WHAT CAN BE DONE ABOUT CONFLICTS BETWEEN MARINE MAMMALS AND FISHERIES?

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ABSTRACT

Conflicts between marine mammals and fisheries are of two sorts: those in which the mammals harm the fishery, and those in which the fishery harms the mammals. Examples of each are presented. Potential reasons to conserve marine mammals include their value as fishery resources, as parts of complex natural systems, as resources for tourism and education and as unique biological entities deserving continued existence. Marine mammal populations are highly vulnerable to depletion because of low reproductive rates. Possible solutions to conflicts include closing the fishery, removing the mammals, scaring or warning the mammals away, releasing entangled mammals, closing areas to fishing, closing seasons to fishing, modifying fishing gear, modifying fishing practices, and setting safe limits on mammal kills. Examples of each are given. A series of steps that can be followed in resolving conflicts are presented.

INTRODUCTION

The purpose of this paper is to review the question of conflicts between marine mammals and fisheries in general and to offer examples of how such conflicts might be resolved. I will address three questions:

1) What are the conflicts?

2) Why worry about the marine mammals?

3) What can be done?

WHAT ARE THE CONFLICTS?

Marine mammals cause problems for fisheries, and fisheries cause problems for marine mammals. A few examples of each kind of conflict follow; there are many more.

Marine mammals causing problems for fisheries

Killer whales in Alaska

Killer whales (*Orcinus orca*) eat many of the same fish that humans eat, and sometimes they decide that it's easier to let humans catch the fish for them than it is to catch the fish themselves. This, of course, makes the fishermen unhappy. This has happened in Alaska, in the bottom longline fishery for blackcod, *Anoplopoma fimbria*, in the Gulf of Alaska and Bering Sea (Dahlheim, 1988; Holleman, 1988).

The U.S. blackcod fishery began in the early 1980s and is still expanding. The fishermen set the longlines on the bottom at depths of 400-1100 meters. The longlines are typically 3.5-7 kilometers meters long, with hooks at about 1-meter intervals.

The fishermen first reported damage to catch by killer whales in 1985, in Prince William Sound. Only one pod of killer whales was involved at first. The behavior has since spread to other pods and other areas. The whales bite off the bodies of the blackcod while the longline is being retrieved, leaving only the head. They gather at the buoy markers when a fishing vessel approaches, waiting for the fishermen to haul the longline.

The damage has been considerable. About 20% of the catch is taken by killer whales in some areas. The cost to the fishermen averages about $2,300 per day. The total loss since the problem began may be over a million dollars.

The fishermen tried to solve the problem themselves. They tried many methods to scare or trick the whales, including seal bombs, decoy boats, night fishing, shooting, explosives, electricity and other things. Some of this was illegal, of course. The State of Alaska tried other things, but without much success. In the last two or three years, the problem has diminished in some areas, possibly because the individual whales doing most of the thieving have been killed by the fishermen. Meanwhile, research continues.

Sea otter in California

The sea otter, *Enhydra lutris*, is a very attractive and endearing animal. Unfortunately, it too likes to eat what humans eat, in this case abalone.

The sea otter was almost exterminated in California by fur hunters in the 19th Century (Kenyon, 1981). Since the late 1930s, a small remnant population has grown and re-expanded the range to much of the coast of central California. As this happened, the otters moved into areas that had been free of otters for many years. The abalone populations in these areas were very high because of the otters' absence. The high abalone populations had supported very valuable fisheries. When the otters came, the abalone became very scarce. Not only did the

abundance decrease, but the average size also decreased greatly. Where sea otters are present in large numbers, only the small abalone that can get into crevices beyond the reach of sea otters survive.

Abalone populations in California overall have fluctuated for a variety of reasons, including overfishing, but there can be no doubt that sea otters and commercial abalone fisheries are incompatible (Estes and VanBlaricom, 1985). In California, environmentalists have formed an organization called Save Our Shellfish (S.O.S.), and the fishermen have formed a group called Friends of the Abalone.

Dolphins in Japan

Dolphins and small whales affect fisheries in Japan in a number of ways (Kasuya, 1985). They damage fishing gear, take fish from hooks and nets and are reported to disperse fish schools or cause the fish to stop feeding. The main cetaceans involved are the bottlenose dolphin (*Tursiops truncatus*), the false killer whale (*Pseudorca crassidens*), Risso's dolphin (*Grampus griseus*) and the Pacific white-sided dolphin (*Lagenorhynchus obliquidens*). The greatest effect is on the yellowtail (*Seriola dorsalis*) and squid fisheries at Iki Island and other neighboring islands. This has been known since the early part of the century, and the fishermen and the local government have been trying to deal with the problem since that time.

In the mid-1970s, after other remedies had been tried, large culls began at Iki Island, and the situation came to the attention of the world. The picture has been confused by two scientific findings: some of the fish stocks in the region may be declining due to overfishing, and examination of stomach contents of the dolphins and whales has shown that only one of them, the false killer whale, feeds on yellowtail.

Seals and sea lions in California

Seals and sea lions interfere with fisheries around the world. In California, the main species are the harbor seal (*Phoca vitulina*), which you see here, and the California sea lion (*Zalophus californianus*). Nearly all of the direct damage to catch and gear in California is caused by these two species.

The most severe damage is to the catch. This table (from DeMaster et al., 1985) shows the estimated annual value of fish and gear stolen or damaged by marine mammals in California in 1979-81. The estimated annual total is about $600,000. The largest financial loss reported was in the commercial salmon trolling fishery. A minimum loss of $130,000 was estimated for the month of May, 1980; this did not include damage to gear.

Fisheries causing problems for marine mammals

Tuna fishery in the eastern Pacific

The tuna purse-seine fishery in the eastern tropical Pacific has killed millions of dolphins in the last 30 years (Allen, 1985).

The fishermen seek out the dolphin schools and set their nets on them in order to catch the tuna that associate with the schools. The main dolphins involved are the spinner dolphin (*Stenella longirostris*) and the pantropical spotted dolphin (*Stenella attenuata*). Many of the dolphins become entangled in the folds of the net and suffocate. The dead dolphins are discarded.

The dolphin kill declined in the 1970s from its very high level of nearly a half million annually in the early 1960s. In the mid 1980s, it went up again. Earlier on, most of the kill was by the United States fleet, but in recent years most of the kill has been by the vessels of other nations, including Mexico, Venezuela, Ecuador and others (data from Inter-American Tropical Tuna Commission, Nov., 1990).

Gillnet fisheries in the western North Atlantic

Harbor porpoise seem especially vulnerable to being entangled in gillnets. One example of this is along the east coasts of the U.S. and Canada, where there are several gillnet fisheries for cod, hake and pollack. The nets are set on the bottom and vary between 450 to 2000 meters in length. There are thousands of vessels, each setting about 5 km of net a day (Read, 1990).

It is estimated that the fisheries kill 300-800 harbor porpoise a year. This is 4-10% of the estimated population of 8000 porpoises. With this pressure, the population will almost certainly decline.

Driftnet fisheries in the North Pacific

Several hundred driftnet boats operate in the North Pacific. They come from Japan, Taiwan and Korea and fish mainly for squid, tuna, pomfret and salmon. Each boat fishes as much as 50 km of net a day, making the total in a year several million km of net. These nets kill dolphins, porpoises, whales, birds, turtles, sharks and unwanted fish (Jones et al., 1990).

One of the dolphins killed in large numbers is the northern right whale dolphin (*Lissodelphis borealis*). A very crude estimate of total kill of the right whale dolphin is 18,000 a year (IWC, in press). (It must be stressed that this estimate is based on extrapolation from a very small sample of data that may not be representative of the entire fisheries.) The population size is unknown, therefore the impact of the incidental kill on the population is also unknown.

Coastal fisheries in Peru

Coastal fisheries of a wide variety in Peru have grown tremendously since the collapse of the anchoveta fishery, wnich was the largest fishery in the world, a few years ago put many fishermen out of work. These fisheries use small gillnets and purse seines. As bycatch, they kill dusky dolphins (*Lagenorhynchus obscurus*), Burmeister's porpoise (*Phocoena*

spinipinnis) and common dolphins (*Delphinus delphis*) in large numbers and smaller numbers of many other species (Reyes and Oporto, 1990).

The dolphins and porpoise that the fishermen catch go to the market. The public has developed a taste for them, so now the fishermen go out to hunt dolphins, using nets and harpoons. Something more than 1800 dusky dolphins are killed by boats operating out of the major fishing ports. Since the structure and size of the dolphin populations are unknown, the impact is unknown.

WHY WORRY ABOUT THE MARINE MAMMALS?

A logical question is, why worry about marine mammals? We know why we should worry about the fisheries; many of us depend on them for a living, and our nations depend on them for food. But why should we worry about the marine mammals? People's attitudes toward marine mammals vary a great deal. Some people view marine mammals as requiring complete protection. Others view them only as something to eat or as nuisances to be eliminated. In any case, most of us would agree that there are several potential reasons to care about what happens to marine mammals, even if we don't agree on their relative importance.

1) Marine mammals themselves are fishery resources.
Marine mammals are not eaten just by Eskimos. They are also eaten in Japan, India, Sri Lanka, Peru, Norway, Spain, France, Greenland, Canada, the Soviet Union, the United States and many other countries, not by everyone, but by some people (Report of the IWC, 1980-1990; IWC, in press). If we drive a population of marine mammals to extinction, then we eliminate forever the possibility of using it as such a resource.

2) Marine mammals function as parts of natural systems.
Marine mammals are parts of complex ecological systems. We cannot always predict what will happen when we remove part of such a system. For example, what would happen to the valuable tuna fisheries in the eastern tropical Pacific if the dolphins the tuna associate with were removed? Would the tuna be able to find enough food on their own? Would the fishermen be able to find the tuna?

In another example, gray whales may be very important to the bottom ecology of the Bering Sea because of their feeding behavior (Nerini, 1984; Oliver, 1983). The conditions they create by constantly digging up the bottom may promote productivity. What would happen to the valuable fisheries in the Bering Sea if the ecosystem there were disturbed by removal of the gray whales?

There are many more such examples; in some cases cetaceans may even benefit fishermen by eating species that could compete with fishermen for commercially valuable fish (Katona and Whitehead, 1988).

3) Marine mammals have value for tourism and education.
Another reason to worry about marine mammals is that they can be very valuable for tourism and education. The whale-watching industry is worth millions of dollars annually in California (Tilt, 1986) and is growing rapidly in other places, including Japan and Norway.

4) Marine mammals, like other creatures, deserve to exist and should not be killed unnecessarily.
Many people worry about marine mammals because they believe that they should not be killed. This must be included in the list of potential reasons for the government to worry about the welfare of marine mammals.

Marine mammal populations are very easily depleted.
If we accept any of these reasons to worry about marine mammals, then we must consider two important facts about them. First, marine mammal populations are very easily depleted (IWC, in press). This is mainly because of their low reproductive rates. They are not like fish, which can produce thousands of eggs at a time. They are more like humans; they produce one calf a year at a maximum. Pregnancy lasts 10 to 15 months, depending on the species. The usual interval between births in dolphins is two years or more. The calf may nurse for more than a year. Dolphins are not sexually mature until they are about 6-12 years old, depending on the species. The result of all this is that most dolphin populations cannot stand kills of more than a few percent a year, or even less; more than that and the population declines.

Depleted marine mammal populations require a very long time to recover.
The second caution is that this low reproductive rate means that recovery of a depleted population is very slow. The damage that is done by a fishery in a year or two could take generations to repair.

In some cases, it may not be possibly to restore a depleted population. For example, the blue whale has completely protected in the Antarctic since the 1960s, but it has not recovered; numbers are still very low (Perrin, 1989). It may never recover; the food resources that it used in the past may now be important to other animals that increased in number after depletion of the blue whale. These possible replacements include crabeater seals, penguins and perhaps other, smaller whales. The system may arrive at a new balance that does not include a lot of blue

whales. This tells us that in some cases it may not ever be possible for a depleted population to recover; once it's gone, it may be gone forever.

WHAT CAN BE DONE ABOUT THE CONFLICTS?

If we believe that both fisheries and marine mammals are worth worrying about, then we must consider how to resolve the existing conflicts between them. There have been many attempts at solutions in a number of places. Some have worked; others have not. A partial list:

1) *Close the fishery.*
2) *Remove the mammals (cull or translocate).*
3) *Scare the mammals away.*
4) *Release the mammals.*
5) *Close areas to fishing.*
6) *Close seasons to fishing.*
7) *Modify fishing gear.*
8) *Modify fishing practices.*
9) *Set safe limits on mammal kills.*

Examples of each of these follow:

1) Close the fishery.

One example of a fishery closure is what happened to the driftnet swordfish fishery in Italy. The fishery killed thousands of cetaceans, including the sperm whale you saw a minute ago. Hundreds of them washed up on the beaches. The Italian Government last year banned the fishery, because of public pressure (IWC, in press).

Another example is the coastal gillnet fishery for halibut in California. This fishery kills harbor porpoise and other marine mammals (Heyning et al., 1990;Barlow et al., in press; Fulton, 1989). The people of California voted last year to close the fishery and buy out the boats.

In these examples, the mammals are now protected, but the fisheries, of course, are gone or will be gone, jobs will be gone, and fish prices may go up for the consumer.

2) Remove the mammals.

One example of the removal of marine mammals in conflict with fisheries, of course, is the cull at Iki Island in Japan. This was an extreme measure, and the consensus now is that it probably was not effective.

Alternatives to killing the mammals are to prevent them from entering the fishery area or translocate them. This approach is being used in southern California for the sea otter. The otter population is presently being prevented from expanding to the

south, in order to maintain an otter-free zone in which abalone, clam, oyster and sea-urchin fisheries can continue. When otters stray into the fishery zone, they are captured and moved back to the otter zone. This scheme has not been in use long enough yet for us to know if it is going to work. It is a compromise between those who don't care much about the otters and those who don't care much about the fisheries. The recovery plan for otters in California also includes the establishment of a new population at San Nicolas Island (Fulton, 1988).

3) Scare the mammals away.

Most attempts to warn or scare the marine mammals away from the fishing operation, to prevent either theft of the catch or entanglement of the mammals, have been failures. This did work in one case in Alaska, where killer whale sounds have been used to prevent white whales (*Delphinapterus leucas*) from entering a salmon stream (Fish and Vania, 1971).

In another example, there are plans to use acoustic alarms to warn humpback whales away from cod traps in Newfoundland (Lien et al., 1990). The whales apparently recognize the alarms, and the hope is to condition them to associate the alarms with the dangerous nets. This is possible because the whales are very large and strong and most of the time escape alive from entanglements.

There are many cases where the alarm approach has been tried but failed. These include the tuna fishery in the eastern tropical Pacific, where we tried killer whale sounds, and at Iki Island, where a variety of noises and sound devices were tried. Another place the approach has failed is in the salmon driftnet fishery in the North Pacific (Hatekeyama et al., 1990). The usual problem is that the mammals react to the sounds initially but soon accomodate to them and ignore them. The animals are relatively intelligent and quickly understand that the noises are harmless. The noises may actually act as beacons to attract the marine mammals to the netted fish. And the dolphins and porpoises that become entangled do not learn to associate the warning with the dangerous nets, because they are unable to escape and they die (IWC, in press).

4) Release the mammals.

One way to reduce the number of marine mammals dying in nets is to rescue as many as possible from the nets. This is required in the U.S. tuna fishery in the eastern Pacific, where about 99% of all the dolphins captured are now released alive (data from Porpoise Rescue Foundation, 1987) compared to about 80% in the 1960s (Perrin, 1970). This has also helped in California, where several gray whales have been cut loose from gillnets and in Newfoundland, where nearly all humpback whales entangled in cod traps are now released alive pers. comm. from John Lien, 1990).

Of course, for best success this approach requires that the net be closely tended, because mammals entangled below the surface will quickly drown if not released.

Rescuing large whales is difficult and dangerous. A special program has been set up in Newfoundland to train and equip the fishermen to do this, and the IWC has recommended that similar programs be established elsewhere (IWC, in press).

5) Close areas to fishing.

If large kills of marine mammals occur in only part of the area of operation of a fishery, then the kill can be eliminated or reduced by keeping the fishery out of that area. This was successful in reducing the incidental kill of sea otters in Central California. The gillnetters were prohibited from setting their nets in very shallow water near shore. The kill of sea otters dropped a great deal very rapidly (Fulton, 1985).

This approach has also been effective around the Channel Islands in California, where fishermen have been prohibited from setting their nets in shallow water near seal and seal lion rookeries. This has reduced the incidental kill of pinnipeds. The fishery still exists but operates elsewhere.

6) Close seasons to fishing.

If the marine mammals migrate through an area or live there only part of the year, then a seasonal closure of the area to a fishery can reduce the incidental kills. This has been successful in New Zealand, where gillnetting has been banned in waters around Banks Peninsula during the part of the year when Hector's dolphins (*Cephalorhynchus hectori*) are most common there (Dawson, in press).

In California, waters along the migration route of the gray whale (within 25 miles of shore) are closed to driftnetting during the migration season. This has resulted in a lower frequency of entanglements (LaGrange, 1990).

7) Modify fishing gear

There have been many attempts to reduce kills of marine mammals by modifying the fishing gear. Some of these have succeeded and others have failed.

One success has been in the tropical tuna fishery in the eastern Pacific. The entanglement rate has been lowered by using smaller mesh webbing in parts of the seines and by modifying part of the net to allow the dolphins to escape more easily during rescue operations. These changes, together with a requirement that live animals in the net be rescued, has reduced the U.S. dolphin kill rates by a factor of 10 over the last 20 years (data from Inter-American Tropical Tuna Commission).

There have been many attempts to make gillnets more detectable for dolphins by making them more "visible" acoustically. Most of these experiments have not been successful. This has been tried in the salmon driftnet fishery in the North Pacific, in the Taiwanese shark gillnet fishery off Australia, and in other fisheries. The problem may be that the dolphins can easily detect the nets but are just too busy pursuing prey and don't pay any attention to them (IWC, in press).

A gear modification that has been successful in California is the use of lighter twine in gillnets. This allows large whales to break free before they drown (LaGrange, 1990).

There is much room for more research to develop fishing gear that is less dangerous to marine mammals.

8) Modify fishing practices

The way in which nets are set can reduce marine mammal kills. For example, in the U.S. tuna fishery in the eastern tropical Pacific, the captains identify the portion of a dolphin school "carrying" the most tuna and try to isolate it from the rest of the school before setting the seine. Thus the number of dolphins captured is lower, but the tuna catch remains high.

There have been several experiments with setting drift nets below the surface rather than at the surface. This was done in the Taiwanese shark fishery off Australia (Hembree and Harwood, 1987). Fewer dolphins were caught, but fewer fish were caught also. The results of similar trials of subsurface nets in the Japanese driftnet fishery for tuna in the South Pacific and squid in the North Pacific have been unconclusive. In this case, the fish catches were unaffected, but it was not clear that the dolphin catch rates were lower (Hayase and Watanabe, 1990). We need more research here.

9) Set safe limits on mammal kills.

Limits or quotas can be set on kills or kill rates. However, in order to know what a safe level is, you must know something about the size and reproductive rates of the mammal population. We usually don't have this information, and it's very expensive to obtain it. It's very difficult to set safe limits; this is one of the reasons that the International Whaling Commission has temperarily halted commercial whaling; we don't know what is safe.

One case where quotas have been used for U.S. fishermen is in the tropical tuna purse-seine fishery. The limits here are not based on population analysis and do not apply to the entire international fleet. The quotas for the U.S. fleet are almost certainly far below levels that would endanger the populations. (However, the takes by the non-U.S. fleets exceed the U.S. take by a wide margin.) U.S. law says that the kills should be as low as practically possible, that no dolphins should be killed

unnecessarily. The overall quota of 20,000 dolphins of all species and the quotas for individual species and stocks are based on the kill rates for the more capable captains. In some years, the quotas have been filled before the end of the year, and the U.S. fishermen were prohibited from setting their nets on dolphins for the rest of the year. This approach is valuable because it motivates the fishermen to fish in such a way that they minimize the dolphin kills. The fewer dolphins they kill, the longer they can fish.

We also have quotas for some pinnipeds for U.S. coastal fisheries in the North Pacific. 675 Steller sea lions, (*Eumatopias jubatus*) and 50 North Pacific fur seals (*Callorhinus ursinus*) may be killed annually. We have fairly good estimates of population size for these animals, because they come out on land to bear young.

We hope to be able to set safe mammal kill limits for many other fisheries in the future. We are just now doing the necessary research to estimate what is safe (Barlow et al., in press). There are very many fisheries, so it is a large undertaking. We have classified all of our fisheries into three categories based on mammal kills:

Category I. Those taking marine mammals frequently (more than one in 20 days),

Category II. Those taking them occasionally (one in 20 days), and

Category III. Those with a remote or no liklihood of taking marine mammals (none in 20 days).

Category-1 and Category-2 vessels must obtain permits to continue fishing. Category-I vessels must carry government observers if asked. The Category-1 fisheries have the highest priority in our research to determine what the kill levels are and what is safe.

Choosing an approach

The choice of approach depends on the situation. Each fishery is different, and each problem is different. The choice also depends on the prevailing laws and on the value systems and goals of the people who make and influence the decisions. There can be concern about the mammals and goals at three levels:

1) *Prevent extinction of the species or population.* (Nearly all would agree with this goal, including most fishermen.)

2) *Prevent significant decrease in the population.* (Most of the public and wildlife managers would probably agree with this goal, but most of the fishermen may disagree).

3) *Prevent the killing or harm of any marine mammal, for any reason.*
(This view is held by some of the public but not by others, and usually by very vew fishermen.)

In deciding on a solution, the views, goals and needs of all should be considered. However, damage to some interest may be unavoidable. It may be necessary to close or severely restrict a fishery to save a marine mammal population from extinction or severe depletion. Or, it may be necessary to allow the continued kill of some marine mammals in order to save a valuable fishery. We have had both of these experiences in the United States.

How to proceed

Experience has taught us that there are several logical and necessary steps to take in solving a conflict between marine mammals and fisheries:

1) Determine the nature, extent and monetary costs of the conflict, based on independent and objective observations, data and analyses.

2) Determine the extent, size and status of the marine mammal population(s).

3) Give all involved and interested parties an opportunity to state their needs and views and have their questions answered.

4) Decide what the goals are and what legal requirements must be satisfied.

5) Develop a plan to solve the problem, with time limits and criteria of success for each step.

6) Provide the resources (money, authority, people and equipment) needed to carry out the plan and enforce its provisions.

6) To the extent possible, involve the fishermen, local residents and other interested parties in carrying out the plan.

7) Monitor the results and decide if the plan succeeded.

8) Develop a plan to mitigate any damage done to the fishery, and provide the resources to carry it out.

We have not always carried out all of these steps, or even most, in the United States, of course, and we have had our share of irrational or unwise decisions, delays, failures, and unwanted damage to fisheries and to marine mammal populations. We hope that we will do better in the future; we must try. Our goal is to have both healthy fisheries *and* healthy marine mammal populations.

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