This need is particularly acute in remote fishing communities.

5. Develop safe and effective shipboard incineration methods and other technologies for shipboard waste handling, storage and transfer to shoreside facilities.

6. Examine cost-effective systems to facilitate the identification, recovery and return of lost fishing gear to port or owners.

7. Quantify the economic losses to fishing and recreational vessels caused by marine debris.

Table 3: Previous Conference Recommendations, Industry Actions

	First International Marine Debris Conference (1984)	North Pacific Fishermen's Conference (1987)	Interagency Report on Persistent Marine Debris (1988)	Workshop on Derelict Fishing Gear (1988)	Second International Marine Debris Conference (1989)	In C
Recommendations						
Gear modification	X		X	X	X	
Degradable materials	X		X	X	X	
Source Identification	X	X				
Economic Impacts	X	X	X		X	
Education	X		X	X	X	
Gear Recycling	X	X	X	X		
Shoreside Disposal Methods		X				
Shipboard Disposal Methods		X				
Gear Recovery Methods		X	X			
Enforcement			X			
Gear Loss Reduction Methods		X	X		X	
Monitoring	X					
Regulatory Measures					X	
Economic Incentives				X		

Report of the Interagency Task Force on Persistent Marine Debris (1988)

1. The US Coast Guard should begin a public education campaign on the requirements of the Marine Plastic Pollution Research and Control Act as soon as possible to assure that owners and operators of all vessels, ports and the boating public are aware of requirements prior to enforcement.

2. The US Coast Guard and other federal enforcement agencies should make enforcement of regulatory requirements of the Marine Plastic Pollution Research and Control Act a high priority.

3. NOAA should encourage regional fishery management councils to include requirements that fish and shellfish traps and pots have degradable panels or latches.

4. Federal agencies should work with state and local governments, universities, merchant vessel owners and operators, commercial and recreational fishermen and local communities to quantify economic impacts caused by persistent marine debris.

5. NOAA should work with fishermen and equipment manufacturers to develop pragmatic ways to:
   a. reduce loss of fishing equipment, particularly traps, trawl nets and gill nets;
   b. improve ways to recover lost fishing traps and nets; and
   c. recycle used fishing nets and nets fragments.

6. The National Bureau of Standards should work with the ASTM (formerly known as American Society for Testing Materials) and other industry associations to develop standards and criteria for what constitute bio-degradable and photo-degradable.

7. NOAA, EPA and FDA should work with plastics manufacturers to examine how degradable plastics react in the environment, including potential environmental effects as the plastic degrades.

Oceans of Plastics: A Workshop on Fisheries Generated Marine Debris and Derelict Fishing Gear (1988)

1. Explore financial incentive- based solutions for reducing gear discard and loss. These could include net deposits, gear inventories and bounty systems.

2. Pursue programs to educate the public and users groups to help reduce marine plastic debris.

3. Pursue technological solutions to reduce marine plastic debris including the use of degradable plastics in packaging as well as in fishing gear, recycling plastics and marking nets at the time of manufacture to identify owners at some point in the future.

Second International Conference on Marine Debris (1989)

1. Pursue technological and procedural solutions to the marine debris and solid waste problems while avoiding policies and regulations that may restrict solutions.

2. Expand marine debris and solid waste disposal education to people and institutions worldwide, recognizing regional and cultural differences in the perception of these problems.

3. Design and implement experiments to evaluate ghost fishing in gillnet and trap fisheries with high gear loss rates, developing mitigative measures as needed

4. Evaluate the economic impacts of marine debris, both direct, as in vessel disablement and commercial fish loss, and indirect, as in aesthetic damage and solution costs.

Third International Conference on Marine Debris (1994)

1. Research and implement mechanisms to reduce fishing gear loss. These could include technological changes in gear design or incentives to recover lost gear. Given the appropriate incentives, the collection of derelict gear may be feasible.

2. Establish an impact reporting system to promote and collate observations by beach users, fishermen, oceanographers, scuba divers and others. Start by compiling past records.

3. Make efforts to recover lost fishing gear in areas where it is likely to be concentrated. Also, take steps to better evaluate the kinds and amounts of fish caught and the potential effectiveness of such work to clean up hazardous ghost fishing gear. Establish a system to record gear loss by commercial fishermen.

Table 4. provides a summary of comments received from several Pac-Rim nations concerning the types of ongoing governmental and industry programs and actions needed to deal with the issue of derelict fishing gear.

Table 4. Summary of Governmental and Industry Actions for Derelict Fishing Gear

	Nation				
	Cook Islands[1]	Fiji[2]	Japan[3]	Philippines[4]	Ko
Recommendations					
Degradable materials					
Education	X	X	X	X	
Gear Recycling	X			X	
Shoreside Disposal			X	X	
Shipboard Disposal Methods			X		
Gear Removal & Recovery Methods					
Enforcement	X	X	X		
Gear Loss Reduction Methods					
Monitoring		X		X	
Regulatory Measures	X	X			
Gear Marking				X	
Industry Code of Conduct	X				
Regional/International Cooperation	X	X			
Gear Restrictions	X	X			
Clean-ups					

1. Ministry of Marine Resources, Cook Islands
2. Ministry of Agriculture Fisheries and Forests, Fisheries Division, Fiji Islands
3. Office of Ecosystem Conservation, Resources and Environmental Research Division, Fisheries Agency Government of Japan
4. Bureau of Fisheries and Aquatic Resources, Republic of the Philippines
5. Ministry of Maritime Affairs and Fisheries, Republic of Korea
6. Fisheries Administration, Republic of China

4.0 Potential Topics for Working Group Discussion

A. Gear modification

1. Degradable materials

Synthetic fibers currently used in fishing gear construction degrade primarily due to exposure to UV radiation from sunlight and heat. As the material degrades it becomes more susceptible to microbial degradation. While the technology exists to chemically modify plastics to accelerate degradation and decomposition very little is known about the effectiveness of these techniques in the marine environment. Degradable escape panels are widely used in crab, lobster and shrimp traps. The cost of degradable materials that could potentially be used in fishing gear construction remain significantly higher than those synthetic fibers currently used (e.g., nylon and polyethylene). Questions remain about both the performance and safety of degradable plastics in fishing gear construction (Andrady 2000).

2. Lightstick modifications

Lightsticks are lost during the course of normal longline fishing operations. Lightsticks are positively buoyant and if ingested by marine mammals, seabirds or marine turtles can cause health problems. Proposed solutions to the problem have included requiring a deposit for lightsticks, increasing the length of the light stick to make it more difficult for marine life to ingest and developing sinking light sticks.

Lindgren and Pittman, a major manufacturer of lightsticks used in longline fisheries, has developed a battery-powered sinkable light stick. While initially more expensive than disposables, it is estimated that over time the costs will be cheaper than chemical disposables. Based on initial trials conducted in Florida there may be an increase in catch rates associated with the new lightsticks.

B. Gear marking

1. Gear Marking

The concept of marking fishing gear during manufacture for future identification has been proposed. The marking of nets through the use of some type of tracer has been proposed as a mains to help identify and reduce sources of lost fishing gear. Concerns have been expressed about the concept. During the lifetime of a net it may sold, traded or loaned and thus used by multiple vessels. Another consideration is the long residency time of lost fishing gear in the marine environment. Recovery of lost fishing gear may not occur until years after its loss. The vessel operator that lost or discarded the gear may no longer be involved in fishing. Gear marking is a potentially useful tool to help focus prevention, reduction and enforcement efforts on specific domestic and international sources of derelict fishing gear.

2. Color coding trawl web

Developing a color coding system to has been proposed as one possible means to identify sources of derelict webbing. In addition to the fishing industry, merchant shipping reportedly uses webbing that is indistinguishable from that used in some fishing net construction.

C. At-sea disposal systems

The US Navy has spent millions on developing vessel disposal systems for waste. The problem is scaling these systems down to a typical commercial fishing vessel. Some systems require more power than available on average commercial vessels. Some of the large, factory vessels might be able to accommodate the waste disposal systems developed by the Navy. The Government of Japan has provided support for the installation of on-board incinerators by the fishing industry.

At sea disposal systems include incinerators, burn barrels and compactors. A number of issues related to the use of the type of disposal methods include safety, effectiveness and costs.

D. Education and outreach

Educational programs, designed to inform all user groups and the public, have wide support among the fishing industry. Education is seen as one of the most effective means of influencing members of the public including fishermen (Anonymous 1988).

E. Enforcement

Enforcement of MARPOL is difficult. Nonetheless, the USCG has vigorously pursued enforcement of the law. Fines for MARPOL violations are high and have served as significant determent to the illegal disposal of nets and other plastics by fishing vessels. Review and inspection of fishing vessels waste management plans, procedures and logbooks by the USCG has led to enhanced compliance with MARPOL by the fishing industry.

F. Fishing Gear Disposal

Net disposal and recycling programs have proved popular with fishermen and have generally received industry support where implemented.

G. Economic Incentives

Providing economic incentives to help prevent and reduce the problem of derelict fishing gear has been proposed. Possible incentives include gear deposits, inventory and bounties for lost gear.

5.0 References

Alverson, D.L. and J.A. June. 1988. Proceedings of the North Pacific Rim Fishermen's Conference on Marine Debris. 13-16 October 1987, Kailua-Kona, Hawaii, Natural Resources Consultants, Seattle. 459 p.

Andrady, Anthony. 2000. Research Triangle Institute, Pers com.

Anonymous. 1988. Ocean of Plastic. Report on a Workshop on Fisheries-Generated Marine Debris and Derelict Fishing Gear. February 9-11, 1988, Portland, Oregon, USA. Alaska Sea Grant Report No. 88-7. December 1988. 68 pp.

Araki, Ed. 2000. Honolulu Agency, Inc., Pers com.

Burch, Alvin. 2000. Alaska Draggers Association, Pers com.

Carr., H. Arnold and Jessica Harris. 1997. Ghost Fishing Gear: Have Fishing Practices During the Past Few Years Reduced the Impact? In J.M.Coe and D.P. Rogers (eds.), Marine Debris: Sources, Impacts and Solutions. Springer-Verlag, New York. 432 p.

Coan, Atilio L. Jr., G. Sakagawa, D. Prescott, P. Williams, K. Staish and G. Yamasaki. 1999. The 1999 U.S. Central-Western Pacific Tropical Tuna Purse Seine Fishery. Annual meeting of parties to the South Pacific Regional Tuna Treaty, 3-10 March 2000, Niue.

Cottingham, David. 1988. Persistent Marine Debris: Challenge and Response: the Federal Perspective. Alaska Sea Grant Publication, no 1.

FAO, Fishing Technology Service, Fishing operations. *FAO Technical Guidelines for Responsible Fisheries*. No. 1 Rome, FAO. 1996, 26p., 6 Annexes.

FAO Code of Conduct for Responsible Fisheries. 1995. Food and Agriculture Organization of the United Nations, Rome.

Faris, J., and K. Hart, 1995. Sea of Debris: A Summary of the Third International Conference on Marine Debris, North Carolina Sea Grant College Program Publication No. UNC-SG-95-01, 54p.

Henderschedt, John. 2000. Groundfish Forum, Pers com.

Hendrickson, Steve. 1999. Skagit River Steel and Recycling, Pers com.

Koehler, Holly R., Brent Stewart, Paula Carroll and Terry Rice. 2000. Legal Instruments for the Prevention and Management of Disposal and Loss of Fishing Gear at Sea. Unpublished White Paper, International Marine Debris Conference on Derelict Fishing Gear and the Ocean Environment. Honolulu, Hawaii, August 6-11, 2000.

Laurs, Michael. 2000. Minutes 104th Meeting of the Western Pacific Fisheries Management Council, 14-15 June 2000, Makena, Hawaii.

Leipzig, Peter. 2000. Fisherman's Marketing Association, Pers com.

National Fisheries Institute. 2000. http://www.nfi.org/main.html.

National Marine Fisheries Service. 2000. http://www.st.nmfs.gov/recreational/index.html

O'Hara, Kathryn J., S. Iudicello and R. Bierce (eds.). A Citizens Guide to Plastics in the Ocean: More than a Litter Problem. Center for Marine Conservation. Washington, 1988. 143 p.

Recht, Fran. 2000. Pacific States Marine Fisheries Commission. Pers, Com.

Recreational Fishing Alliance. 2000. http://www.savefish.com
Shomura, R.S. and M.L. Godfrey (eds.), 1990. Proceedings of the Second International Conference on Marine Debris 2-7 April 1989, Honolulu, Hawaii. U.S. Department of Commerce, NOAA Technical Memorandum. NMFS, NOAA-TM-NMFS-SWFSC-154. 1274 p.

Shomura, R.S. and H.O. Yoshida (eds.), 1985. Proceedings of the Workshop on the Fate and Impacts of Marine Debris 27-29 November 1984, U.S. Department of Commerce, NOAA Technical Memorandum. NMFS, NOAA-TM-NMFS-SWFSC-54. 580 p.

Topping, P.D. Morantz and Glen Lang. 1997. Waste disposal practices of fishing vessels: Canada's east coast (1990-1991) In J.M.Coe and D.P. Rogers (eds.), Marine Debris: Sources, Impacts and Solutions. Springer-Verlag, New York. 432 p.

Uchida, R.N. 1985. The types and estimated amounts of fish net deployed in the North Pacific. In *Proceedings of the Workshop on the Fate and Impacts of Marine Debris 27-29 November 1984, U.S. Department of Commerce, NOAA Technical Memorandum. NMFS, NOAA-TM-NMFS- SWFSC-54. 580 p.*

Zuanich, Robert. 2000. Purse Seine Vessel Owners Association, Pers com.

APPENDIX 1

"Fisherman's Pledge For a Clean Ocean"

I recognize that a clean, productive ocean is necessary for the livelihood of fishermen throughout the world.

I realize that pollution and marine debris, particularly plastics, threaten marine life and my safety at sea.

Therefore, I pledge to:

Return all discarded fishing gear and other plastics to port and dispose of them properly;

Make every effort to prevent accidental loss of fishing gear;

Make an effort to safely collect others' lost fishing gear and debris I find at sea and return them to port for proper disposal;

Follow the marine debris regulations required by the international treaty, MARPOL Annex V; and

Encourage all my fellow fishermen to follow my good example.

Through these actions I will preserve clean ocean today and for fishermen of the future.