

REPORT ON STUDIES CONDUCTED ABOARD  
THE DEDICATED VESSEL, HOYO MARU #67  
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As part of the U.S.-Japan cooperative research program on the incidental take of marine mammals in Japanese salmon gillnets, the Japan Fisheries Agency chartered a vessel during 1979, which was dedicated to research on marine mammals and salmon. The vessel, Hoyo Maru #67, (JJKW) undertook two cruises, the first predominantly for marine mammal research, the second predominantly for salmon research.

Cruise one departed from Kushiro, Japan on, 16 May 1979, after a one day delay due to storm conditions. The U.S. scientific staff were: Christopher Boucher (National Marine Mammal Laboratory), James Coe (Southwest Fisheries Center, National Marine Fisheries Service), Linda Jones (NMML) and William Walker (Los Angeles County Museum). The Japanese scientific staff were Jun Ito (Far Seas Fisheries Research Laboratory), Junichiro Okamoto (Japan Fisheries Agency), and Dr. Akira Takemura (Nagasaki University). The cruise ended in Kushiro on 23 June. Cruise two departed Kushiro on 29 June and returned to the ship's home port of Kesenuma on 10 August. The Japanese scientists aboard Cruise II were Masayoshi Narita (Japan Fishery Agency), Dr. Nobuyuki Miyazaki (National Museum, Tokyo) and Dr. Haruo Ogi (Hokkaido University). The

U.S. scientists were Richard Beach (NMML) and Dr. David Ainley (Point Reyes Bird Observatory).

The objectives of the marine mammal research were to:

1. Obtain information on the factors involved in marine mammal entanglements including location in the net, environmental conditions, gear characteristics and associated catch;
2. Conduct ecological studies of the organisms associated with the fishing area, collecting stomach samples, and plankton and neuston samples;
3. Obtain information concerning the behavior of marine mammals near vessels and gillnets and the conditions which affect sighting of the marine mammals;
4. Study the acoustic environment of the gillnet and the acoustic characteristics of Dall's porpoise; and
5. Obtain information on the distribution and abundance of Dall's porpoise and other marine mammals.

The dedicated vessel provided an excellent opportunity to study the problem of marine mammal entanglements in salmon gillnets. The results of these

preliminary studies provided the basis for new studies proposed for 1980 research.

### Marine Mammal Sighting Surveys

Throughout the cruises whenever the vessel was in transit and as weather conditions permitted, the marine mammal sighting surveys were conducted to obtain data for population abundance studies. When the ship was not transiting or when weather conditions prohibited the surveys, observers recorded the presence and behavior of marine mammals, however these data were not used for population estimates but for distributional and behavioral studies.

Initial sighting of animals was by unaided eye. Species identification and behavioral observations were conducted using 7 x 50 binoculars. The surveys began at daybreak (0200 Japan Standard Time) and continued until sunset (1700 JST).

During Cruise I, Dall's porpoise sightings obtained by other salmon research vessels were radioed daily to the dedicated vessel. The data included number of animals sighted each day, location, water temperature, (at 0, 50 and 100 m) and water clarity. This information was useful in locating areas for

studies of Dall's porpoise during the cruise.

## Results

A total of 459 marine mammals were sighted during Cruise I (Table 1). The predominant species sighted was Dall's porpoise (433 animals, 79 sightings, average group size of 5-6 animals). Northern fur seals (Callorhinus ursinus) and northern sea lion (Eumetopias jubatus) were frequently sighted near the gillnets during retrieval, with 14 and 8 animals sighted, respectively. Sightings of other species were rare.

During Cruise II, a total of 776 marine mammals were observed in 218 sightings. Of these, 644 were Dall's porpoise, including Trues' and unidentified Phocoenoides. Mixed schools of Trues' and Dall's were observed on seven occasions. A total of 44 northern fur seals and 9 northern sea lions were sighted (Table 1).

Entanglement Studies.

## Methods

The gillnet routinely used aboard the dedicated vessel consisted of 50 tans (2.5 km) of 114 mm stretch

Table 1.-- Marine Mammal Sightings aboard Japanese Research Vessels, 1979.

	<u>Oshoro Maru</u>				<u>Hoyo Maru</u>				<u>Hokusei Maru</u>		Totals	
	5 June- 2 July		7 July- 12 August		16 May- 23 June		29 June- 10 August		16 July- 13 August			
	A	B	A	B	A	B	A	B	A	B	A	B
<u>Cetaceans</u>												
<u>Phocoenoides dalli dalli</u>	48	192	117	514	62	349	63	241	13	60	303	1356
<u>Phocoenoides dalli truei</u>	5	17	1	2	3	4	28	161	14	45	51	229
<u>Phocoenoides unknown</u>	17	60	5	21	14	80	63	242	32	109	131	512
<u>Phocoena phocoena</u>	1	2	4	4							5	6
<u>Lagenorhynchus obliquidens</u>			4	263					7	124	11	387
<u>Globicephala macrorhynchus</u>							2	5			2	5
<u>Lissodelphis borealis</u>			2	300					2	10	4	310
<u>Delphinus delphis</u>			21	1857					3	110	24	1967
<u>Grampus griseus</u>			5	60					1	6	6	66
Unidentified porpoise/dolphin	4	6	14	210			1	1	33	295	52	541
<u>Pseudorca crassidens</u>			1	2			1	5			2	7
<u>Orcinus orca</u>			3	24	1	4	4	33	2	6	13	67
<u>Berardius bairdii</u>	1	2	3	11			2	13			6	26
<u>Ziphius cavirostris</u>			3	4			1	5			4	9
<u>Mesoplodon stejnegeri</u>			1	2							1	2
<u>Mesoplodon sp.</u>			2	5							2	5
<u>Physeter macrocephalus</u>							1	1			1	1
<u>Balaenoptera acutorostrata</u>			12	20			5	15	1	1	18	36
<u>Balaenoptera physalus</u>			2	18							2	18
<u>Balaenoptera musculus</u>											0	0
<u>Balaenoptera borealis</u>	1	1									1	1
<u>Megaptera novaeangliae</u>			1	4							1	4
Unidentified whales	2	5	10	16			2	3	7	14	21	38
<u>Pinnipeds</u>												
<u>Callorhinus ursinus</u>	53	74	46	294	14	14	35	42	20	22	168	446
<u>Eumetopias jubatus</u>			3	81	6	8	8	9			17	98
<u>Enhydra lutris</u>			4	7							4	7
<u>Phoca vitulina</u>			1	1							1	1
Unidentified pinniped			1	1							1	1
	132	359	266	3750	103	459	216	776	135	802	852	6146

A = Number of sightings.

B = Total number of individuals sighted.

mesh (as used in the land-based salmon fishery), 30 tans (1.5 km) of research net consisting of 3 tans each of 48, 93, 157, 106, 63, 121, 72, 138, 82 and 55 mm mesh nets (in this sequence) and 50 tans of 114 mm mesh, for a total of 130 tans (6.5 km). This net differed from nets used by the high seas fishery in three respects: (1) The mesh size was predominantly 114 mm rather than 121 or 130 mm; (2) The total length was 200 tans shorter (130 vs 330); and (3) 30 tans of research mesh sizes were included in the net. The net was set each day, weather permitting, at 1600 (Japan Standard Time). A second net of 100 tans of 114 mm mesh was set on one occasion. On several sets, only 80 tans were deployed. Deployment usually required half an hour.

Immediately prior to net deployment, an oceanographic station was conducted. Water transparency (Secchi disk depth) and temperature (XBT), 300 m to surface, were measured. A vertical plankton tow was taken, 150 m to the surface. One hour after sunset, a surface neuston net was towed for 10 minutes. Neuston and plankton samples were preserved in 10% formalin.

Retrieval of the net began at daybreak the following day. If weather permitted, prior to

retrieval the vessel cruised at slow speed parallel to the gillnet ("Net patrol") in order to observe entanglements, the configuration of the net, and marine mammal behavior near the net. The following data were recorded during net patrol: swell and wind direction, wind speed, weather conditions, surface water temperature, begin and end time, net configuration and location. Number of marine mammals present and their behavior were recorded. Net patrol was usually completed in half an hour. Retrieval required 2-3 hours, and processing of the catch and salmon data collection, an additional 2-3 hours. The vessel then either moved to a new location or drifted until time for the next gillnet set.

During retrieval, entanglement of marine mammals, seabirds, invertebrates and fish other than salmon were recorded. Seabirds, squid and fish were collected for food habit studies. Specimens were obtained for the NMML reference collection.

In addition to marine mammal behavior data and detailed information on entangled marine mammals, the following data were collected for each gillnet set for studies of the entanglement of Dall's porpoise:

DATA COLLECTED DURING SETTING OF THE NET

Date:                      Set number:                      Location:

A. Configuration

1. Time of initiation of set (in JST time):
2. Time of research panel set (in JST time):
3. Time of termination of research panel set:
4. Termination of set:
5. Direction of set (in degrees true):
6. Tans of net set:
7. Type of net (i.e. the number tans of research or commercial gear):

B. Environmental conditions

1. Wind velocity and direction (in knots and compass points):
2. Swell direction and height (in compass points and meters):
3. Visibility (in meters):
4. Surface water temperature ( $^{\circ}\text{C}$ ):
5. Air temperature ( $^{\circ}\text{C}$ ):
6. BT trace:
7. Secchi disk transparency (meters):

C. Biological parameters

1. Vertical plankton tow
  - a. Duration (i.e. 1554 to 1600):
  - b. Wire angle (in degrees):
  - c. Wire depth (meters):
  - c. True depth (meters):
2. Horizontal plankton tow
  - a. Duration (i.e. 1914 to 1924):
  - b. Depth
3. Field notes on marine mammals around the net:

D. Miscellaneous: anomalies in set, birds, etc.

DATA COLLECTED DURING RETRIEVAL OF THE NET

- A. Net Patrol
- Date: Set number: Location:
- Time: Course: Speed:
- B. Configuration
1. Initial time of haul (in JST time):
  2. Lay of net in degrees true:
  3. Time of research net haul and position:
  4. Lay of net in degrees true:
  5. Time finish research net and position:
  6. Lay net in degrees true:
  7. Time finish the entire haul and position:
- C. Environmental conditions
1. Wind velocity and direction (knots and compass points):
  2. Swell direction and height (compass and meters):
  3. Visibility (in meters):
  4. Air temperature ( $^{\circ}\text{C}$ ):
  5. Water temperature ( $^{\circ}\text{C}$ ):
- D. Salmon
1. Overall count:
  2. Position in net of first 200 salmon hauled aboard:
  3. Breakdown of species:
  4. Salmon stomachs taken:
- E. Other fish and invertebrates
1. Overall count:
  2. Breakdown of species:
  3. Position in the net vertical and horizontal:
  4. Samples taken:
- F. Field notes on marine mammals and birds, interacting

with net haul

G. Birds caught in net

1. Breakdown by species:
2. Horizontal and vertical position in the net.

Results

The total number of gillnet sets during Cruise I was seventeen, utilizing 2130 tons (106.5 km). Two Dall's porpoise entangled, resulting in a catch rate per 1000 tons of 0.94. The first animal was alive, and broke through the net as we attempted to bring it aboard to release it. The porpoise subsequently swam away. The entanglement occurred on 27 May (Set 5) at 47°39'N and 160°59'E. The animal was in the upper portion of the net, an estimated 80 m from the radio buoy marking the end of the net in the commercial mesh net (114 mm). The length was estimated to be 140-150 cm. The second porpoise, taken on 12 June (Set 15) at 49°18'N and 177°26'W, was dead, brought aboard, systematically untangled and a complete necropsy was performed. The animal was also entangled near the corkline (about 2 m down) an estimated distance of 360 m from the upwind end of the net, in the commercial net section. The animal was a small female, 152 cm in length.

During Cruise II, there were 20 gillnet sets,

utilizing 2600 tans (130 km). One Dall's porpoise (catch rate = 0.38) and one northern fur seal were taken. The fur seal became entangled in the research net (82 mm mesh) on 26 July (Station 17, 57°56'N and 178°05'W). The young male animal was alive, brought onboard, untangled and released alive. The Dall's porpoise was entangled and drowned in 138 mm mesh net (near the commercial net section) in the upper 2 m of the net on 30 July (Station 20, 57°58'N and 178°57'E). It was not heavily entangled, fell free of the net and was gaffed in order to bring it aboard. A necropsy was performed and samples were collected. It was a small male, 160 cm in length.

Oceanographic conditions at the time of these entanglements were:

Date	Water Temperature	Water Transparency	Beaufort	Weather
27 May	2.8°C	22 m	4	Overcast
12 June	5.0°C	12 m	3	Fog
30 July	7.8°C	15 m	4	Fog

No conclusions on conditions associated with entanglement can be obtained from this small sample. All animals were entangled in the upper portion of the net, generally near to one end of the net, in commercial or larger mesh sizes.

During the interval 15-19 July, the dedicated vessel fished with the fleet of the mothership Nojima maru. No marine mammals entangled during this time, either on the dedicated vessel or on any of the catcher boats. This operation with the commercial fleet provided an excellent opportunity to observe some of the conditions and methods of the commercial fishing operation.

The following is a summary of the preliminary results of the studies of the relationship between marine mammal entanglement and fishing gear characteristics. During the interval that nets were deployed, little small scale disfiguration which could potentially be dangerous to marine mammals was observed. In four of the seventeen sets, large pockets formed in the net which could possibly confuse animals and result in their entrapment.

Net construction may be conducive to marine mammal capture. The nets are constructed to allow slippage of the knots between the meshes. This feature may reduce the probability of an animal breaking through the net and thereby avoiding capture.

Observation of the two entangled porpoises on Cruise I suggested that the response of each animal to contact with the net was to execute a sharp turn. This

turning behavior was observed as a common behavior in porpoises observed swimming near the vessel and gillnet and may be part of their natural avoidance response. It is suggested that this behavior of the porpoise may result in a high percentage of the animals which encounter the net being captured. Two hypotheses related to the process of entanglement are proposed: (1) the porpoise perceive the net but fail to turn so as to avoid the net; (2) the porpoise do not perceive the net but turn upon contact. Observations during retrieval of the net aboard the dedicated vessel (during daylight hours) indicated the porpoise could probably perceive the net, possibly by visual means. However, studies of the acoustical capabilities of Dall's porpoise conducted by Hubbs-Sea World Research Institute indicate that the porpoise probably can not acoustically detect the monofilament portion of the net. Additional studies are necessary to resolve the problem of whether the porpoise can detect the net and by what means.

## Behavioral Observations

During Cruise I Dall's porpoise were observed approaching the gillnet on several occasions. As the net was deployed for set 6 a group of 6 porpoise were observed swimming under the net approximately 20 m astern. Entanglement danger was probably low because of the early stage of the deployment process at that time. In the observers' opinion, the animals appeared aware of the presence of the net.

During retrieval of sets 5 and 14, porpoise were seen approaching the gillnet. On both days, the animals approached the net at high speed and at several meters distance from the net, executed radical turns away. Several times the animals were seen crossing underneath the net. The lower boundary of the net seemed to be apparent to the animals. Whether the animals visually, or acoustically detected the net is unknown. Certainly the retrieval process generated high noise levels which would be detectable by the porpoise.

Dall's porpoise were observed in close proximity to the gillnets on two occasions during Cruise II. At Station 2, four porpoise swam at high speed towards the net as it was being retrieved. Approximately 50 m from

the net, all animals executed a sharp turn away and swam out of the area. At station 10, four Dall's porpoise approached within 5 m of the net as it was deployed, at a distance of 50 m from the stern. Again, all animals turned sharply away from the net, apparently aware of its presence.

Observers concluded that the porpoise are aware of the presence of the net during set and retrieval operation during daylight hours. The mechanisms of perception remain unknown.

#### Acoustical Studies

The research contract initiated in 1978 for studies of Dall's porpoise acoustical capabilities has been completed by scientists at Hubbs-Sea World Research Institute. The objectives of the study were to obtain and analyze recordings of Dall's porpoise, analyze hearing potential based on morphological studies and determine whether the animals were capable of detecting Japanese salmon gillnets.

The investigators obtained good quality recordings of one group of 5 to 7 Dall's porpoise in the Straits of Georgia, British Columbia, Canada. These animals produced high frequency (120-160 KHz) narrow-band,

constant frequency echolocation pulses. This is the first report of such signals from a cetacean. The studies of the auditory capabilities of this species indicated the upper auditory threshold of Dall's porpoise is probably between 170-200 KHz.

Based upon these results, the investigators predict that the monofilament net used by the Japanese salmon fisheries will be difficult for Dall's porpoise to detect under many conditions, for example, in high sea states. The investigators suggest that increasing the net's target strength (i.e., the reflection of pulse energy from the net) might increase the probability of the porpoise detecting the net. One method recommended for increasing the target strength is to weave air-filled braided nylon line at intervals through the net. Such line is commercially available. A second possibility is to emplace metal tags at intervals in the net.

Because porpoise mortality in the gillnets is unpredictable in time and space, it is very difficult to design field tests which would conclusively demonstrate the effectiveness of such devices. Such experimentation would probably require the use of a captive animal. At present the U.S. does not have plans for such research on Dall's porpoise.