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WORKSHOP ON MARINE MAMMAL-FISHERIES INTERACTIONS IN THE NORTHEASTERN PACIFIC

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16. Abstract The workshop reviewed what is currently known of marine mammal/fisheries conflicts in Alaska, British Columbia, California, Hawaii, and Oregon (except sea otter and tuna/porpoise problems). Set gear types (such as longlines and gill nets) are more troubled by marine mammals (principally harbor seals and Steller or California sea lions) taking the catch and damaging gear and moving types of gear (such as trolled hooks or drag nets). There are increased conflicts with sport fisheries due to redistribution since the MMPA of 1972. The participants determined what data and methods were needed to make future management decisions and recommended that research be initiated on the conflicts of the Columbia River to develop these types of data.

17. Originator's Key Words

Marine Mammal/Fishery Conflicts, Seal, Sea Lion, Porpoise, Gillnet Fishery, Longline Fishery, Troll Fishery, Drag Fishery, Fishing Gear Damage, Competition, Optimum Sustainable Population, Maximum Net Productivity, Harassment, Incidental Take, Carrying Capacity

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INTRODUCTION

Marine mammals interact with sport and commercial fisheries in a number of ways. They are taken incidentally in fisheries such as the yellowfin tuna purse seine fishery, are responsible for gear damage and loss or damage of caught fish in fisheries such as the North Pacific salmon gill net fishery, and, in several areas, compete with fishermen for the same fish resources. The Marine Mammal Protection Act of 1972 was enacted, in part, because of concern that certain species and stocks of marine mammals were in danger of extinction or depletion as a consequence of incidental mortality and injury associated with fisheries such as the yellowfin tuna purse seine fishery.

Prior to passage of the Marine Mammal Protection Act, sport hunting, bounty hunting, and various forms of harassment were used to control the distribution and/or abundance of certain marine mammal populations to eliminate or reduce competition for fish resources and gear damage, fish damage, and fish loss caused by marine mammals. The Act imposed a moratorium on such taking and, in recent years, there have been reports that populations of harbor seals and other marine mammals are increasing and that there has been a corresponding increase in the amount of gear damage, fish damage, and fish loss caused by marine mammals.

In response to the reports that marine mammal-caused gear damage, fish damage, and fish loss were increasing in some areas, the Marine Mammal Commission (MMC) sponsored a workshop to better identify the nature and magnitude of the problem and what could be done to resolve it. Since most reports of increasing gear damage etc. were from Alaska, Washington and Oregon, the workshop focused on identifying the nature and magnitude of the problem in these states. Because of similar problems in adjacent states or countries and the possible movement of the involved marine mammals across state and national borders, conflicts between fisheries and marine mammals in Hawaii, California, and British Columbia also were considered. 1/

The workshop was held in Seattle, Washington on 19 and 20 December 1977 (Appendix I is the workshop agenda). Participants included representatives of the Marine Mammal Commission, the National Marine Fisheries Service, the fishing industry, the academic community, the Province of British Columbia, and the States of Alaska, Washington, Oregon, California and Hawaii (Appendix II is the list of participants). The workshop objectives were to determine:

1. which species of marine mammals interact with specific fisheries in Alaska, British Columbia, Washington, Oregon, California and Hawaii;

2. how much is known regarding each of the marine mammal-fishery interactions (i.e., the extent of incidental take, gear damage, fish damage, and fish loss);

1/ To sharpen the focus of the workshop, issues related to the "tuna-porpoise" problem and the sea otter/shellfish issue in California, which are well known, were not considered during the workshop.

3. the types of biological, ecological, and socio-economic data that will be needed to make sound management decisions regarding such interactions; and

4. the methods of data collection that should be employed to obtain the quantity and quality of data needed to make sound management decisions.

Background papers were prepared by a number of workshop participants and were circulated prior to the workshop and/or provided to participants during the workshop (Appendix III lists the background papers).

BACKGROUND

Prior to passage of the Marine Mammal Protection Act of 1972, most aspects of marine mammal protection and conservation were the responsibilities of coastal states and/or international authorities such as the International Whaling Commission, the North Pacific Fur Seal Commission, and the International Commission on North Atlantic Fisheries. Management by some of these authorities, particularly the international authorities, was not very effective and, in the late 1960's, there were expressions of concern, by the American public and the Congress, that certain species and populations of marine mammals were in danger of extinction or depletion as a result of man's activities. (cf., H.R. Report No. 92-707 (1972), H.R. Report No. 92-1488 (1972), and S. Rep. No. 92-863 (1972)).

The Act established a moratorium on the taking of marine mammals in U.S. waters and the importation of marine mammals and marine mammal products into the U.S. It defines "take" as harassing, hunting, capturing, killing, or attempting to harass, hunt, capture, or kill any marine mammal and provides a special exemption for the taking of marine mammals by certain natives for subsistence, handicrafts, and clothing. It also provides for waiver of the moratorium and return of management to the states, and for issuing permits to take marine mammals incidental to commercial fishing operations and for purposes of public display and scientific research.

Under the Act, the Secretary of Commerce is responsible for cetaceans and pinnipeds, other than walrus, while the Secretary of the Interior is responsible for all other marine mammals (i.e., walrus, manatees, dugongs, sea otters, and polar bears). The Secretaries of Commerce and the Interior have delegated responsibilities to the National Marine Fisheries Service and the U.S. Fish and Wildlife Service, respectively, and are authorized, among other things, to support research relative to the conservation and protection of marine mammals and to make grants to assist States in developing and implementing State programs for the

protection and management of marine mammals. The Act established the Marine Mammal Commission to advise the Secretaries of Commerce and the Interior, and other Federal officials, as to actions needed to meet the intents and provisions of the Act.

The primary objective of the Marine Mammal Protection Act is to maintain the health and stability of the marine ecosystem and, whenever consistent with this primary objective, to obtain and maintain optimum sustainable populations of marine mammals. The Act defines "optimum sustainable population" ("OSP") as "the number of animals which will result in the maximum productivity of the population or the species, keeping in mind the optimum carrying capacity of the habitat and the health of the ecosystem of which they form a constituent element." "Optimum carrying capacity" is defined as "the ability of a given habitat to support the optimum sustainable population of a species or population stock in a healthy state without diminishing the ability of the habitat to continue that function."

To facilitate application in the management context, the National Marine Fisheries Service has interpreted the statutory definition of "OSP" as follows:

> "Optimum sustainable population is a population size which falls within a range from the population level of a given species or stock which is the largest supportable within the ecosystem to the population level that results in maximum net productivity. Maximum net productivity is the greatest net annual increment in population numbers or biomass resulting from additions to the population due to reproduction and/or growth less losses due to natural mortality." (50 C.F.R. 216.3)

This "interpretive" definition of OSP has been used in the course of decisions concerning the status of porpoise stocks impacted by the yellowfin tuna purse seine fishery and the State of Alaska's application for a waiver of the moratorium on taking marine mammals. (cf. Report of the workshop on stock assessment of porpoises involved in the Eastern Pacific yellowfin tuna fishery. La Jolla, California. July 27-31, 1976. SWFC Admin. Rpt. No. LJ-76-29.).

The "interpretive" definition of OSP and the aforementioned provisions of the Act, as well as the information summarized below, were discussed by the workshop participants and considered in the process of identifying research and management needs.

SUMMARY OF AVAILABLE DATA

As noted above, a number of workshop participants prepared background papers which were presented and discussed during the course of the workshop. The information contained in these papers is summarized below. 2/

Marine Mammals and Fisheries being Affected

Marine mammals that affect, and/or are affected by, sport and commercial fisheries in Alaska, British Columbia, Washington, Oregon, California and Hawaii include the harbor seal (Phoca vitulina), the Steller sea lion (Eumetopias jubatus), the California sea lion (Zalophus californianus), the northern fur seal (Callorhinus ursinus), the gray whale (Eschrichtius robustus), the humpback whale (Megaptera novaeangliae), the beluga whale (Delphinapterus leucas), the pilot whale (Globicephala macrorhynchus), the killer whale (Orcinus orca), the bottlenose dolphin (Tursiops truncatus), the harbor porpoise (Phocoena phocoena), and the Dall porpoise (Phocoenoides dalli). The commercial fisheries being affected by marine mammals include: salmon gill net and troll fisheries in areas such as Bristol Bay (Alaska), the Copper River Delta (Alaska), the Columbia River (Washington-Oregon), Willapa Bay and Gray Harbor (Washington), and Monterey Bay (California); the Japanese salmon drift net and sablefish fisheries in the Bering Sea; the North Pacific halibut fishery; the Alaskan king crab fishery; the West Coast hake and herring fisheries; the California squid and anchovy fisheries; and long-line, hand-line, and troll fisheries for tuna, bottom fish, and other species in Hawaii. The sport fisheries being affected include salmon and steelhead fisheries, particularly on the Columbia River (Washington/Oregon) and the Rogue, Umpqua, Siletz, and Alsea Rivers in Oregon.

History and Present Status of Marine Mammal Populations and Management

The history and present status of marine mammal populations and management in the Pacific states and the Province of British Columbia are as follows: 3/

2/ Because of time contraints, workshop discussions were focused primarily on issues related to the incidental take of marine mammals and marine mammal-caused gear damage, fish damage, and fish loss. The need to consider the possible biological and socio-economic effects of marine mammals and fishermen competing for the same fish resources was recognized and is discussed briefly in Appendix VI.

3/ The information summarized here has been extracted from background papers and other data sources provided by the workshop participants. The subject area is complex and is not discussed completely.

1. Alaska (This summary is based upon information provided by by J. Burns, L. Lowry and K. Pitcher.)

Alaska has the greatest variety and largest populations of marine mammals in U.S. waters. Utilization of these species occurred prior to European influence and continues today by natives for subsistence. A seal control program was instituted in 1927 to reduce pinniped populations believed to be preying heavily upon salmon in river mouth areas such as the Copper River Delta and Bristol Bay. During the period between 1951 and 1958, 30,000 harbor seals were taken from the Copper River Delta (Lensink, 1958). A regulated harvest program was initiated in 1958.

The Marine Mammal Protection Act ended the State's harvest program and management authority. Immediately after passage of the Act, the State requested a waiver of the moratorium and return of management authority for nine marine mammal species. After more than five years, a waiver and return of management has been effected for only one species (walrus, Odobenus rosmarus). A decision on the remaining eight species is pending. 4/

Information compiled by the State and presented during the "waiver" proceedings indicates that the marine mammal populations, for which the State requested a waiver, are within the "optimum range" defined by the National Marine Fisheries Service (see page 3). 5/

4/ Since this workshop, the return of walrus management to the State of Alaska has been challenged in a law suit concerning the regulation of taking by Alaskan natives and the State has returned management to the Fish and Wildlife Service which has suspended the waiver. The waiver and return of management of the other eight species has been conditionally approved but will not be effective until the State's revised laws and regulations are submitted and approved. Further action to implement the waiver and return of management have been delayed pending a decision by the court and resolution of associated issues.

5/ This information, as well as other information, concerning the waiver proceedings can be requested from the Alaska Department of Fish and Game, the National Marine Fisheries Service, and the U.S. Fish and Wildlife Service.

2. British Columbia (This summary is based upon information provided by M. Bigg.)

Since 1913, marine mammal management policies in British Columbia have varied according to public opinion. From 1913 to the 1960's, salmon fisheries influenced marine mammal management policies. As a result, marine mammals were harassed or killed to minimize competition, gear damage, fish damage, and fish loss. During the period from 1913 to 1978, a reported 58,000 Steller sea lions were killed in government hunts, commercial harvests, and by fishermen (one major rookery was completely eliminated by 1939). From 1914 to 1964, approximately 110,000 harbor seals were reported killed. Protection was afforded sea lions, harbor seals, elephant seals, killer whales, and sea otters in 1970. Under this policy, none of these animals can be harvested or killed without a permit. Since 1970, no permits for control programs have been issued.

In 1968, the Steller sea lion population was estimated at 5,000 to 6,000 animals (down from 12,000 to 14,000 in 1913). The present population of harbor seals is on the order of 30,000 to 40,000 individuals. The current estimate of killer whales, off eastern and southern Vancouver Island, is 220 (from 1964 to 1977, a total of 26 killer whales were taken for public display). The status of these populations, with respect to the "optimum range" defined by the National Marine Fisheries Service, has not been determined.

3. Washington (This summary is based upon information provided by M. Johnson and S. Jeffries.)

As in Alaska and British Columbia, seal and sea lion predation on gill-netted salmon led to the establishment of a bounty program. From 1947 to 1960, 9,503 seals were killed for the bounty. In 1960, the bounty was eliminated but the seals remained classified as predators. In 1970, all marine mammals in the state were placed on the "protected" list.

The number of harbor seals in the coastal waters of the state is thought to be increasing. The most recent surveys indicate that there are approximately 5,500 harbor seals in the state's coastal waters. The status of the harbor seal population and other populations of marine mammals in the state has not been determined with respect to the "optimum range" defined by the National Marine Fisheries Service.

In the future, the state may consider seeking a waiver of the moratorium and the return of marine mammal management as provided for by the Marine Mammal Protection Act.

4. Oregon (This summary is based upon information provided by D. Snow.)

Five species of pinnipeds are found in Oregon, two of which are transient. The harbor seal, Steller sea lion, and California sea lion are seasonally abundant, while the northern fur seal and northern elephant seal are only found in Oregon occasionally. 6/

Prior to passage of the Marine Mammal Protection Act, the state controlled seal populations to minimize impacts on sport and commercial fisheries. From 1925 to 1933, bounties were claimed for approximately 3,300 harbor seals and 3,900 sea lions. In 1935, a seal control program was initiated in the Columbia River, providing a bounty ($5.00 to $25.00) for each seal killed. From 1935 to 1972, the Fish Commission of Oregon paid bounty claims on 3,150 animals. The Fish Commission also hired a seal hunter (1959 to 1970) to control animals in the lower forty miles of the Columbia River. During this period, 468 seals were killed and 487 reported as possibly killed or wounded - the kill ranged from 26 to 54 seals per year.

Since the control program was stopped, more seals have been reported in the Columbia River and other rivers and estuaries. Coastal aerial surveys conducted in June 1976 and June 1977 produced counts of over 2,300 harbor seals, 1,500 Steller sea lions, a few California sea lions, and a few sea otters. These counts, when compared with counts of 8 to 10 years ago, suggest that harbor seal numbers are increasing in several areas. The status of the harbor seal and other marine mammal populations in the state have not been determined with respect to the "optimum range" defined by the National Marine Fisheries Service.

Oregon, like Washington, may consider seeking a waiver of the moratorium and return of marine mammal management as provided for by the Marine Mammal Protection Act.

6/ Cetaceans, as well as pinnipeds, occur in the state's coastal waters, but cetaceans do not have a significant impact on fisheries and, for this reason, were not included in the data survey.

5. California (This summary is based upon information provided by M. Odemar.)

Six species of pinnipeds (harbor seals, California and Steller sea lions, Northern and Guadalupe fur seals, and Northern elephant seals) and numerous species of cetaceans occur in the coastal waters of California. From about 1860 to 1870, thousands of seals and sea lions were harvested for oil. In more recent years, the state has controlled certain marine mammal populations to minimize impacts on fisheries. Control programs were ended in 1946 but, until the MMPA was passed in 1972, fishermen were allowed to take California and Steller sea lions, northern fur seals, and harbor seals when they were endangering their gear or catch. Elephants seals and Guadalupe fur seals were fully protected before passage of the Marine Mammal Protection Act.

In 1976, the state requested a waiver and return of management authority for the sea otter. The request subsequently was withdrawn. The status of the marine mammal populations in the state has not been determined with respect to the "optimum range" defined by the National Marine Fisheries Service.

6. Hawaii (No information on the history and status of marine mammal populations and management in Hawaii was presented at the workshop.)

Incidental Take of Marine Mammals

The number of marine mammals killed or injured during the course of sport and commercial fishing operations in Alaska, British Columbia, Washington, Oregon, California and Hawaii are not well documented. Gray whales, humpback whales, pilot whales, and beluga whales occasionally are entangled and drown in gill nets, trammel nets, and purse seines. Smaller cetaceans, seals, and sea lions are more abundant and are entangled and drown in nets more frequently. Dall porpoise, harbor porpoise, Steller sea lions, harbor seals, and northern fur seals apparently are taken in substantial numbers. It is estimated, for example, that 10,600 to 12,600 Dall porpoises and 3,150 to 3,750 northern fur seals are taken incidentally each year in the Japanese salmon drift net fishery in the North Pacific Ocean and the Bering Sea. 7/

7/ Since this workshop, the National Marine Fisheries Service has convened a workshop on the "Dall porpoise problem" and the U.S. and Japan have initiated a cooperative research program to assess the nature and magnitude of the incidental kill and what can be done to reduce it.

Marine Mammal-Caused Gear Damage, Fish Damage, and Fish Loss

Available information concerning the nature and extent of marine mammal-caused gear damage, fish damage, and fish loss in the Pacific states and the Province of British Columbia is as follows: 8/

1. Alaska

Steller sea lions, harbor seals, and beluga whales apparently are the species responsible for most marine mammal-caused gear damage, fish damage, and fish loss in Alaskan waters. Steller sea lions primarily affect salmon gill net fisheries, long-line fisheries for halibut and sablefish, and the "pot" fishery for king crab. Harbor seals primarily affect the salmon gill net fisheries in river mouth areas such as the Copper River Delta and Bristol Bay. Beluga whales damage gill net gear but do not remove fish from the nets - they feed seasonally on smelt and adult salmon in areas such as Bristol Bay and have been excluded effectively from these areas by recorded killer whale sounds (Fish and Vania, 1971). The most acute problems seem to be associated with: (a) the Copper River Delta salmon fishery; (b) the North Pacific halibut fishery; (c) the Bering Sea sablefish fishery; and (d) the Alaska king crab fishery.

a. The Copper River Salmon Fishery (C. Matkin)

Imler and Sarber (1947) surveyed individual vessels on the Copper River fishing grounds. They inspected over 10,000 fish and concluded that seal depredation on gill-netted fish would not exceed 2% of the total catch. In 1977, Matkin (unpubl. data) interviewed 15 fishermen and extrapolated estimates of fish damage and gear damage to estimate impact on the entire Copper River Delta Fishery. The extrapolated estimates indicate that approximately 30,683 fish were damaged (8.3% of the total catch of 369,571), that the lost fish were worth approximately $230,000, and that marine mammals caused approximately $72,000 of gear damage. For the 445 boats in the fishery, this would average $517 per boat for damaged fish, and $162 per boat for damaged gear. Considerable variability between boats was noted, some of which may be attributable to the location of fishing operations. It is not known whether the sample is reflective of the

8/ This subject area is very complex and relatively few quantitative studies have been conducted. Much of the available information is antidotal and has not been verified.

whole fleet and, therefore, whether the extrapolations represent a realistic approximation of the amount of gear damage and fish loss caused by marine mammals.

b. Halibut (B. Hardman)

The North Pacific Halibut Fishery was very large until the mid-1960's when reduced stocks led to reduced quotas and other regulations. At its annual meeting in 1958, the International Pacific Halibut Commission (IPHC) noted that Steller sea lions "at least on certain fishing grounds in the North Pacific interfere seriously with halibut taken on long-line gear before they have been landed." Bell (1961) estimated that approximately 8.1% of the caught fish were either damaged or destroyed by sea lions resulting in an annual loss to the halibut fishery of approximately $500,000. There are no more recent data, but since the fishery has been reduced in size and no longer operates in many of the geographic areas where severe fish loss was experienced in the past, it seems likely that fish damaged or destroyed by sea lions may be substantially less than in the past. The problem continues to exist, however, and remains a concern to the IPHC.

c. Sablefish (J. Burns)

Sablefish, also known as black cod, are caught by foreign long-line fishermen and by domestic fishermen using long-lines and fish traps. Japanese long-line fishermen claim that Steller sea lions damage up to 50% of the catch in the Bering Sea south of the Pribilofs. These claims have not been documented.

d. King Crab (J. Burns)

Pots for Alaskan king crab are deployed in "strings" (serial units tied together by a strong line) which rest on the bottom. Traditionally, the line to recover the string of pots is held afloat with two inflated floats. Steller sea lions apparently bite these floats, causing them to sink, making it difficult and time consuming, if not impossible, for fishermen to recover the pots and the catch. The fishermen have solved the problem by attaching a solid styrofoam float (termed a "sea lion buoy") to prevent the recovery line from falling to the bottom in the event that the inflatable floats are punctured. The extent of the problem and the cost to the fishermen are not documented.

2. British Columbia (M. Bigg)

Marine mammal-fishery interactions in British Columbia are similar to those in Alaska. The most acute problems are with the salmon gill net and troll fisheries and are caused primarily by Steller sea lions and harbor seals and, to a lesser extent, by killer whales.

Schutz (1975) notes that killer whales may frighten salmon (especially spring chinook), making them more difficult to catch. Pike (unpubl. data) calculates that, during the period from May to September 1962, Steller sea lions caused an average loss of $54.00 in damaged fish and $22.00 in damaged gear to each gill netter in Eastern Hecate Strait. Fisher (1952) estimated that 8 to 12% of the salmon catch was damaged by harbor seals. There apparently are no more recent or comprehensive data.

3. Washington-Oregon

The harbor seal and California sea lion are responsible for most marine mammal-caused gear damage, fish damage, and fish loss in Washington and Oregon. The fisheries affected by these marine mammals include the salmon gill net fishery and the sport fisheries for salmon and steelhead. Although not a problem at the present time, private- and state-owned salmon hatcheries, which are becoming increasingly important to augment reduced natural stocks of salmonids, could be affected in the future. The most serious problem involves harbor seals and the salmon gill net fishery on the Columbia River.

a. The Columbia River Salmon Fishery

Since 1972, fishery biologists from the Oregon Department of Fish and Wildlife (ODF&W) annually have examined 1-25% of the salmon caught in the Columbia River and turned into processors. They found "predation marks" presumably caused by seals, on 1-2.3% of the fish examined (Hirose, unpubl. data). When extrapolated to the fishery as a whole, these data indicate that nearly 6,000 fish are damaged each year and that the dollar value of these fish is approximately $60,000.

The highest rate of fish damage seems to occur during "test" fishing (conducted prior to the commercial season to help determine the size of the salmon run), and late in the season during "scratch" fishing when few fish are being caught and few boats are fishing. The percentage of damaged and destroyed (unusable) fish in the test fishery at River Mile 28 increased from 15% and 5%, respectively, in 1976 to 30% and 12%, respectively, in 1977. Damaged fish in test fishing at River Mile 125 increased from 0% to 11% in the same time period.

Most of the fish damage and fish loss is attributed to harbor seals (Pearson and Verts, 1970) but fishermen also report that there were greater numbers of California sea lions in the Columbia River in 1977. Increased damage during "test" and "scratch" fishing likely is due to the fact that there are fewer boats fishing resulting in a higher ratio of seals to boats.

b. Sport Fisheries for Salmon and Steelhead

The popularity of salmon and steelhead sport fisheries on certain rivers in Oregon and Washington apparently has declined in recent years. At the same time, the numbers of harbor seals and sea lions apparently have increased in these areas. Seals and sea lions catch and eat salmon and there is a general feeling, particularly among fishermen, that the seals and sea lions are responsible, at least in part, for the decline in sport fisheries.

One example of the problem is the Rogue River in southern Oregon where the local economy is based largely upon tourism (which depends in part on the River's world famous sport fishing reputation). Oregon Department of Fish and Wildlife employees and river guides claim that there have been increased numbers of seals and sea lions in the river since 1973. Since then, the river has become less and less popular for sport fishermen (which the local businessmen attribute directly to the presence of seals and sea lions), causing an unknown adverse economic impact on the community.

Local residents have petitioned the National Marine Fisheries Service to reduce or eliminate seals and sea lions in the Rogue, Umpqua, Siletz, and Alsea Rivers of Oregon.

c. Private- and State-Owned Salmon Hatcheries

Private- and state-owned salmon hatcheries are becoming increasingly important for augmenting stocks of salmonids which have been reduced due to overfishing, habitat deterioration, dams, and pollution. State hatcheries are interested in adult salmon only for their eggs and milt, and, to date, have shown little concern over the presence of seals and sea lions in areas where the adult fish are taken. Private groups, which build and operate hatcheries to enhance harvestable stocks of adult fish, may be more concerned about possible seal and sea lion predation.

4. California

Marine mammals that affect sport and commercial fisheries in California include the California sea lion, the Steller sea lion, the harbor seal, the northern fur seal, and the pilot whale. The fisheries that are affected include: salmon troll fisheries in areas such as Monterey Bay; the Indian gill net fishery for salmon on the Klamath River in northern California; lampara fisheries for squid and anchovy in southern California; the beach and purse seine fisheries for herring; and the mid-water troll fishery for hake.

a. The Salmon Troll Fishery (B. Mate) 9/

Some California and Steller sea lions apparently learn to follow and take salmon caught by commercial trollers and sport charter boats. Trollers drag from 2 to 12 lines (some baited and some with lures) which are retrieved, usually with a hydraulic assist, when a salmon is caught. Sea lions sometimes follow boats for long periods of time, taking the caught salmon before they can be brought aboard. This type of "fish loss" occurs in certain areas and may be caused by a small number of animals that have learned to follow boats.

9/ The salmon troll fishery occurs in the coastal waters of the entire eastern North Pacific. Marine mammal-caused fish damage and fish loss occur, to a greater or lesser extent, throughout the fishery.

A study conducted in Monterey Bay, during the 1969 commercial salmon season, indicated that approximately 4% of the caught salmon were preyed upon by California sea lions (Briggs and Davis, 1972). Sea lions also were observed catching free-swimming salmon.

b. The Indian Gill Net Fishery in the Klamath River

There is an Indian gill net fishery in the Klamath River in northern California which apparently has experienced some difficulty with California sea lions. It is reported (NMFS enforcement records) that, in the spring of 1975, more than 50 sea lions were killed in the river. Little more is known of the situation.

c. Squid and Anchovy Fisheries

Lampara nets are used to catch squid and live bait, principally anchovy, in southern California. Squid are caught in breeding areas, principally near islands and rocky reefs, from November to January and from March to May. Schools are attracted at night by deck lights and then concentrated by use of small purse seines, lampara nets, or half-ring nets (modified purse seines with lampara-like wings). The squid then are brailled from the partially drawn-up net. On larger boats, the squid or anchovy are pumped out of the net with a fish pump.

California sea lions and pilot whales apparently are attracted by the dense concentrations of squid or fish in the nets, and tear large holes in them when they become accidentally entangled or attempt to get into or out of the nets. Holes in the nets permit the catch to escape and must be repaired before fishing can be resumed. The extent of the gear damage and fish loss is unknown.

d. Herring and Hake Fisheries

Herring are taken in both beach and purse seines. California sea lions, Steller sea lions, and harbor seals eat herring and damage nets when they become accidentally entangled or attempt to get into or out of the nets. The extent of gear damage and fish loss is unknown.

Hake is known to be an important component of the diets of many marine mammals, including California and Steller sea lions and northern fur seals, during certain times of the year and in certain geographic areas. Hake also is the target of a mid-water troll fishery, primarily by foreign fishing vessels, and, while the nature and extent of the problem are unknown, it seems reasonable to assume that marine mammals are taken incidentally or cause damage to this type of gear or catch.

5. Hawaii

Porpoise are the primary cause of marine mammal-caused gear damage, fish damage, and fish loss in Hawaii. Fisheries affected by these marine mammals include long-line, hand-line, and troll fisheries for tuna, bottom fish, and other species.

a. Tuna (H. Yuen)

Long-lines consisting of between 120 to 600 hooks on 8 to 38km of line are used to catch large species such as tuna (Thunnus sp.), marlin (Makaira sp.) and shark in the vicinity of the Hawaiian Islands. These lines are fished at various depths, and are adjusted by buoys and line length. Fishing is done during the day and, in some areas, fresh mackeral scad, used for bait, apparently is removed by porpoises (the rough-tooth dolphin, Steno bredanensis, unverified) to the extent that fishermen have had to abandon fishing. Fishermen in other areas occasionally bring in their gear to find only the heads of tuna and attribute these losses to the false killer whale (Pseudorca crassidens). The cost to the fishermen in terms of gear damage, fish damage, and fish loss has not been determined.

b. Hand-Line Fisheries (H. Yuen)

A night hand-line fishery for big-eye tuna (Thunnus obesus), albacore tuna (T. alalunga), and yellowfin tuna (T. albacares) is conducted within two to twenty km offshore off the southern half of the Island of Hawaii. Underwater and surface lighting is used to attract squid (Notodarus hawaiiensis) which is used for bait. Fishermen have reported that tuna stop biting when porpoise are in the area.

A day hand-line fishery for yellowfin tuna takes place off the southeastern and western shores of the Island of Hawaii, where a single hook, baited with mackeral scad, is fished at approximately 140 meters. Fishermen have reported porpoises

"hitting" the smaller tuna less than 15kg) off their hooks and damaging larger tuna (40 to 50kg) by "bumping" them on the ventral side. Although the porpoise species has not been identified, one fishermen in the South Point area says it is not the bottlenose dolphin (Tursiops truncatus) and that only one or two individuals out of a herd of 15 or 20 engage in the practice of "bumping" hooked fish. At times the catch will not be damaged although porpoise may be within 10 meters. Attempts to lower protective devices over caught fish proved unsuccessful.

A hand-line fishery for bottom fish, including snappers (Pristipomoides microlepis, P. seiboldii, Etelis carbunculus, Aphareus rutilans, Aprion virescens), the carangid (Seriola dumerilii), and the grouper (Epinephelus quernus), uses 6 hooks spaced at 0.4 to 0.6m intervals at depths of 120 to 250m. Above the highest of these hooks is a chum bag containing chopped fish which is opened by a strong jerk of the line. The gear is fished at 1 to 3m off the bottom from a 4 to 6m boat and is pulled after several fish are hooked. In the Kona area of Hawaii, bottlenose dolphins sometimes remove the catch from the line while it is being hauled. A single animal can remove six fish from the line in the time it takes to get it to the surface. When a porpoise jerks a fish from a hook, it may pull 10 to 15m of line from the fisherman's hands, thereby exposing him to the risk of open hooks. This has been serious enough to cause fishermen to quit using this method of fishing. Less than 30 Tursiops were thought to be involved when the problem was most acute around 1975. Questioned in December 1977, fishermen indicated only 1 or 2 Tursiops appeared on the fishing grounds.

The hand-line fishery for mackeral scad (Decapterus pinnulatus) takes place at night in leeward areas over a bottom of 100-200m. Lights placed underwater or at the surface are used in conjunction with six feathered jigs attached to a single lightweight line and fished at 15 to 25m within the perimeters of the illumination. Off the Kona coast of Hawaii and the Waianae coast of Oahu porpoises sometimes take the catch from these jigs within a few meters of the boat. Fishermen believe this species is the bottlenose dolphin but are not certain.

The spinner dolphin (Stenella longirostris) and the pigmy killer whale (Feresa attenuta) have been observed in the vicinity. Fishermen complain about porpoises approximately one night out of four (usually between 1400 and 2100 hrs.). Fishermen have attempted to evade the porpoises by turning off their lights and moving at top speed to another site several kms away, without success. If their lights are turned off and they drift, however, the porpoise sometimes will move to another skiff in the vicinity.

The Permit System

Regulations promulgated by the National Marine Fisheries Service, pursuant to Sections 101(a)(2), 104, and 103 of the Marine Mammal Protection Act, provide for issuing permits which allow fishermen to take whatever steps may be necessary to protect themselves, their gear, and their fish catch from damage by marine mammals. Permits are issued in each of five categories: (1) towed or drag nets; (2) encircling gear - purse seines involved in deliberate setting on marine mammals and associated fish schools; (3) encircling gear -purse seines that take marine mammals accidentally; (4) stationary gear; and (5) other gear (e.g., troll and long-line gear). Once a permit is issued for a given gear category, fishermen may apply for certificates of inclusion. Certificates cost fishermen $10.00 per year, except for class 2, which cost $200.00 per year. Reporting of incidental take is required under the permit system.

Few fishermen have applied for permits or certificates of inclusion in gear categories 1, 3, 4, or 5. 10/ In 1977, for example, only 115 of the several thousand fishermen involved in Pacific fisheries applied for certificates of inclusion (see Table 1).

FINDINGS AND CONCLUSIONS

After reviewing and discussing the information summarized above, workshop participants concluded: that substantial and, perhaps, significant 11/ numbers of marine mammals, particularly Dall porpoise, harbor porpoise, Steller sea lions, northern fur seals, and harbor seals are being killed,

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10/ Gear category 2 applies to the yellowfin tuna purse seine fishery, where fishermen "set-on-porpoise" to catch the yellowfin tuna which associate with them. U.S. fishermen involved in this fishery have certificates of inclusion under the general permit issued to the American Tunaboat Association.

11/ For the purpose of this workshop, it was assumed that a few tens of marine mammals constitute a "substantial" incidental take and that any incidental take which results in a marine mammal population being reduced and/or maintained below its level of maximum net productivity, constitutes a "significant" incidental take.

TABLE 1.

Summary by region and by year of Certificates of Inclusion by gear category, total investigations, reported incidental takes, and NMFS notification methods.

NORTHWEST REGION

Gear Category*	1975(1)**	1976	1977	No. of Investigations
#1	5	0	0	)
3	14	0	2	)
4	9	0	1	) 7
5	146	14	17	)
Total	174	14	18	
Appl. to fishermen	10,000	?	?	

ALASKA REGION

Gear Category*	1975(2)**	1976(2)**	1977(1)**	No. of Investigations
#1	-	0	1	)
3	-	46	7	)
4	-	23	1	) 0
5	-	185	19	)
Total	485	254	28	
Appl. to fishermen	18,000	18,000	News releases	

SOUTHWEST REGION

Gear Category*	1975(2)**	1976	1977
#1	1	1	0
3	28	4	40
4	1	0	1
5	39(+7FNW)	11	18(+1FNW)
Total	69	15	69
Appl. to fishermen	?	?	?
No. Investigations	2	3	6

*1 = towed nets; 3 = purse seines outside the Eastern Tropical Pacific; 4 = stationary gear; and 5 = troll and longline gear.
**() means number of formally reported incidental takes.

injured, and harassed in conjunction with certain commercial fisheries, particularly the Japanese salmon drift net fishery in the North Pacific and the salmon gillnet fisheries in the Copper River Delta (Alaska) and the Columbia River (Washington-Oregon); that certain species of marine mammals, particularly harbor seals and sea lions, are causing substantial and, perhaps, significant 12/ economic damage to certain commercial fisheries, particularly the salmon gillnet fisheries in the Copper River Delta and the Columbia River, and certain sport fisheries, particularly salmon and steelhead sport fisheries in Oregon and Washington; that remedial measures (e.g., gear regulations, enforcement actions, control programs, etc.) may well be needed to permit the recovery or prevent the depletion of one or more marine mammal populations and/or to maintain the economic viability of one or more fisheries; and that available information on the status of the affected marine mammal populations and fisheries, and the nature and extent of the interactions among them, is insufficient to determine the precise nature and extent of remedial measures that may be needed, or justified, to reduce competition, incidental take, gear damage, etc.

During the discussions, several workshop participants expressed the view that marine mammals were being protected at the expense of sport and commercial fisheries and that the Marine Mammal Protection Act did not provide the flexibility needed to protect and conserve fisheries and fish resources, as well as marine mammal populations. Other workshop participants expressed the view that marine mammal protection was being blamed, in some cases, for problems caused by poor fishery management (e.g., over-capitalization of fisheries and over-harvesting of fish resources) and that the Marine Mammal Protection Act does in fact provide the flexibility needed to protect and conserve fisheries and fish resources, as well as marine mammal populations. Relative to these points, it was noted that:

- while the MMPA provides for waiver of the moratorium on taking marine mammals, and return of marine mammal management to the States, only Alaska has requested a waiver and return of management and, after more than 5 years and great expense on the part of both the State and Federal governments, the waiver and return of management has been effected for only one of the nine species for which the State has requested a waiver and return of management; 13/

12/ For the purposes of this workshop, it was assumed that a few hundreds of dollars constitutes a "substantial" economic loss to a fisherman and that any loss, which threatens the economic viability of a fishery, constitutes a "significant" economic loss. It was recognized that the economic viability of a fishery is dependent upon a number of factors and that decisions concerning the "significance" of marine mammal-caused gear damage, etc. would be policy decisions and would require "value" judgments concerning the possible cost and benefits to individuals, communities, states, the nation, and the international community.

13/ See footnote 4.

- while regulations promulgated by the National Marine Fisheries Service provide for incidental take permits which allow fishermen to take whatever steps may be necessary - including killing and harassing marine mammals - to protect themselves, their gear, or their catch, few fishermen have applied for permits, suggesting that: (a) marine mammal-caused gear damage, fish damage, etc. is not a significant problem; or, if it is, (b) many fishermen are "taking" marine mammals illegally; and

- given the intents and provisions of the MMPA, and the NMFS' recent interpretative definition of "OSP", the distribution and/or abundance of marine mammal populations presumably can be controlled if it is demonstrated that: (a) control is necessary to maintain the health and stability of the marine ecosystem; and/or (b) control is needed to maintain the economic viability of a fishery and the proposed "taking" will be humane, non-wasteful, and will not cause the affected marine mammal population to be reduced below its level of maximum net productivity.

Relative to the last point, it was noted that the level of maximum net productivity of a population is determined, in part, by habitat carrying capacity and that carrying capacity changes in response to natural, as well as human-related factors (e.g., fishing and pollution) and that determination of "optimum sustainable population" levels would require determination of "optimum carrying capacities" as well as levels of maximum net productivity. It also was noted that habitat carrying capacity (optimum or otherwise) is difficult to measure directly, that it most likely will be necessary to rely upon indirect indicators rather than direct measurements to assess habitat status and carrying capacity, that estimates of historic (pre-exploitation) abundance often will be the only indicator of maximum (pristine) carrying capacity, and that, given the NMFS' interpretative definition of OSP, "optimum carrying capacity" likewise might be interpreted as a range of carrying capacities bounded by the habitat needed to sustain historic (pristine) population levels and the habitat needed to sustain a population at its level of maximum net productivity as determined with respect to maximum (pristine) carrying capacity.

Needed Information and Policy Determinations

During the course of the discussions summarized above, it generally was agreed that resolution of "marine mammal-fishery" conflicts would require better information and/or policy determinations concerning: (a) the status of the affected marine mammal populations with respect to the "optimum range" defined in the NMFS's "interpretative" definition of OSP; (b) the numbers, ages, sexes, and reproductive condition of marine mammals taken during the course of sport and commercial fishery operations and the effects of this incidental take on population status; (c) the feeding habits, food preferences, and nutritional requirements of the affected marine mammal populations; (d) the status of the affected fish stocks with respect to optimum productivity or yield as defined in the Fishery Conservation and Management Act; (e) the importance and status of the affected fisheries with respect to capital investment, economic viability, local economics, etc.; (f) the nature and extent of marine mammal-caused gear damage, fish damage, etc. and its effects on the status of the affected fisheries; and (g) the structure, dynamics, and status of marine ecosystems, and the effects of marine mammal-fishery competition on the marine ecosystems of which the marine mammal populations, fish stocks, and fishermen are component elements.

It was assumed that remedial measures may well be needed to reduce incidental take and/or marine mammal-caused gear damage, etc. in certain areas and, given this assumption, agreed that there is or likely will be a need for information and determinations concerning (i) changes in regulations, fishing gear, fishing practices, and/or enforcement activities that might be required to reduce the incidental kill and injury of marine mammals to insignificant levels; and (ii) the most appropriate and humane methods for controlling the distribution, abundance, and/or behavior of marine mammals so as to reduce marine mammal-caused gear damage, etc. to insignificant levels.

Need for Better Methods of Data Collection

Most of the available quantitative information concerning the numbers of marine mammals taken during the course of commercial fishing operations and the extent of marine mammal-caused gear damage, fish damage, etc. has been derived from personal interviews with fishermen, mail surveys, or logbook surveys. Workshop participants noted that such methods of data collection tend to provide biased data and concluded that definition and resolution of marine mammal-fishery conflicts would be dependent, in no small measure, upon developing better instruments (e.g., questionnaires) and methods for collecting and verifying relevant data. It was noted, for example, that:

- questionnaires concerning the nature and extent of marine mammal-caused gear damage, fish damage, etc. will more likely be completed and returned by fishermen experiencing such damage than by fishermen not experiencing such damage;

- tallies of damaged fish at processing plants tend to underestimate economic losses since they do not include fish which are completely removed from nets by marine mammals or fish that are discarded by fishermen because they are badly mutilated (e.g., fish heads);

- fishermen generally are wary of government surveys, believing that they often lead to additional government regulations or enforcement efforts; and

- many fishermen are fishing without certificates of inclusion in general "incidental take" permits and, understandably, are reluctant to report the incidental take or injury of marine mammals.

It also was pointed out and noted that losses in sport fisheries are in the "kind and quality" of recreational experiences which are and will be difficult to measure directly.

During the course of discussions on needed methodology, it was noted and agreed: that fishermen, government agencies, and private interest groups must work together to identify and solve the problems; that data collection has been and is being hampered because relatively few fishermen have obtained certificates of inclusion in general "incidental take" permits; that the reporting requirements, ten dollar filing fee, and complex application procedure appear to be the primary reasons why relatively few fishermen have obtained certificates of inclusion; that the National Marine Fisheries Service should do everything possible, including simplifying the application procedure and waiving the filing fee, to encourage fishermen to obtain certificates of inclusion; that one or more pilot studies should be undertaken to develop more reliable survey instruments and procedures; that, whenever possible, surveys should be carried out by academic institutions or consulting firms, under contract to the responsible state or Federal agency, to overcome the credibility problems often encountered by government agencies in conducting such surveys; and, finally, that appropriate test fishing and observer programs should be developed and implemented to verify and/or correct information obtained through surveys and "permit" reports.

SUMMARY AND RECOMMENDATIONS

In summary, workshop participants reviewed available information on the nature and extent of marine mammal-fishery interactions in the eastern Pacific and concluded that: (1) harbor seals, sea lions, and other marine mammals apparently are impacting, and being impacted by, certain commercial and sport fisheries; (2) there may well be some validity to the reports that certain populations of harbor seals and other marine mammals are increasing and that there has been a corresponding

increase in the amount of gear damage, fish damage, and fish loss caused by marine mammals; (3) the most acute conflicts seem to be between seals and sea lions and the salmon gillnet fisheries in the Copper River Delta (Alaska) and the Columbia River (Washington-Oregon); (4) while remedial measures may be necessary to reduce incidental take and/or marine mammal-caused gear damage, etc. in certain areas, available information is insufficient to judge the precise nature, extent, or effects of the conflicts and what can or should be done to resolve them; (5) research is needed to develop more reliable methods of data collection, as well as to provide more reliable information on the nature, extent, and possible effects of marine mammal-fishery conflicts; (6) research also is needed to identify the most humane and non-wasteful methods for controlling marine mammal distribution and/or abundance, should it be determined that a control program or programs are necessary and appropriate for reducing marine mammal-caused gear damage, fish damage, etc.; and (7) data collection and ultimate solution of the problem are being hampered by: (a) lack of a comprehensive, goal-oriented research program; (b) funding limitations; (c) the apparent failure of many fishermen to obtain "incidental take" permits and to report marine mammals taken incidentally during fishing operations; and (d) the failure, on the part of the Federal Government, to develop an effective and efficient permit system and research program.

Based upon the aforementioned findings and conclusions, the workshop participants recommended that:

1. the National Marine Fisheries Service do everything possible, including simplifying the application procedure and waiving the filing fee, to encourage fishermen to obtain certificates of inclusion in general "incidental take" permits;

2. the Federal Government, in cooperation with appropriate state agencies, undertake a comprehensive study of marine mammal-fishery interactions in the Columbia River (Washington-Oregon) and, if possible, the Copper River Delta (Alaska) to develop appropriate methodology and a model for assessing and resolving apparent marine mammal-fishery conflicts in these, as well as other areas; and

3. an additional workshop or workshops be convened to identify research and/or management actions that appear necessary or desirable to address questions concerning the nature, extent, and possible effects of marine mammal-fishery competition on (a) fish stocks, (b) marine mammal-populations, (c) fisheries, and (d) the ecosystems of which they are a part. (See Appendix VI).

In partial response to these recommendations, representatives of the National Marine Fisheries Service indicated that the Service was investigating and considering a number of possible alternatives relative to the "permit" problem. Representatives of the Service also indicated that, while available funds were insufficient to initiate a comprehensive research program, they expected some funds to be available for this purpose beginning in Fiscal Year 1979. Representatives of the Marine Mammal Commission indicated that the Commission would entertain a proposal to bring together the responsible Oregon, Washington, and Federal agencies and potential researchers from academic institutions to draft a coordinated plan for marine mammal-fishery research in the Columbia River and adjacent estuaries. 14/

ACKNOWLEDGMENTS

The Convenor thanks all of the participants for their pre-meeting papers, presentations and constructive discussions. In addition, considerable thanks go to Dr. G. Victor Morejohn (Moss Landing Marine Lab.) for allowing the workshop to use his data from Monterey Bay; Dr. Charles Woodhouse (Santa Barbara Museum) for incidental take and stranding data; and Mr. Robert Hudson (All-Coast Fishermen's Marketing Association) for his remarks on the troll salmon fishery. Mrs. Grace Boden, Robin Brown, Jim Harvey, and Tom Roffe provided logistic, clerical and technical assistance which facilitated the meeting and final report preparation.

14/ The Commission subsequently received and funded such a proposal and, in March 1978, scientists and representatives of the States of Oregon and Washington met in Olympia, Washington, to begin work on a research proposal to be submitted to the National Marine Fisheries Service for funding consideration. Following the workshop, the Commission also provided funds to develop methodology and begin assessing the nature and extent of marine mammal-fishery interactions in the Copper River Delta of Alaska (see pages 11 and 12 of the Commission's Annual Report for Calendar Year 1978).

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GLOSSARY OF SCIENTIFIC AND COMMON NAMES

Common Name	Species
PINNIPEDS:	
Steller sea lion	Eumetopias jubatus
California sea lion	Zalophus californianus
northern fur seal	Callorhinus ursinus
spotted seal	Phoca largha
ringed seal	Phoca hispida
ribbon seal	Phoca fasciata
bearded seal	Erignathus barbatus
harbor seal	Phoca vitulina
northern elephant seal	Mirounga angustirostris
walrus	Odobenus rosmarus
CETACEANS:	
gray whale	Eschrichtius robustus
humpback whale	Megaptera novaeangliae
beluga whale	Delphinapterus leucas
pilot whale	Globicephala macrorhynchus
killer whale	Orcinus orca
false killer whale	Pseudorca crassidens
pigmy killer whale	Feresa attenuata
Spotted porpoise	Stenella attenuata
spinner dolphin	Stenella longirostris
rough-toothed dolphin	Steno bredanensis
bottlenose dolphin	Tursiops truncatus
harbor porpoise	Phocoena phocoena
Dall porpoise	Phocoenoides dalli
MUSTELIDS:	
sea otter	Enhydra lutris
FISH:	
anchovy	Engraulis mordax
herring	Clupea harengus
rainbow smelt	Osmerus mordax
capelin	Mallotus villosus
pollock	Theragra chalcogramma
steelhead	Salmo gairdneri
chinook salmon	Oncorhynchus tshawytscha
coho salmon	Oncorhynchus kisutch
red salmon (sockeye)	Oncorhynchus nerka
yellowfin tuna	Thunnus albacares
skipjack tuna	Euthynnus pelamis
kawakawa	Euthynnus affinis
mackerel	Decapterus pinnulatus
hake	Merluccius productus

GLOSSARY OF SCIENTIFIC AND COMMON NAMES
(cont'd)

sablefish	*Anoplopoma fimbria*
blue marlin	*Makaira nigricans*
black marlin	*Makaira indica*
striped marlin	*Tetrapturus audax*
snappers	*Pristipomoides microlepis*
	P. seiboldii
	Etelis carbunculus
	Aphareus rutilans
	Aprion virescens
carangid	*Serida dumerilii*
grouper	*Epinephelus quernus*
rockfish	*Sebastes* spp.
halibut	*Hippoglossus stenolepis*
INVERTEBRATES:	
squid	*Loligo opalescens*
	Notodarus hawaiiensis
king crab	*Paralithodes camtschatica*
octopus	*Octopus* spp.

APPENDIX I

REVISED AGENDA

for

Marine Mammal/Fishery Interactions Workshop
19-20 December 1977, University Towers, Seattle, WA

Tentative Times	19 Dec.
0800	Charge to workshop participants - Doug Chapman (MMC)
	SESSION I
	An identification of marine mammal/fishery interactions in each state including past, present, and future management policies - John Burns (ADF&G), Chairman
0820	Alaska: seals, sea lions, fur seals, beluga whales, others - John Burns
0850	Washington: seals, sea lions, killer whales, others - Murray Johnson (UPS-M)
0910	Oregon: seals, sea lions - Dale Snow (ODF&W)
0930	California: seals, sea lions, pilot whales, others - Mel Odemar (CF&G); Gene Nitta (CA. NMFS)
0950	British Columbia: seals, sea lions, killer whales, others - Michael Bigg (FRBC)
1010	Coffee
	SESSION II
	Discussion of specific data on marine mammal/fishery interactions by fishery and gear type - Bruce Mate (OSU) Chairman
1040	gill netting - harbor seals: Cooper River - Craig Matkin (U.AK); Ken Pitcher (ADF&G)
	Gray's & Willapa Bays - Murray Johnson (UPS-M)
	Columbia River - Paul Hirose (ODF&W): Kent Martin (CRFPU)
1140	beluga whales: Ken Pitcher (ADF&G)
1200	Dall porpoise & sea lions: high seas foreign fleets- Bob French (NMFS/NWAFC)
1220	Lunch
1330	trolling - sea lions: Jim Harvey (Moss Ldg. Mar. Lab.)
1350	purse seining - Jim Fraser (WDF); and/or Ken Pitcher
1410	private aquaculture/state hatcheries - Bruce Mate (OSU); Dale Snow (ODF&W)
1450	sport fishery - Bruce Mate (OSU)

APPENDIX I
(cont'd)

Tentative Times	19 Dec.
1510	Coffee
1530	Herring - Dale Snow (ODF&W)
1550	Halibut - Int'l. Pacific Halibut Comm. - William Hardman
1610	King crab (gear damage)
1630	Anchovy & mackerel (purse seine) - Bill Perrin (NMFS,SWC) Squid - lampara (Monterey) - Jim Harvey (Moss Ldg Mar. Lab.) Hake - Cliff Fiscus (MMD/NMFS) Longline fisheries of Hawaii - Heeny Yuen (NMFS/Hawaii)
1700	Discussion of general feeding habits: Jim Harvey (Moss Ldg.); L. Lowry & K. Pitcher (ADF&G); Cliff Fiscus (MMD/NMFS)
1800	Bering Sea/pollock/fur seal model - Bruce McAlister (MMD/NMFS)
1820	Adjourn*

*According to progress, an evening session may be necessary.

20 Dec.

SESSION III

0800 Identification of data needed to make good management decisions (considering also critical species and habitats, specific fisheries, non-biological disciplines, and geographic areas) - Bob Hofman (MMC) Discussion Leader

0900 Methodology, data reliability & validation procedures - D. Chapman, Chairman

Survey techniques - Lyle Calvin (OSU): Bruce Rettig (U.WA); Donovan Thompson (U.WA); Courtland Smith (OSU); Lucy Sloan (NFF)

1. 1. Enforcement: a. permit procedure - Pete Jensen(NMFS); Al Stankowiak (NMFS/NW)
   b. incidental take statistics
2. Surveys: a. fishermen; b. processors; c. other
3. Observers
4. Other

1000 Coffee
1020 Resume
1200 Lunch
1310 Resume

SESSION IV

1430 Identification of best research opportunities to obtain needed management data (specific fisheries/gear types, population manipulations, assessment of critical factors) - Bob Hofman (MMC) Chairman

APPENDIX I
(cont'd)

Tentative Times	20 Dec.
1530	Coffee
1540	Resume
1600	Discussion of possible research funds & proposal preparation: federal, state, university.
1640	Recommendations
1750	Adjourn

APPENDIX II

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APPENDIX III

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APPENDIX IV

SUMMARY OF AVAILABLE INFORMATION ON MARINE MAMMAL-FISHERY INTERACTIONS IN THE NORTHEASTERN PACIFIC

Marine Mammal	Location of Interaction	Fish Loss or Damage	Gear Damage	Incidental mortality of Marine Mammals	Reference
Eumetopias jubatus	Alaska	Japanese have estimated a 50% damage of sablefish caught in Kodiak region & 20-30% damage of catch in Bering Sea south of Pribilofs.	N.R.*	N.R.	Burns
	No. Pacific (Cape St. Elias & Gulf of Alaska)	Log books from 58 vessels of Pacific Halibut fishery from 1958/1960 indicate 8.1% of fish caught were damaged or destroyed. Extrapolated to the whole fleet, losses were estimated at 500,000.	N.R.	N.R.	International Pacific Halibut Commission Bell (1961)
	Hecate Strait, British Columbia	It was estimated that there was a $54 loss per salmon gillnetter in damaged fish. These losses were attributed to E. jubatus in May-Sept., 1962.	An estimated loss of $22 per gillnetter for damaged gear was reported.	N.R.	Pike (unpubl. data) cited by Bigg
	Oregon	Salmon trollers have reported loss of fish from trolled hooks.	N.R.	N.R.	Mate

*N.R. - None reported at the meeting.

Marine Mammal	Location of Interaction	Fish Loss or Damage	Gear Damage	Incidental mortality of Marine Mammals	Reference
Eumetopias jubatus (cont'd)	Copper River delta, Alaska.*	Based on interviews of 15 salmon gillnet fishermen an estimated 8.3 of the fish were damaged (30,688/ 369,571). This averaged out to a loss of $517/boat in damaged fish for the 445 boats in the fishery.	Gear damage estimated at an average of $162/boat ($72,000 for the fleet).	40-50 in 1977	Matkin **
	Coghill & Eshamy, Alaska	N.R.	N.R.	10 in 1977	Matkin **
Zalophus californianus	Monterey Bay, California	In 1969 4% of the fish caught by salmon trollers were damaged. Observations were on only 0.21% of the catch.	N.R.	N.R.	Briggs & Davis, 1972 cited by Odemar
	California	Damage to the catch of the salmon troll fishery has been estimated as high as $122,000 annually. This represented 2.6% of the ex-vessel landings.	N.R.	N.R.	California Dept. of Fish & Game (unpubl. data) cited by Odemar

Marine Mammal	Location of Interaction	Fish Loss or Damage	Gear Damage	Incidental mortality of Marine Mammals	Reference
Zalophus californianus (cont'd)	California	Take anchovy from purse seines and allow fish to escape through holes.	Cause holes in nets.	N.R.	Gingerich cited by Mate
	Oregon	Movement of sea lions up rivers & subsequent predation on salmonids hooked on sport gear.	N.R.	N.R.	Mate
	Oregon	N.R.	N.R.	Low numbers are incidentally taken in the Pacific trawl fisheries.	Mate
Callorhinus ursinus	North Pacific Ocean & Bering Sea	N.R.	N.R.	U.S. research vessels estimate the Japanese high seas gill net fishery for salmon incidentally catch 3,150-3,750 fur seals. Of the fur seals taken in U.S. research operations, 67% were alive & released. It is not known what proportion of the fur seals taken by the Japanese are taken alive and subsequently released.	French

Marine Mammal	Location of Interaction	Fish Loss or Damage	Gear Damage	Incidental mortality of Marine Mammals	Reference
Phoca vitulina	Copper River flats, Alaska (see also E. jubatus	Inspection of 10,000 caught fish in the salmon gill net fishery predicted that depredation would not exceed 2% of the total catch.	Cause damage to gill nets.	40-50 killed	Imler & Sarber, 1947 Matkin**
	Skenna River, British Columbia	During the 1940's a study of damage to salmon caught in the gill net fishery revealed a loss of 7% for May-July. At times the damage to spring salmon rose to 12%.	Cause damage to gill nets.	N.R.	Fisher, 1952
	Columbia River	Examination of salmon delivered to the processing plant from 1972-77 revealed that 1-2.3% of those examined were damaged (6,000 fish/yr or approx. $60,000). Annually 1.3-25% of the total processed were examined. Higher percentage of spring & summer fish were seal damaged.	Cause damage to gill nets.	N.R.	Hirose

Marine Mammal	Location of Interaction	Fish Loss or Damage	Gear Damage	Incidental mortality of Marine Mammals	Reference
Phoca vitulina (cont'd)	Columbia River cont'd)	While test fishing* at river mile 28 the incidence of "severely damaged" fish rose from 15% in 1976 to 30% in 1977. Unsalable fish rose from 5% in 1976 to 12% in 1977. Washington's test fishing at river mile 125 changed from zero damage in 1976 to 11% of caught fish damaged in 1977.		Using diver nets, 4 harbor seals were incidentally killed during 24 sets in test fishing. *Test fishing operations may encounter greater fish damage because the test fishing boat is the only boat fishing at the time.	Ore. Dept. of Fish & Wildlife (Hirose,
	Coghill & Eshamy, Alaska	N.R.	N.R.	15-20 incidental to gill netting	Matkin **
	Oregon	Reported up river systems where they feed on sport hooked salmonids.	N.R.	N.R.	Mate (Appendix 5)
Globicephala macro-rhynchus	California	Anchovy escape through holes made by marine mammals	On occasions, pilot whales become entrapped in anchovy purse seine nets & tear holes in the net while escaping.	N.R.	Gingerich (pers. comm.) cited by Mate
Orcinus orca	British Columbia	Fishermen feel killer whales may frighten salmon & thus reduce the catch.	N.R.	N.R.	Schutz, 1975

Marine Mammal	Location of Interaction	Fish Loss or Damage	Gear Damage	Incidental mortality of Marine Mammals	Reference
Delphinapterus leucas	Bristol Bay, Alaska	N.R.	Damage gill net gear.	N.R.	Pitcher
Steno bredanensis	Hawaii	Longline fishery for tuna, marlin & shark have had problems with unverified Steno taking bait off hooks.	N.R.	N.R.	Yuen
Tursiops truncatus	Hawaii	Hand-line fishery for snappers, groupers & carangids-fish removed from hooks; 1 porpoise can remove 6 fish. Also line pulled thru hands creates risk.	N.R.	N.R.	Yuen
Phocoena phocoena	Copper River flats, Alaska	N.R.	Some damage to gill nets during entanglement.	75 netted, at least 30 killed	Matkin **
	Prince William Sound, Alaska	N.R.	Same as above.	10 netted, (unknown number killed)	Matkin **
	Central California	N.R.	N.R.	12% of beachcast animals examined had probably died as a result of trammel net entanglement	Morejohn (unpubl. data)

Marine Mammal	Location of Interaction	Fish Loss or Damage	Gear Damage	Incidental mortality of Marine Mammals	Reference
Phocoenoides dalli	North Pacific Ocean & Bering Sea	N.R.	N.R.	U.S. research vessels give estimates of 10,000-12,600 taken incidental to Japanese high seas gillnet fishery.	French
	Copper River delta, Alaska	N.R.	Damage gill nets.	5 netted (unknown number killed)	Matkin **
	Prince William Sound, Alaska	N.R.	N.R.	10 netted (unknown number killed)	Matkin **
Pseudorca crassidens	Hawaii	Longline tuna fishermen implicate the false killer whale in losses of caught fish.	N.R.	N.R.	Yuen
Eschrichtius robustus	California	N.R.	Damage trammel & gill nets in rockfish fishery	Some reported for trammel net fishery	Morejohn (unpubl. data) Woodhouse (unpubl. data)

* These figures inclue impact of seals and sea lions - 75% of the damage was attributed to Steller sea lions, 25% to harbor seals.

** Since the workshop, these data have been published.

APPENDIX V

CONSIDERATION OF MANAGEMENT ALTERNATIVES

In weighing whether or not marine mammal populations should be controlled as a management option, the ecological, subsistence, scientific, economic, and esthetic values of the marine mammals (as individuals and as a population) should be taken into account. "Economic value" presupposes some commercial use (furs, pet food, etc.), but need not be consumptive, i.e., some people pay money to see marine mammals "in the wild" at land-based hauling areas or by boat charter. Many communities place a high cultural and/or economic value on both marine mammals and fisheries. The multi-million dollar display industry involving marine mammals indicates the level of public interest. While practical matters of economics or political expediency may favor certain forms of management, the MMPA dictates that management options address humaneness, waste, and alternatives to killing (such as transplanting animals) in reducing population numbers. Some of the alternatives which range from total preservation to total eradication are listed below with comments.

1. Total preservation - possible adverse impacts to fisheries, possible tourism benefits, possible threat to fish populations if the human fishery is unregulated.

2. Non-lethal harassment - could be short-term or in limited areas to accomplish protection of fishing gear, catch, entrance to a fish hatchery, or the peak period of an anadromous fish run; continuous harassment could affect mammals by disturbing reproductive success (mating, birth, suckling), reducing haul out periods of unknown importance, possibly resulting in emigration and relocation of population (depending upon the availability of suitable alternative habitats).

3. Transplants - requires identification of biologically and politically suitable habitat (the latter could be the greatest problem unless the species is highly "desirable"); agencies may wish to place limits to growth (on the numbers or range) in areas of transplant to minimize future problems; only a stop-gap measure requiring continual transplant efforts if populations being "reduced" continue to expand, also requires finding new suitable habitat as earlier transplant sites "fill", with obvious financial commitment; cost per transplant may be quite high.

4. Collection for scientific research or public display - can be limited to season and/or area; encourage collection of live animals for authorized permit holders.

5. Hunting - can be limited to season and/or area

   a) Professional hunter seasonal collection at period of conflict may produce significant harassment and fulfill goal of minimizing conflict without large kill especially if done with associated cues (acoustic, visual) which marine mammals may respond to without reinforcement (killing).

   b) subsistence hunting depending on species, cultural acceptability, and safety of consumption; some safety considerations, depending upon species and location.

   c) sport hunting - seasons, bag limits, safety, enforcement difficulties, development of regulations and quotas.

   d) eradication - complete removal from geographic areas within the range of a large stock may be technically feasible, but would require considerable justification and care to assure that the genetic stock is adequately safeguarded (exchange, composition, etc.); could result in unforeseen adverse changes in the ecosystem as a result of food web disruption, especially at such "high" trophic levels without complete understanding of functional roles (as predator, prey and intermediate host). See ecological considerations.

This list is by no means comprehensive, but identifies some of the more obvious alternatives and suggests major considerations in evaluating each. Any manipulative management will have to comply with the MMPA and go through the waiver or permit process (assuring public scrutiny).

The waiver process will require an assessment of proposed management programs relative to their possible impacts on marine mammal populations. Follow-up studies to document the actual effects should be required. There is so little known about most management alternatives that they can and should be considered research programs. Research programs require the same justifications as management programs where manipulation (in the form of kill or harassment) takes place, but only need a research permit and not a waiver of the Act or return of management authority to a state. Adequate monitoring to evaluate various manipulative techniques is essential to develop a predictive capability for future management application and elimination of unacceptable practices.

In the event that management for whatever reason involves quotas to be killed, incidental take may also be used as a guide to the number of animals which can be removed (if population data were collected concurrently and demonstrate no declines and if the population can be shown to be at or above MNP levels).

APPENDIX VI

ECOSYSTEM STUDIES AND MODELS

Competition

Workshop participants expressed a general appreciation of the need to understand natural feeding habits so that direct competition with human fisheries could be put in perspective. It was generally agreed that although many of the food web relationships were known on a qualitative level, much work needed to be done to develop quantitative information on the feeding habits of individual species of marine mammals by region and season.

It was the objective of this workshop to deal with the direct take of fishes from fishing gear and damage to that gear. However, participants recognized the value of and need to understand the trophic relationships between marine mammals and other elements of the marine food web. This would be a difficult and lengthy analysis by a group whose composition should include persons with specific expertise in many areas not represented in this workshop. In view of the complexity of conducting a full investigation of food webs, the workshop elected to review some of the basic information which is being developed now for certain regions in order to put the research needs for the fisheries competition in perspective with what is currently underway. Many of the studies underway may also represent research opportunities for focusing investigations involving fisheries conflicts.

I. Alaska

Several million dollars has been directed to research on Alaska marine mammals as a result of current and future offshore oil leasing. Most of this money has come from the Bureau of Land Management's Outer Continental Shelf Energy Assessment Program (BLM/OCSEAP or BLM/OCS). Workshop participants who are also principal investigators for some of these projects included the Alaska Department of Fish & Game (ADF&G), the University of Alaska, and the Marine Mammal Division of NMFS.

The ADF&G is in the process of studying the trophic relationships of four ice-inhabiting seals(the spotted seal, Phoca largha, the ringed seal, P. hispida, the ribbon seal, P. fasciata, and the bearded seal, Erignathus barbatus). From the basic research, two feeding patterns are emerging: one is benthic and the other is much more diverse (but not primarily benthic). Diets vary with geographic location and also seasonally. Feeding habits vary with age and sex of animals (for example, long periods of fasting among adult male otariids during the breeding season). Another important feature is animal mobility. In essence, seals are "sampling" a patchy environment in time and space. Availability of prey is not well understood due to a lack of adequate resolution. Three or four prey species usually account for 90% of seals' diets at any given location or time, but many other species occur at much lower frequencies.

There is an apparent food size preference exhibited among these seals. Ringed seals apparently prefer smaller food items (1 to 10 g), harbor and spotted seals prefer food ranging in size from shrimp to larger sculpin (5 to 500 g) whereas sea lions take the largest food items (10 g to several kg). Other important considerations include depth, time, and range of foraging. Some seals select specific food items on a seasonal basis, such as the bearded seal, which feeds on the muscular siphon of pelecypods (clams) only at certain times of the year. Selection of capelin (Mallotus villosus) over pollock (Theragra chalcogramma) when both are in Bristol Bay by the spotted seal (Phoca largha) demonstrates prey preference rather than simple opportunism. Perhaps one of the most difficult parameters to assess is the effect of learned feeding behavior. Examples cited included sea otters opening beer cans to get resident octopus (Octopus spp.). Learning may be an important aspect of marine mammals eating fish from fishing gear.

Further studies by the ADF&G on Steller sea lions and harbor seals collected from the western part of the northeast Gulf of Alaska, indicate that these species can be generally considered opportunistic fish eaters, with fish comprising about 85% of their diet. Differential consumption of cephalopods, another major food, is also shown. Squid are preferred by sea lions, while seals prefer octopus. This may be prey preference or reflect the relative abundance of these prey species in different forage areas used by the two pinnipeds.

There are obvious data gaps in offshore feeding habits that need to be filled in. Many (of what are considered to be) coastal species of marine mammals may, in fact, be feeding offshore more often than is realized. Changes in abundance and distribution of prey species of marine mammals are important considerations. If, for example, an important food item of a mammal should become steadily more abundant, this may increase the carrying capacity of the environment for that mammal species. Conversely, significant reduction in prey density may cause a shift in feeding habits or possibly a decrease in the capacity of a local environment to support marine mammal populations.

II. The Bering Sea Pollock-Fur Seal Model

The Northwest and Alaska Fisheries Center of NMFS has, and continues to develop, a Bering Sea model incorporating trophic interactions of the pollock groundfish fishery and the northern fur seal populations showing how they and eight other groupings of vertebrates and invertebrates interact in the marine food web. The Bering Sea was focused upon because of the accumulated knowledge of the pollock fishery in that area and food consumption studies of fur seals (determined by stomach content analysis). However, there is a lack of confidence in estimates used to construct the model due to inadequate sample sizes or high variability, which prevents this model from being a functional management tool. Some specific data included in the model are as follows: estimated fish consumption by fur seals - 500,000 metric tons per year (MT/yr), by birds - 500,000 MT/yr, by other pinnipeds - 2,200,000 MT/yr, by whales - 400,000 MT/yr, and totalling 3,200,000 MT/yr for all vertebrates. The estimated total

fishery catch is 1,400,000 MT/yr. 17% of the standing stock in the Bering Sea is consumed per year and 2% is consumed by fur seals. In 10 years, changes in estimating techniques have raised the standing stocks estimate of the Bering Sea from 7 million MT to 27 million MT. Squid is the major non-vertebrate stock and is estimated at 4 million MT. Approximately 52% of squid stocks are consumed annually, largely by cetaceans, an estimated 3% of the squid standing stock is annually consumed by northern fur seals. This is perhaps the only attempt at the present time to make quantitative estimates of the interactions of such a large and highly complex food web. While the estimates lack confidence intervals, modeling of this sort is useful in identifying what types of data influence the model most critically and hence subject it to greatest error. Obvious areas of sensitivity include: 1) estimates of populations which may be difficult to determine; 2) determining an average body weight for a species; 3) the composition of feeding habits regionally and seasonally for key species (e.g. little is known of the role of the feeding habits of cetaceans); 4) small changes in food consumption rates (multiplied by population, duration of predation, etc. make this a critical factor which is poorly known and has been demonstrated to vary greatly for some species). Food consumption rate estimates for northern fur seals vary from 5 to 21% of body weight per day, probably due to variations of season, age and sex of specimen, environmental conditions, and caloric content of prey items.

The principal value of this type of model then becomes: 1) determining where incorrect values of various parameters occur; 2) identification of data gaps where additional information is required; 3) identification of elements of the model which are most sensitive to error. All of these are important to know for the design of future research.

III. Central California

Work underway at the Moss Landing Marine Laboratory has been directed toward a better understanding of Monterey Bay and the nearshore marine food web. A baseline study investigating the vertebrate predation on the commercial market squid was supported for three years (1975 to 1977). Feeding habits of the marine fishes, birds, and mammals were examined in Monterey Bay. Over 40 species of sea birds occur in Monterey Bay but 27 occur in large numbers and seasonally move into the bay for a three- to six-month residence. Sixteen species consumed squid and eight fed on squid extensively. Five species of pinnipeds and four species of cetaceans were found beach cast and examined for feeding habits. Eighty-eight species of fish were collected using hook,trawl, seine and gill net.

Fish predation in Monterey Bay centers on a few recurring prey items. Squid, euphausiids, rockfish (Sebastes spp.), and anchovy were the significantly important food items for many species of fish. Birds, as well, seem to feed more heavily on squid, anchovies and euphausiids than on other prey. A division between specialists (Fulmar, Kittiwake, Bonaparte's Gull and Rhinocerus Auklet) and generalists (Murre, Shearwater, and Heermann's Gull) is evident from prey diversity. The pinniped diet appears to favor fish while the cetacean diet favors squid.

Although there is a general difference, both groups of marine mammals also seem to prey most heavily on the recurring prey of birds and fish.