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Observations on High-Seas Squid Gill-Net Fisheries, North Pacific Ocean, 1985

by
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OBSERVATIONS ON HIGH-SEAS SQUID GILL-NET FISHERIES, NORTH PACIFIC OCEAN, 1985

by

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ABSTRACT

The National Marine Fisheries Service (NMFS), in cooperation with the U.S. Coast Guard (USCG), conducted observations of the high-seas squid gill-net fisheries in the North Pacific Ocean for 36 days, from 15 August to 19 September 1985. USCG personnel boarded 15 gill-net vessels, and NMFS scientists observed five deployments and 11 retrievals of gill nets, The squid boats varied in size, as did their gill nets which were 7-30 nautical miles (nmi) long. A single day's catch ranged from 871 to 8,256 squid and 5 to 530 tuna. Average catch per nautical mile for squid, tuna, and pomfret was 127.0, 9.4, and 78.9, respectively. No salmon or marine mammals were identified in the observed catch. Few birds were caught relative to salmon gill-net fisheries, (28 birds in 53.4 nmi of gill net).

Sighting surveys of marine mammals, seabirds, and marine debris were undertaken while the vessel was in transit. No great numbers of marine mammals or birds were observed. An average rate of 3.4 discarded gill nets per 1,000 nmi was observed. No gill net was discarded from the 11 fishing vessels observed during net retrievals. In addition to catch data, in formation on the vessels, fishing techniques, equipment, and schedules was also collected.

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INTRODUCTION

High-seas gill-net fisheries for squid in the North Pacific Ocean have grown since 1978 to involve about 700 vessels from Japan, Taiwan, and the Republic of Korea (ROK). Each vessel fishes from 18 to 40 km of monofilament gill net nightly, and the fishing season extends from June through November. These fisheries may have high incidental catches of marine mammals, seabirds, and salmon. They may also generate significant amounts of potentially hazardous marine debris which, in turn, contribute to the mortality of marine animals and pose a threat to human safety by interfering with vessel operation.

Because' these squid fisheries are outside the U.S. Exclusive Economic Zone and not subject to any international treaty to which the United States is a party, it has not' been possible to place U.S. observers in these fisheries. Therefore, the extent of entanglement of' marine species in squid gill nets is not known. Qualitative evidence, however, discussed at the Workshop on the Fate and Impact of Marine Debris in Honolulu (November 1984), suggests that entanglement may be substantial for certain species. Widespread public concern over entanglement of marine mammals, seabirds, and commercial fishes by squid fisheries. prompted the U.S. Congress in 1985 to fund a study of the problem. This study was conducted by the National Marine Fisheries Service (NMFS) in cooperation with the U.S. Coast Guard (USCG), 17th District. The USCG provided the USCG cutter Storis as a research platform for the study. Built in 1942, the Storis is 230 ft long with a 43 ft beam and displaces 1,790 tons; cruising-speed is 8-13 knots.

We embarked on the cruise with 'many objectives but with little knowledge of these fisheries. The limited extent of our knowledge was illustrated by our recognition that the probability of not finding a single vessel to observe was significant. We also recognized that sampling methods would be devised on an ad hoc basis. Thus, with our cruise track completely flexible and not prearranged, we trusted information from sources such as the Japanese Squid Association and USCG C-130 aircraft overflights to define our daily work schedules (Appendix). The following scientific objectives provided the focus for our research activities:

1. Determine the feasibility of monitoring squid fisheries by direct observations from the Storis.
2. Make an initial appraisal of ways of locating these fisheries.
3. Observe, in situ, marine mammals, seabirds, salmon, and other species entrapped in gill nets.
4. Make initial estimates of catch by species and spec ies groups caught by gill-netters in these fisheries.
5. Determine the feasibility of locating and marking derelict fishing gear.
6. Identify the fishing patterns and techniques of each squid gill-net fishery, namely Japanese, ROK, and Taiwanese, in a study area defined by the following coordinates: 40°OO'N 145°OO'W, 40°OO'N 180°00', 46°00,'N 145°OO'.W, and 46°OO'N 18O°OO'W.
7. Conduct seabird and marine mammal abundance surveys.

LOCATING THE SQUID BOATS

We relied almost totally on USCG aerial surveillance flights from C-130 aircraft to direct us to squid fishing vessels. The C-130 aircraft is a four-engine turbo prop airplane with long endurance patrol capability. The aircraft flew transects within the northern portion of the squid regulation area.

Five squid boats were found without specific- guidance from the aircraft. The Hoshi Maru No. 38 was intercepted on its way to Kodiak as we traveled south from Kodiak; the Enami Maru No. 15 was fishing in an area where the aircraft earlier reported the presence of 'squid boats; and the Sankichi Maru No. 23,. Wakashio Maru No. 22, and Hokutatsu Maru No. 88 were found as we searched the general area where we had previously seen squid boats. Knowledge from earlier aircraft sightings and, our experience in the study area were essential elements in the successful location of these last four Japanese boats.

We encountered no Taiwanese or ROK squid boats. Information indicated their probable locations were far to the west and to the south of the primary study area. We concluded that, considering the distances and time involved and without specific vessel locations from aircraft information, it was not practical to survey those areas.

The Storis debarked Kodiak on 15 August 1985 and began transiting south towards the squid fishing grounds. After 4 days in transit, we entered the squid fishing area and began observations on squid gill-net vessels. During the next 29 days, we encountered 16 fishing vessels (Appendix) and observed five gill-net deployments and 11 net retrievals, and USCG personnel boarded 15 gill-net vessels (Fig. 1).

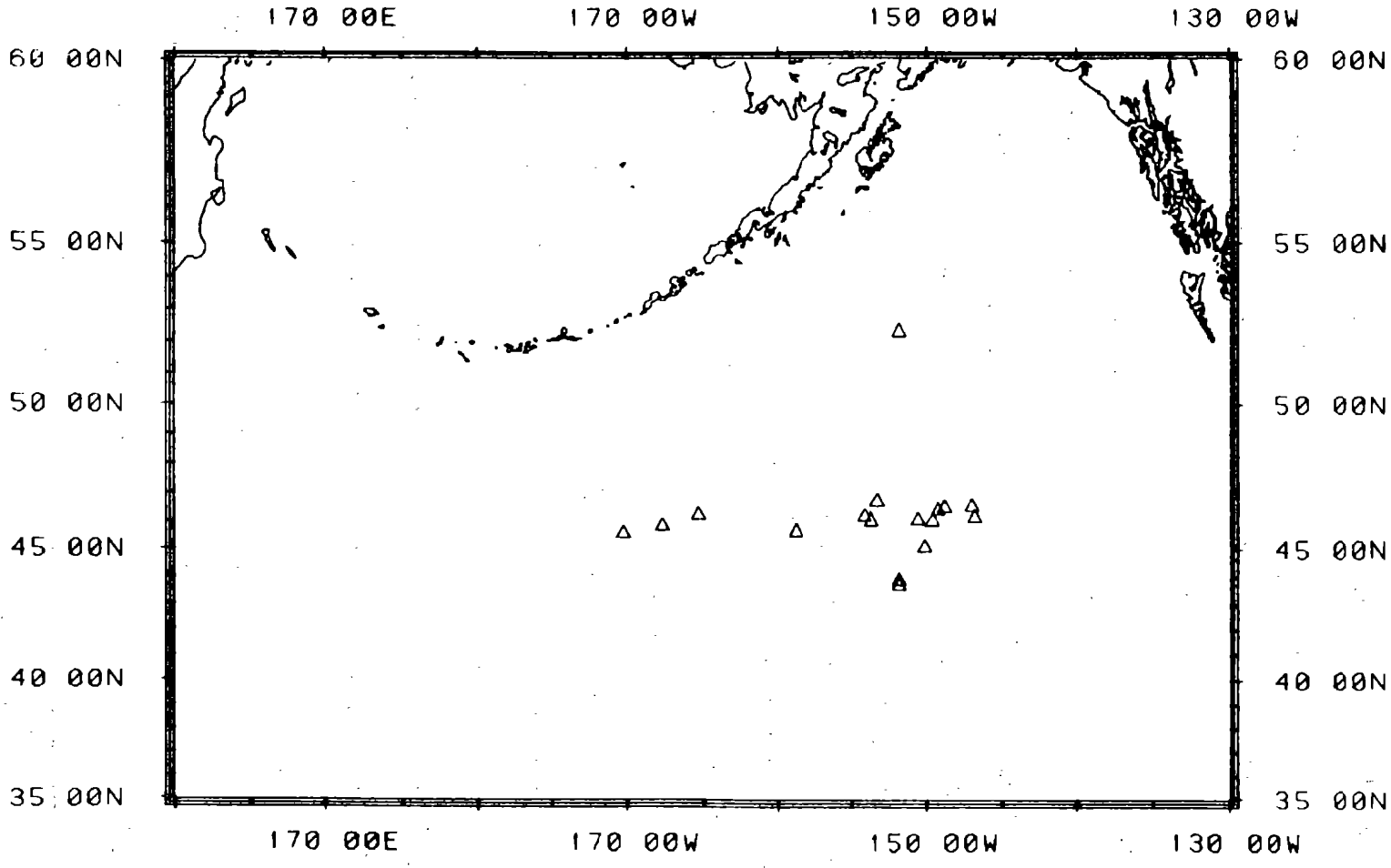

Figure 1.--Locations of Japanese squid gill-net vessels that were either observed by National Marine Fisheries Service scientists or boarded by U.S. Coast Guard personnel.

Fifty-six percent of the northernmost portion of the Japanese squid regulatory area was sampled. The Japanese squid regulation area is 'an area bounded by 170°E, 20°N, 145°W, and either 44°N in August or 46°N in September. Thirteen days were spent in waters between, 17O°W and 157°W, and 16 days between 157°W and 145°W: Because of inclement weather westward and increased availability of vessels eastward; most observations were made of vessels in the easternmost portion of the fishing area.

Conditions of wind, sea; rain, and fog prevented us from either deploying the motor launch or net-counting catches from the bridge wing of the Storis while we were at the west end of the study area (46°N, 167°W). The Shoshima Maru No. 15 was located at 0600 hours on 5 September 1985 and followed as she retrieved nets until 1320 hours. Sea condition was rated Beaufort 5 and visibility varied from <200 to 1,500 m. Retrieval of -the net apparently started before. 0700 hours. Because of the inclement weather, it was unsafe to approach any closer than 800 m. The net was barely visible, and, even: in daylight- we could not see squid in the net. At about 1600 hours, the USCG boarded -the vessel;, she had caught about 1 metric ton (t) of squid as we watched. On the following day, after a similar experience with the Enami Maru No. 15, we decided to travel eastward to locate boats under better viewing conditions.

GILL-NET RETRIEVAL

Catch Counts

Gill-net retrievals were observed and sample counts of catches were made from the bridge wing of the Storis and from a motor launch. The

bridge wing was used as an observation platform to make 63 5-minute sample counts of gill-net catches by three Japanese squid boats. Counts were made in both daylights and darkness. These counts sampled 40% of the total time for retrieval of seven nets. Sample counts were limited to 5 minutes because longer counts would often be 'interrupted. by maneuvers of either vessel or by the end section of net being retrieved.

The approach of the Storis to less than 250 m from a gill-netter was deemed unsafe by the Captain and the observers. Approaches within 250 m elicited radio calls, megaphone calls, and arm waving from the Japanese vessels. All squid vessels utilize frequent and rapid changes in direction and speed while retrieving nets; therefore, squid guill-net observations from any large. vessel should be performed at distances greater than 400 m.

A motor launch was used to make 148 5-minute sample counts of gill-net catches by seven Japanese squid boats. Counts were made in daylight. Overall, we sampled 24% of the total time of retrieval of seven nets. Initially, we observed retrieval of gill nets 100-200 m off the port quarter aft of the gill-netter. Attempts to position ourselves farther forward or closer caused apparent concern for our safety, and hand signals waved us away from the fishing vessel on our first attempts. 'Later the squid boat crews, now familiar with our operation, showed no concern even when we approached within 30 m of the port quarter aft of the beam.

Counts of individuals which fell from the net during retrieval, hereafter called dropouts, were also made at 5-minute intervals. Binoculars were initially used to determine the species of some of the

incidental catch. Initially, dropouts and catches were not counted at the same time because of the difficulty in concentrating simultaneously on different parts of the net. After gaining experience and working closer to the boats, we did not need binoculars and were able to count catches and dropouts simultaneously.

Observations from the motor launch were vastly superior to those, from the bridge because of the closer viewing distance. Birds were recognized in the gill net; tuna distinguished confidently from pomfrets. Although no salmon were seen, we probably could have distinguished them from tuna.

We could identify squid at (800 m in daylight and (600 m at night (the squid vessels 'illuminated the work deck and the nets in the water) when there was no fog or rain. Tuna were not reliably distinguished from pomfrets at night when viewing distance was >150 m. Sharks were recognized at (400 m day or night. If salmon had been caught, we could not have recognized them from the bridge of the Storis but probably could have from the launch. Our experience suggests that viewing distance should be <200 m day or night to distinguish salmon from tuna. Birds and mammals were not seen in net catches during initial observations from the bridge of the Storis. We probably could not have recognized birds at any safe viewing distance from the bridge of the Storis. Marine mammals probably would have been recognized through binoculars from <800 m.

Boardings

Fifteen Japanese squid boats were boarded by USCG personnel under International North Pacific -Fisheries Commission (INPFC) authority to

inspect for incidentally caught salmon (Fig'. 1). Two more boats were contacted and observed, but were not "boarded because of weather conditions. On most squid boats, English was not spoken or understood very well, and the boarding officers did not speak Japanese although they had some prior experience in communicating' under similar circumstances. Boarding crews carried a questionnaire written in English and Japanese, with questions which could be answered simply: yes,no, or with a' number. The questionnaire was used to obtain most information about the vessels.

The USCG conducted boardings only in daylight and usually after net retrieval and before the next deployment. Request to board was made by flag signal and was never refused. Masters. of Japanese vessels and their crews were always courteous and cooperative. The only information they would not communicate was the location of other Japanese squid boats.

One boat, the Hatsue Maru No. 68, was inadvertently boarded while she still had three sections of net to deploy, and the boarding crew was invited to remain on board and observe.' The Master of the Kairyu Maru No. 5 invited the USCG boarding party to remain on board while he retrieved three sections of gill-net. We used this opportunity to make' 5-minute counts from the Storis, which was 1,200-1,300 m from the squid boat, and compare the results to counts made by the boarding officers. Officers counted 320, 344, and 365 squid caught in these -three sections; estimates from the bridge wing of the Storis were 257, no estimate, and 398 squid. Aboard the Storis, only dropouts were counted on the second of the three sections of gill net. Officers on the squid

boat observed two birds caught in the first section of net, one bird in the second, and none in the third. The birds were not seen from the Storis.

The USCG boarding crew asked the master of each squid boat, "Is the fishing good?" The Master of the Miyagi Maru said the fishing was good. He was interviewed immediately after catching. squid at the rate of 348/nmi of net. The Master of the Sankichi Maru No. 23 said the fishing was not good; he had just caught squid at the rate of 208/nmi. Other catch rates were 56-146 squid/nmi.

CATCH RATES

Target Species

Catch estimates were determined by using the number of, squid, sharks, pomfrets, and others counted per 5-minute sample, the number of 5-minute samples, and the total time of retrieval (Table 1). Catch for a single day was 871-8,256 squid and 5-533 tuna and yellowtail (Table 2). Average catch per nautical mile for squid, tuna and yellowtail, and pomfret was 127, 9.4, and 78.9, respectively.

Dropout estimates were determined from observations on seven vessels. Sharks and pomfrets had the highest dropout rates, 16.56. and 12.61% of total catch, respectively. Dropout rates for squid were--low, averaging about 3% of the total catch (Table 3).

More than 90% of the squid appeared to be flying squid (Omastrephes bartrami), based on their large size and red color. According to the masters of the squid boats, all squid caught were flying squid.. Less than 10% may have been other species, based on smaller size and greyish color. Our counts are totals of all squid caught.

Table 1.--Sampling information used to estimate catches and catch per unit effort (CPUE) during the National Marine Fisheries Service squid research cruise on the USCC cutter Storis, 15 August-19 September 1985. Data, unless otherwise stated, were collected from the motor launch.

Vessel	Net (nmi)	Net sections			Retrieval rate (min/nmi)	Sampling time			Length of net sampled		
		No.	Length (nmi/sect.)	Avg retrieval time (min/sect.)		Catches (min)	Dropouts (min)	Total (min)	Catches (per nmi)	Dropouts (per nmi)	Total (per nmi)
Eikyu Maru No. 12 [a]	30	9	3.3	38.9	11.8	85	0	85	7.20	0	7.20
Hatsue Maru No. 68	30	10	3.0	41.4	13.8	90	55	145	6.52	3.99	10.51
Kairyu Maru No. 5 [a]	15	5	3.0	54.3	18.1	50	5	55	2.76	.28	3.04
Miyagi Maru	27	7	3.9	66.0	16.9	115	80	195	6.79	4.71	11.47
Kiyo Maru No. 8 [a]	13	4	3.3	65.2	20.1	180	0	180	8.97	0	9.38
Kiyo Maru No. 8	13	4	3.3	65.2	20.1	60	50	110	2.99	2.60	5.73
Kashima Maru No. 58	20.3	7	2.9	47.0	16.2	105	100	105	6.48	6.17	6.48
Sankichi Maru No. 23	21.6	10	2.2	47.3	21.5	135	135	135	6.28	6.28	6.28
Wakashio Maru No. 22	23.8	8	3.0	60.5	20.2	100	100	100	4.95	4.95	4.95
Hokutatsu Maru No. 88	30	11	2.7	48.0	17.1	135	135	135	7.89	7.89	7.89

[a] Counted from the bridge wing of the Storis.

Table 2.--Catch estimates from retrieval observations on Japanese gill-net. squid boats during the National Marine Fisheries Service squid research cruise on the USCC cutter Storis, 15 August-19 September 1985. Counts were conducted from the motor 1 launch unless stated otherwise.

Vessel	Length net (nmi)	Catch, CPUE [a]									
		Squid		Tuna/yellowtail		Shark		Pomfret		Other fish	
Eikyu Maru No. 12 [b]	30	2,600	87.0	458	15.3	320	10.7	-	-	1,214	40.5
Hatsue Maru No. 68	30	1,734	57.8	143	4.7	156	5.2	4,403	146.8	14	0.5
Kairyu Maru No. 5 [b]	15	1,179	78.6	5	0.4	16	1.1	201	13.4	33	2.2
Miyagi Maru	27	8,256	305.8	20	0.7	16	0.6	509	18.8	87	3.2
Kiyo Maru No. 8 [b]	13	871	67.0	-	-	-	-	-	-	-	-
Kiyo Maru No. 8	13	900	69.2	87	6.7	148	11.4	826	63.5	9	0.7
Kashima Maru No. 58	20.3	1,322	65.1	533	26.2	19	0.9	545	26.9	22	1.1
Sankichi Maru No. 23	21.6	4,406	217.0	224	11.0	206	10.2	151	7.5	31	1.5
Wakashio Maru No. 22	23.8	3,327	139.8	125	5.3	476	20.0	3,457	145.3	14	0.6
Hokutatsu Maru No. 88	30	4,259	141.9	430	14.3	186	6.2	11,646	388.2	23	0.8

[a] CPUE (catch per unit effort) is given in units of number per nautical mile.

[b] Counted from the bridge wing of the Storis.

Table 3.--Percentage of fish that dropped out of the net during retrieval. Observations were made during the National Marine Fisheries Service squid research cruise of the USCG cutter *Storis*, 15 August-19 September 1985.

Vessel	Squid	Tuna and yellowtail	Shark	Pomfret
Hatsue Maru No. 68	3.9	5.2	38.6	9.7
Miyagi Maru	1.9	0.0	0.0	19.2
Kiyo Maru No. 8	1.7	0.0	16.9	10.3
Kashima Maru No. 58	2.5	4.9	17.4	16.3
Sankichi Maru No. 23	4.4	21.5	21.7	18.2
Wakashio Maru No. 22	3.3	7.7	11.1	11.0
Hokutatsu Maru No. 88	4.4	13.3	10.2	3.6
Average	3.16	7.51	16.56	12.61

Tuna and yellowtail counts included yellowtail (*Seriola lalandei*) and albacore (*Thunnus alalunga*). Pacific bonito (*Sarda chiliensis*) may have been included because a USCG boarding party reported mackerel-like tuna on a squid boat. The large pectoral fins of the albacore were easily visible only when profiled against a light background.

Shark counts were composed of blue sharks (*Prionace glauca*), hammerhead sharks (*Sphyrna* spp.), and possibly one salmon shark (*Lamna ditropis*). Although some individuals' were recognizable-to species, we could not identify them rapidly. A high rate of dropout was observed for sharks, many intentionally shaken or rolled out of the net by the fishermen. There is some possibility that spiny dogfish sharks (*Squalus acanthias*) could have been mistaken for blue sharks. Dogfish sharks and small blue sharks were probably not distinguishable from our viewing

distance. The presence of blue sharks was confirmed from specimens caught in a piece of derelict gill net, but the presence of dogfish sharks was not.

Pacific pomfrets (Brama japonica) were recognized by their silvery color, round shape, and small size relative to other fish in the catch. They could be confused with small ocean sunfish (Mola mola) when viewed at distances exceeding 200 m. Pomfrets appeared to be caught in the net by their pectoral fins and characteristically could be seen actively flipping as the net was pulled aboard the vessel. Many of the smaller pomfrets were tossed overboard soon after being caught. A high percentage of those released in this manner probably survived.

Other species of fish recognized in the catches included longnose lancetfish (Alepisaurus ferox), pelagic armorhead (Pentaceros richardsoni), swordfish (Xiphias gladius), and marlin (Makaira spp.).

Our catch rate observations were generally consistent with previous research findings of Murata and Shingu (1985). We found that CPUE rates of squid and of various fishes change with sea-surface temperature (SST) and are related somewhat to the latitude of the fishing location.. A difference of two degrees latitude may translate into a difference of two or more degrees Celsius in SST and thus significantly affect the numbers of fish or squid in the catch. For example, the Miyagi maru fishing 27 nmi of net at 46°N 154°W caught over four times the average catch of squid for two boats, Eikyu Maru No..12 and Hatsue Maru No. 68, fishing about 100 nmi farther south. Each of the latter boats fished 30 nmi of net at about 43°50'N 152°W. Similarly, the Kairyu Maru No.5, fishing 15 nmi of net at 46°48'N 153°3O'W caught more squid per nautical

mile of net than the average for the two boats farther south. The boats fishing farther south contended with 8 to 10 times as many incidentally caught fish, such as pomfrets, tunas, sharks, and lancet fish..

Non-Target Species

No salmon were observed caught by the squid boats. Vessel masters' response to "Have you caught any salmon?" was always "No." There is some evidence that the 15" isotherm occurs to the south of the southern limit of salmon (Takagi 1983). We recorded surface water temperature every hour during daylight and found all actively fishing squid boats in water warmer than 16°C. We crossed the 15°C isotherm at 47°30'N on our way south from Kodiak on 19 August and between 47° and 48°N on our way north to Kodiak on 16 September. Water temperatures were above 15°C throughout the study area and may have been relatively warm in the squid fishery area this year (Burgner and Meyer 1983). If so, this warm water may have reduced the likelihood of observing incidental salmon catches.

Seabirds observed to be caught in squid nets included the black-footed albatross (*Diomedea nigripes*), short-tailed shearwater (*Puffinus tenuirostris*), and perhaps the sooty shearwater (*Puffinus griseus*). The catch of seabirds could be effectively monitored only from the motor launch. Since bird catches were fairly infrequent, all observations were noted. Therefore, the numbers of birds sighted during the total counts and the dropout counts can be combined.

A total of 28 birds--27 shearwaters and 1 black-footed albatross--were seen in the nets (Table 4). The shearwaters could not be closely examined to determine species, except in one instance. This exception occurred when two birds, discarded' from the ship after being observed in the net, were recovered and identified. One was the only

black-footed albatross observed caught, and the other was a short-tailed shearwater. Most, if not all, other shearwaters were probably the short-tailed species. However, these birds are indistinguishable without close examination. Three of the shearwaters were released unharmed. Birds were easily seen and identified (at least to genus) in the net since they tended to have fully extended wings. All the birds were seen near the corkline, sometimes solitary, once in a group of six.

Table 4.--Seabirds seen in the gill nets of Japanese squid boats by observers in a motor launch, during the National Marine Fisheries Service squid research cruise of the USCC cutter Storis, 15 August-19 September 1985. The black-footed albatross (BFA) (Diomedea nigripes), short-tailed shearwater (SW) (Puffinus tensirostris), and other unidentified dark shearwaters (also categorized as SW) were observed entrapped by gill nets.

Vessel	Net observed (nmi)	Birds caught		Catch rate (birds/nmi)		
		SW	BFA	SW	BFA	Combined
Hatsue Maru No. 68	10.5	2	1	0.19	0.09	0.29
Miyagi Maru	11.5	0	0	0	0	0
Kiyo Maru No. 8	5.7	0	0	0	0	0
Kashima Maru No. 58	6.5	7	0	1.08	0	1.08
Sankichi Maru No. 23	6.3	16	0	2.54	0	2.54
Wakashio Maru No. 22	5.0	1	0	0.20	0	0.20
Hokutatsu Maru No. 88	7.9	1	0	0.13	0	0.13
Total	53.4	27	1			

During the total and dropout counts, as well as casual observations between counts and observations from the Storis, the net was examined for marine mammals, but none were seen. The Master of the squid boat Hatsue Maru No. 68 acknowledged catching four or five dolphins on one occasion this season. The other masters, when queried about marine mammals, stated they had caught none. Marine mammals were seen close to a gill net only once: a fur seal was observed swimming

near the port side forward of the beam of a squid boat retrieving a gill net. The fur seal was not entangled in the net. Officers on the Storis frequently supplemented our own efforts to observe incidentally-caught marine mammals, and none were seen.

Our observations of low numbers of salmonids in the 'catches compare favorably with those by a U.S. observer aboard a Japanese squid drift-net fishing vessel in 1982 (Cary and Burgner 1983). However, observations in 1982 identified 19 entrapped cetaceans in 11 gill-net sets, whereas our research observed no marine mammal-s in 9 gill-net sets. No information on seabird entrapment was taken in 1982. Two factors may explain the differences between ours and the 1982 data. The 1982 data were collected a month later than ours and in SST's of 12°-15°C; SST's in our data were 16°-18°C. Differences in SST may best explain these differences in entrapment rates or marine mammal distribution. Four of the 11 sets in 1982 occurred where the SST was at least 15°C. Of these four, entrapment of marine mammals occurred in only one set. Entrapment of marine mammals was observed in four of the remaining seven sets, and these four sets accounted for 17 of the 19 entrapped mammals.

SURVEYS OF BIRDS, MARINE MAMMALS, AND DERELICT FISHING GEAR

Transects were conducted during the cruise to augment our understanding of the distributions of marine mammals, birds, and discarded fishing nets. Transects were conducted opportunistically and were not designed for population surveys. Thus, no estimates of abundance were made.

Birds

Bird surveys were conducted opportunistically when the ship was under way, winds were <25 knots, and visibility was >5 nmi. Surveys were conducted by research personnel from the bridge wing of the Storis. A 90" sector was surveyed, extending 300 m from the ship and originating from directly in front to abeam of the ship. Counts were conducted over lo-minute sample periods, resulting in a total of 69 transects (118.3 nmi over 11.5 hours) conducted south of 47°N and an additional 18 transects (31.8 nmi over 3.0 hours) north of 47°N (Table 5).

Birds tended to aggregate in the vicinity of the fishing vessels during both deployment and retrieval of nets. The only bird observed actively feeding from the net was a black-footed albatross, the most numerous species near fishing boats during net retrieval, occasionally numbering over 100 individuals directly astern of the ship. Fork-tailed storm-petrels (Oceanodroma furcata) and occasionally Leach's storm-petrels (Oceanodroma leucorhoa), northern fulmars (Fulmaris glacialis), and long-tailed jaegers (Stercorarius longicaudus) were commonly seen during net retrieval. Buller's gull (Larus bulleri), Laysan albatross (Diomedea immutabilis), kittiwakes (Rissa tridactyla), arctic terns (Sterna paradisaea), and some unidentified skuas were also observed near fishing vessels.

Dark shear-waters (sooty or short-tailed) were infrequently seen near the fishing vessels. The exceptions were during two net retrievals when they were feeding behind the ships. Twenty-three of the 27 shearwaters observed in the nets were caught in these two retrievals.

Table 5.--Results of seabird transects that were conducted while the USCC cutter Storis was under way during the National Marine Fisheries Service squid research cruise, 15 August-19 September 1985. Data are presented as the number of birds sighted by area. Numbers in parentheses are birds per nautical mile of search effort.

Species	North of 47°	South of 47°N				Total
		46°N-47°N	45°N-46°N	44°N-45°N	43°N-44°N	
Black-footed albatross (*Diomedea nigripes*)	1 (0.03)	13 (0.06)	5 (0.28)	17 (0.40)	3 (0.15)	38 (0.32)
Laysan albatross (*Diomedea immutabilis*)	0 (0)	1 (>0.01)	0 (0)	0 (0)	0 (0)	1 (>0.01)
Northern fulmar (*Fulmarus glacialis*)	6 (0.19)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Dark shearwater (*Puffinus* sp.)	22 (0.69)	4 (0.02)	3 (0.17)	2 (0.05)	1 (0.05)	10 (0.08)
Pink-footed shearwater (*Puffinus creatopus*)	0 (0)	0 (0)	0 (0)	1 (0.02)	10 (0.50)	11 (0.93)
Mottled petrel (*Pterodroma inexpectata*)	55 (1.73)	3 (0.01)	1 (0.05)	1 (0.02)	0 (0)	5 (0.04)
Fork-tailed storm petrel (*Oceanodroma furcata*)	2 (0.06)	24 (0.11)	41 (2.26)	37 (0.86)	120 (6.06)	222 (1.88)
Leach's storm petrel (*Oceanodroma leucorhoa*)	2 (0.06)	3 (0.01)	0 (0)	35 (0.82)	0 (0)	38 (0.32)
Long-tailed jaeger (*Stercorarius longicaudus*)	0 (0)	1 (>0.01)	1 (0.05)	4 (0.09)	0 (0)	6 (0.05)
South polar skua (*Catharacta maccormicki*)	3 (0.09)	1 (>0.01)	0 (0)	0 (0)	0 (0)	1 (>0.01)
Skua (Family Stercorariidae)	0 (0)	10 (0.04)	4 (0.22)	8 (0.19)	2 (0.10)	24 (0.20)
Effort (nmi)	31.8	37.6	18.1	42.8	19.8	118.3
Effort (h)	3.0	3.7	1.5	4.5	1.8	11.5

Marine Mammals

Observations of marine mammals were recorded by the lookout on watch on the flying bridge, and by bridge personnel as well as researchers who also identified species types. Observations were classified into two categories: "on effort" sightings were during daylight hours when the ship was under way, winds <15 knots, and visibility >2 nmi; "off effort" sightings were during other conditions, Marine mammal observations were also made while squid boats deployed and retrieved nets.

A total of 1,113 nmi (111 hours) of marine mammal surveys were conducted in the study area south of 47°N. An additional 383 nmi (37 hours) were conducted north of 47°N. No cetaceans were seen during deployment or retrieval of nets; however, one observation of a Dall's porpoise (*Phocoenoides dalli*) was made within 1 nmi of the beginning of a net deployed earlier in the day. Numerous marine mammal species were present in the research area, particularly species that are, at least partially, squid eaters. These include sperm whales (*Physeter macrocephalus*), pilot whales (*Globreephala macrorhynchus*), beaked whales (Family Ziphiidae), Dall's porpoise, Pacific white-sided dolphins (*Lagenorhynchus obliquidens*), and northern right whale dolphins (*Lissodelphis borealis*) (Table 6). Additionally, based on behavioral characteristics, one group of dolphins was likely Risso's dolphin (*Grampus griseus*), but identification was not confirmed due to unfavorable sea conditions.

Marine Debris

Marine debris surveys were conducted principally by the lookouts on the flying bridge and usually ran concurrently with marine mammal

Table 6.--Results of marine mammal transects that were conducted while the USCG cutter Storis was under way during the National Marine Fisheries Service-research cruise, 15 August-19 September 1985. Sightings are listed as A-B, where A is the number of animals and B is the number of sightings. Observations are classified into two categories: "on effort" sightings were during daylight. hours when the ship was under way, winds <15 knots, and visibility >2 nmi; "off effort" sightings were duriiig other conditions.

Species	South of 47°N		North of 47°N	
	On effort sightings	Off effort sightings	On effort sightings	Off effort sightings
Dall's porpoise (*Phocoenoides dalli*)	61-16	25-8	44-12	5-3
Pacific white-sided dolphins (*Lagenorhynchus obliquidens*)	50-2	135-3	350-1	-
Northern right whale dolphins (*Lissodelphis borealis*)	105-2	78-2	50-1	-
Minke whale (*Balaenoptera acutorostrata*)	1-1	-	-	-
Sei whale (*Balaenoptera borealis*)	-	2-1	-	-
Fin whale (*Balaenoptera physalus*)	6-2	8-3	-	-
Sperm whale (*Physeter macrocephalus*)	3-3	-	-	-
Pilot whale (*Globicephala macrorhynchus*)	15-1	30-1	-	-
Killer whale (*Orcinus orca*)	-	-	2-1	-
Curvier's beaked whale (*Ziphius cavirostris*)	3-1	-	-	-

Table 6.--Continued.

Species	South of 47°N		North of 47°N	
	On effort sightings	Off effort sightings	On effort sightings	Off effort sightings
Beaked whale [a] (Family Ziphiidae)	12-4	-	-	-
Dolphin [a]	22-1	-	2-1	4-1
Whale [a]	4-1	3-3	1-1	-
Northern fur seal (*Callorhinus ursinus*)	5-5	1-1	21-13	4-4
Northern elephant seal (*Mirounga angustirostris*)	1-1	-	-	-

[a] Unidentified.

surveys. Marine debris was seen only when in proximity to the ship (discussions with the lookouts suggested 100 m as an effective half-width perpendicular distance “from the trackline). We considered transects to be valid if visibility was at least 1 nmi. Additionally, vessel speed changes did not appear to disturb observations during the transects; therefore, periods of variable speed did not invalidate' the transects.

Net debris surveys totaling 1,312 nmi (145 hours) were conducted south of 47°N in good sighting conditions with winds <15 knots. An additional 1,044 nmi (114 hours) was surveyed in marginal sighting conditions with winds of 16-25 knots.

Ten fragments of net were sighted, nine of which were pieces of gill net (Table 7, Fig. 2). A sample of each was retrieved, labeled with date and location, and delivered to the Auke Bay Laboratory. Five gill-net fragments were recovered in good sighting conditions, but one was observed during net retrieval--it was momentarily entrapped by the fishing gear--and is therefore not part of the transect data. Four additional gill-net fragments were recovered in marginal sighting conditions. The one piece of trawl gear was recovered in rough seas when effective transects could not be conducted.

Because there is no decrease in the rate of net fragments encountered in good sighting conditions (3.05 nets/l,000 nmi) and marginal sighting conditions (3.83 nets/l,000 nmi), the data were pooled. These data yield a survey of 2,356 nmi (259 hours) and a sighting rate of 3.40 net fragments per 1,000 nmi surveyed.

Table 7.--Derelict net recoveries during the National Marine Fisheries Service squid research cruise of the USCC cutter Storis, 15 August-19 September 1985.

Date	Position	Length (m)	Mesh (mm)	Leadline?	Comments and descriptions
8/21	43°48.0'N 152°00.2'W	>30	115	No	Around log, released after being entangled with an active fishing net. 3 yellowtails (2 dead, 1 alive).
8/23	44°17.4'N 156°27.1'W	18.5	120	No	Net gathered in vertical folds, not tangled. 18 floats. Depth = 4.3 m.
8/26	44°46.6'N 166°07.1'W	40	115	Yes	Dead fur seal (immature male) in net. Net very tangled. Depth (full stretch) = 9 m. Length measured at leadline.
8/27	45°05.6'N 162°21.3'W	13	115	No	16 floats, corks damaged as if cut by ship. Net very shallow.
9/1	45°38.9'N 158°11.1'W	>30	105	Uncertain	Wrapped around log. No obvious catch. Entire net not examined. 38-40 corks.
9/2	44°29.6'N 162°48.5'N	12	140	No	Not gill net, probably trawl net. Nylon cord, not monofilament. Length not stretch measure, depth about 12 m and mesh size is stretch measure. Net wadded at surface. Only amphipods present in net.
9/2	44°15.8'N 163°39.6'W	>30	None	No	Only corkline, no net. 28-30 floats knotted and tangled. Large concentration of barnacles. Estimated 12+ skillfish live in this structure.
9/6	46°02.2'N 169°18.0'W	Short	??	??	5 floats on surface, some net below but looked shallow. Not recovered due to seas.
9/7	46°00.2'N 165°39.7'W	75	115	No	1 dead pomfret, 2 pelagic armorhead: 1 dead, 1 alive. Decayed fish parts also present. 111 brown floats.
9/9	45°59.4'W 153°56.6'W	86	115	No	3 blue sharks, 1 tuna, 1 sunfish dead in net. All fish partly decayed. Depth = 2.28 m. Net not badly tangled.

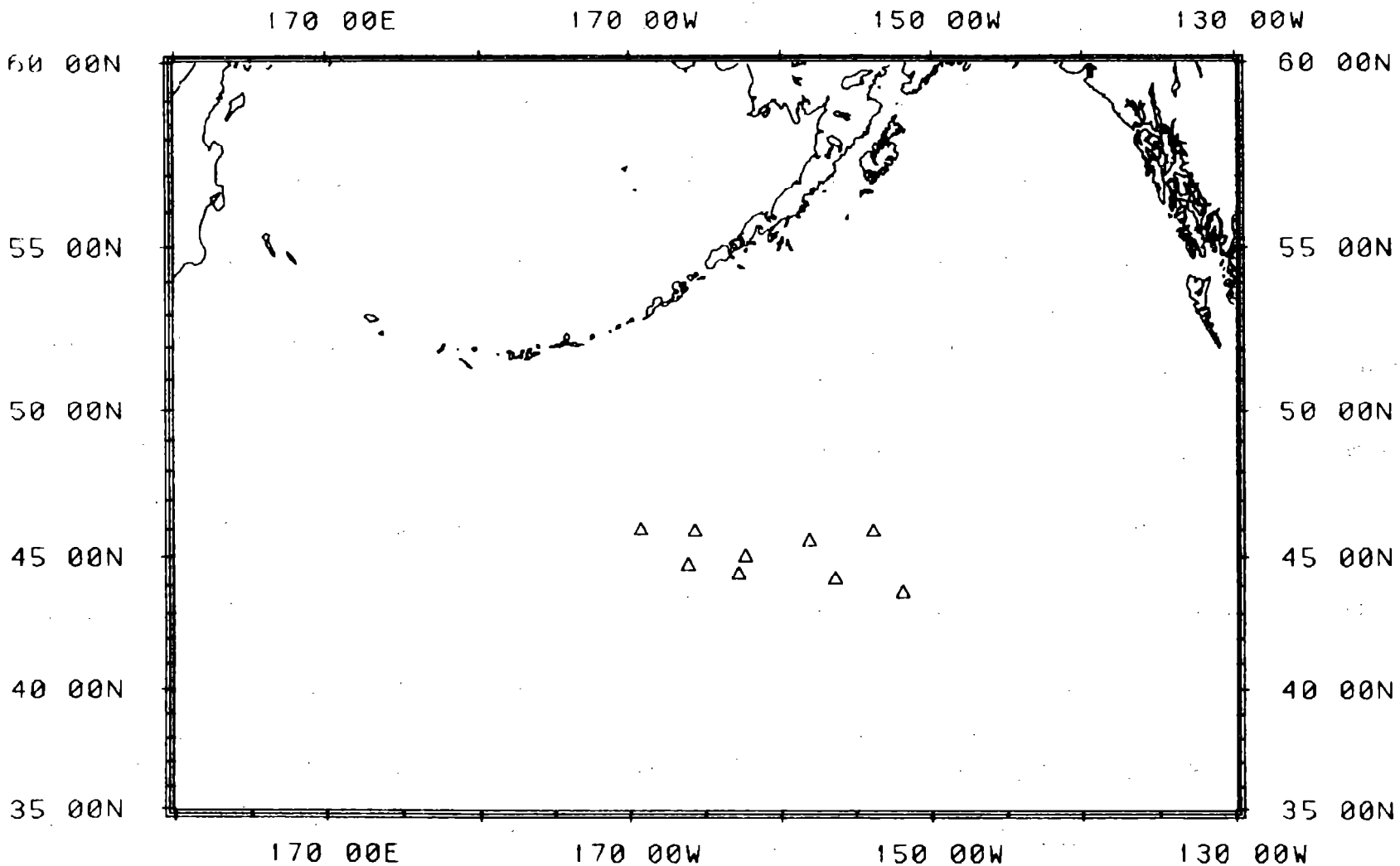

Figure 2. --Locations of derelict gear found in survey area during the National Marine Fisheries Service research cruise of the USCG cutter Storis, 15 August-19 September 1985.

SQUID VESSELS

Characteristics

Information about the squid boats, their gear, and daily schedules of activity was gradually accumulated as the Storis contacted. and boarded vessels. The USCG boarded 15 Japanese squid boats (Table 8); however, no specifications were obtained from the Hoshi Maru No. 38. The other 14 squid boats were 32-57 m in length and 6.6-10.3 m in
1 breadth. All had single engines with 440 to 2200 horsepower. Gross tonnage ranged from 225 to 500 t. The oldest was built in 1966 and the newest in 1984. The Eikyu Maru No. 12, the newest vessel, was in a size and performance class by itself.

It was difficult to obtain information on both cruising and maximum speeds because the language barrier apparently prevented the Japanese from understanding our distinction between the two. Most 'squid boats that we followed cruised at about 8-11 knots. The Eikyu Maru No. 12 cruised at 12 knots, with a top speed of 16 knots. The Master claimed to deploy gill nets at 10 knots and retrieve at 5 knots. Our observations confirmed his claim.' The older squid boats deployed gill nets at about 6-8 knots and retrieved at about 3-4 knots.

Squid boats had one to three flash freezers in addition to one to five freezer holds. Flash freezer temperatures were -35" to -60°C. Each day's catch of squid was left in the flash freezer about 6-10 hours and then placed in the freezer hold at -25° to -36°C for the duration of the voyage. Freezer hold capacities ranged from approximately 75 to 846 t, but these data are uncertain. Hold capacities were generally stated in metric tons but sometimes given- in cubic meters or in number

Table 8.--Some features of Japanese squid boats boarded by the USCG during the National Marine Fisheries Service squid research cruise of the USCG cutter Storis, 15 August-19 September 1985.

Vessel	Year built	Length (m)	Breadth (m)	Draft (m)	Gross tons (t)	Horse-power (hp)	Cruising speed (knots)	Max. speed (knots)	Endur-ance (days)	Departed Japan (date)	ETA Japan (date)	Crew (No.)	Freezer hold capacity (tons)	Flash freezer (°C)	Fish holds (°C)
Hoshi Maru No. 38	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
21 R Ho	1970	44.10	8.0	3.65	-	-	-	10	-	6/19	9/01	18	-	-	-
Eikyu Maru No. 12	1984	57.00	10.3	6.79	-	2200	12	16	-	6/30	9/30	27	309	-60	-
Hatsue Maru No. 68	1979	51.70	9.8	4.37	499.92	2000	-	11	120	6/26	9/20	23	846	-40	-
Ominato Maru No. 38	1966	53.90	9.4	4.30	499.58	-	-	10	90	5/27	9/14	18	75	-40	-
Kairyu Maru No. 5	1970	43.80	8.0	3.50	284.80	850	-	10	90	8/15	+11/01	17	200	-40	-
Miyagi Maru	-	38.46	7.6	3.30	224.95	-	-	-	-	7/28	9/20	16	-	-35	-
Hiyoshi Maru No. 11	-	-	-	-	298.56	1000	11	-	-	-	-	-	364	-50	-40
Shoshima Maru No. 15	1983	32.00	6.6	2.85	-	440	8 [a/]	10	90	8/15	10/15	17	-	-45	-
Ryuon Maru No. 21	-	-	-	-	-	-	11.5	-	-	-	-	24	206	-40	-35
Kiyo Maru No. 8	-	50.98	9.9	5.99	-	1350	-	10	100	8/17	when full	20	134	-40	-25

Table 8. --Continued.

Vessel	Year built	Length (m)	Breadth (m)	Draft (m)	Gross tons (t)	Horse-power (hp)	Cruising speed (knots)	Max. speed (knots)	Endur-ance (days)	Departed Japan (date)	ETA Japan (date)	Crew (No.)	Freezer hold capacity (tons)	Flash freezer (°C)	Fish holds (°C)
Kashima Maru No. 58	1970	40.70	7.9	3.45	334.90	-	10	10	90	8/01	11/01	18	187	-40	-
Sankichi Maru No. 22	early '70's	44.13	8.2	3.65	299.26	1000	-	10	120	8/15	+11/01	18	241	-36	-
Wakashio Maru No. 22	1968	42.51	8.4	3.78	344.67	850	9	-	90	8/01	10/05	15	151	-35	-
Hokutatsu Maru No. 88	-	35.78	7.4	3.20	192.00	470	-	10	-	7/27	10/10-15	16	141	-55	-
Hull No. 7-624	1970	38.46	7.6	3.30	224.88	470	-	-	-	-	-	-	-	-	-

[a] Net is set at 8 knots; cruising speed is a little faster.

of blocks of frozen squid. The USCG crew that boarded the Kiyo Maru No. 8 obtained data on the numberof frozen 20 kg blocks of squid mantles that could be placed in her three holds:

Hold number	Space (m^3>	Number of blocks
1	54.26	650
2	139.24	3,000
3	141.46	3,000

Estimates of time required to fill the holds of some squid boats may explain why whole squid plus almost all incidentally caught fish were retained on some boats, whereas only squid mantles were retained on others (Table 9). USCG boarding crews learned that 18 squid are required to make a 20 kg block of frozen squid meat. With this information plus the known length of gill nets, the average catch rate of squid, and the hold capacities of some of the squid boats, we estimated roughly the fishing time required for these boats to fill their holds (Table 9). Interestingly, Hatsue Maru No. 68, with the largest hold space, was retaining whole squid and almost all incidentally caught fishes. If our assumptions are reasonable, this boat must fish for over 200 days to fill its hold space. By contrast, the Hokutatsu Maru No. 88 retained only squid mantles and could fill its much smaller hold in 34 days.

Squid boats can remain at sea up to 4 months, but most fish about 3 months before returning to Japan. We were not able to determine how or whether their movements onto, within, and out of the fishing areas were coordinated. They appeared to operate as individuals, each

Table 9.--Estimated fishing time needed to fill holds with squid mantles, assuming average catch rate of 124 squid/nmi of net and 1.11 kg average weight of a squid mantle during the National Marine Fisheries Service squid research cruise of the USCC cutter Storis, 15 August-19 September 1985.

Vessel	Length of net (nmi)	Freezer capacity (t)	Fishing time needed to fill holds (days)	Catch retained (kind)
Hatsue Maru No. 68	30	846	205	Whole squid--less eyes. Tuna--less tails. Sharks and pomfrets.
Kairyu Maru No. 5	15	200	97	Sharks--headed & gutted. Albacore--tails off. Squid--headed.
Kiyo Maru No. 8	19.4	134	50	Tuna--tails off. Squid--headed. Sharks.
Kashima Maru No. 58	29	187	47	Squid. Tuna--tails off. Sharks.
Sankichi Maru No. 23	21.6	241	81	Squid and tuna.
Wakashio Maru No. 22	23.8	151	46	Tuna--tails off.
Hokutatsu Maru No. 88	30	141	34	Squid mantles.

controlling its own activities, sometimes fishing alone, sometimes within a few miles of two to six other squid boats.

Only three of the boats appear to be used in other fisheries. One had participated in a joint venture longline fishery, a second was a converted stern trawler that still retained trawl gear, and a third, also a converted stern trawler, formerly fished snails in the Bering Sea by pots,

Crew

Squid boat crews numbered from 15 to 27 people. Typically, there was a vessel master, two mates, a master fisherman, an engineer, an assistant engineer, a cook, a radio operator, and 7 to 19 fishermen. Diesel-electric boats had more engineers. The fishermen retrieved the nets, removed and processed the catch, and assisted with deployment.

Fishing Gear

Equipment and procedures used in deploying and retrieving squid gill nets were similar to those used in the Japanese high-seas salmon gill-net fisheries. Length of net deployed was dependent, on size of vessel. The net was set in several (4-11) separate 'sections, each section usually about 3 nmi long (Table 10). The beginning and end of each section was usually marked with an array of floats and radio-and-light buoys, the arrangement varying from vessel to vessel. In some arrangements, two or more sections were joined together with a piece of line, creating. a long "supersection." These junctions were usually marked with radio buoys.

Table 10.--Gill-net specifications from Japanese, squid vessels that were observed or boarded, during the National Marine Fisheries Service squid research cruise of the USCG cutter Storis, 15 August-19 September 1985. (Dash indicated data unavailable.)

Vessel	Length of net (nmi)	No. of sections	Mesh size (mm)	Depth of net (m)	Spare net (nmi)
Hoshi Maru No. 38	13	-	-	-	-
21 R Ho	7	-	135	3	30
Eikyu Maru No. 12	30	9	114	9	-
Hatsue Maru No. 68	30	10	115	9.7	17
Ominato Maru No 68	35	-	-	3	-
Kairyu Maru No. 5	15	5	116	7	-
Miyagi Maru	27	7	115	10	-
Hiyoshi Maru No. 11	19.4	10	120	10.8	2
Shoshima Maru No. 15	19.4	6	128	11	-
Ryuon Maru No. 21	30	-	118	11	2.7
Kiyo Maru No. 8	19.4 a/	6	118	9	13
Kashima Maru No. 58	29	10	118	10	1.2
Sankichi Maru No. 23	21.6	10	115	10	-
Wakashio Maru No. 22	23.8	8	115	5	-
Hokutatsu Maru No. 88	30	11	113-14	11	-

a/Deployed only 12 nmi of net in four sections due to rough seas.

Nets were all of similar design corkline at the. -surface, monofilament mesh, and a leadline at the bottom. Corkline and leadline were sewn directly to the monofilament with braided nylon cord. Single panels, or tans, of net were tied together at the corkline and leadline, and the monofilament mesh was laced together, again using braided nylon cord. This cord was not always visible from our position in the small boat so it was not feasible to determine catch per tan.

Although all nets were of similar design, gear differed among vessels. Dimensions were not standard; and a tan of net ranged from 45 m to 105 m in length. Most Japanese masters were uncertain as to how many tans of net they were using; the principal measure. for length of

net was kilometers or nautical miles. Stretched mesh size also varied from vessel to vessel, with a-range of 113 mm to 135 mm.. Depth of net was frequently difficult to determine. Masters of squid vessels did not know the precise measurements, indicating that sizes were not standard. Additionally, depth was measured as either an estimate of depth of leadline when the net was in water, or the maximum perpendicular stretch distance between corkline and leadline.

Five complete net deployments were observed during the cruise. Deployments usually started 2-4 hours before sunset and -took 1.8-4.0 hours to complete, depending on amount of net deployed and speed of the vessel (Table 11). Japanese squid boats deployed their nets east to west, compass course 270°, or west to east, 90°, as we confirmed many times while running parallel to them. Net was deployed from the stern net well over a large horizontal roller. One or two men, positioned at either side (port and starboard) of the roller, used bamboo poles to keep the leadline and corkline separated. Four of the five vessels sprayed water from the stern to keep the net untangled. A combination float, radio; and light buoy was released from the port side of the stern at the beginning- and end of each section. A constant speed (approximately 8-10 knots) and heading was maintained throughout deployment of the net. Thus, all sections of net were deployed in a continuous line, with an average distance between sections of 100-200 m.

Eight of the 11 retrievals of gill nets were observed from beginning to end (Table, 12). Net retrieval began O-4.4 hours before sunrise. Net was retrieved with the aid of a grappling hook used to snag a section, of line between the radio buoy and net. The ship traveled along the net at l-5 knots, frequently and sharply turning as

Table 11.--Observations of deployment of gill nets by Japanese squid boats during the National Marine Fisheries Service squid research cruise of the USCG cutter Storis, 15 August-19 September 1985.

Vessel	Date	Time: Start (hours)	Time: End (hours)	Time: Elapsed (h:min)	Sunset (hours)	Set[a] direction (° bearing)	Wind direction	Total net (nmi)	SST (°C)	Storis' position at start of set	
Eikyu Maru No. 12	8/20	1708	2005	2:57	2106	274	235	30	17	43°46.3'N	151°59.7'W
Hatsue Maru No. 68	8/21	1700	2100	4:00	2108	263	220	30	18.3	43°57.5'N	152°00.6'W
Kiyo Maru No. 8	9/10	1859	2048	1:49	2055	208	340	13	16.7	45°57.9'N	148°56.9'W
Kashima Maru No. 58	9/11	1711	2000	2:49	2018	276	330	29	16.7	46°36.8'N	148°55.5'W
Hull No. 7-624	9/15	1700	2100	3:00	2016	74.4	240	30	16.7	46°02.9'N	151°04.4'W

[a] Direction of set was probably either 270° or 90°; our data represent these approximate bearings as they were calculated from the position of the Storis within 2,000 m of the start and finish of each set.

Table 12.--Information collected on gill-net retrievals during the National Marine Fisheries Service squid research cruise of the USCG cutter Storis, 15 August-19 September 1985. All Japanese squid boats encountered during the cruise are listed in this table.

Vessel	Date	Time of retrieval			Sunrise (hours)	Direction [a] of retrieval (°)	Wind direction (°)	Wind speed (knots)	Swell height (ft)	Swell direction (°)	Storis position at start of retrieval	
		Start (hours)	End (hours)	Elapsed (h:min)							Latitude	Longitude
Hoshi Maru No. 38 [b]	-	-	-	-	-	-	-	-	-	-	-	-
21 R Ho [c]	-	-	-	-	-	-	-	-	-	-	-	-
Eikyu Maru No. 12 [d]	8/21	0258	0931	6:13	0720	93	165	5	calm	calm	43°49.5'N	152°42.1'W
Hatsue Maru No. 68 [d]	8/22	0400	1120	7:20	0723	90	187	9.5	1	190	43°59.3'N	152°45.1'W
Ominato Maru No. 38 [e]	-	-	-	-	-	-	-	-	-	-	-	-
Kairyu Maru No. 5 [f]	8/30	-	1321	-	0727	132	238	19	3	280	46°52.2'N	153°33.4'W
Miyagi Maru [g], [d]	8/31	0439	1350	9:11	0725	268	225	11	1	305	46°13.0'N	154°12.4'W
Hiyoshi Maru No. 11 [h]	-	-	-	-	-	-	-	19	-	-	-	-
Shoshima Maru No. 15 [f]	9/05	0700	1320	6:20	0834	274	139	19	3	180	45°57.8'N	167°21.4'W

Table 12.--Continued.

Vessel	Date	Time of retrieval: Start (hours)	Time of retrieval: End (hours)	Time of retrieval: Elapsed (h:min)	Sunrise (hours)	Direction of retrieval (°) [a/]	Wind direction (°)	Wind speed (knots)	Swell height (ft)	Swell direction (°)	Storis position at start of retrieval: Latitude	Storis position at start of retrieval: Longitude
Enami Maru No. 15 [i/]	9/06	0730	0950	2:20	0846	83	149	24	5	185	45°40.5'N	170°05.8'W
Ryuon Maru No. 21 [e/]	-	-	-	-	-	-	-	-	-	-	-	-
Kiyo Maru No. 8 [j/], [d/]	9/11	0706	1143	4:37	0720	24	335	18	3	350	45°43.4'N	149°06.2'W
Kashima Maru No. 58 [d/]	9/12	0400	1058	6:58	0729	283	325	12	2	350	46°33.9'N	148°54.7'W
Sankichi Maru No. 22 [d/]	9/13	0400	1246	8:46	0723	271	258	6	1	020	46°37.6'N	146°57.1'W
Wakashio Maru No. 22 [d/]	9/14	0435	1330	8:55	0725	279	253	14	1	255	46°16.1'N	146°42.5'W
Hokutatsu Maru No. 88 [d/]	9/15	0400	1403	10:30	0736	263	243	13	2	290	46°04.3'N	149°42.0'W

Table 12. --Continued.

Vessel	Date	Time of retrieval Start (hours)	End (hours)	Elapsed (h:min)	Sunrise (hours)	Direction of retrieval (°) [a]	Wind direction (°)	Wind speed (knots)	Swell height (ft)	Swell direction (°)	Storis position at start of retrieval Latitude	Longitude
Hull												
No. 7-624 [k]	9/16	0336	-	-	0743	-	275	14	2	310	46°08.2'N	150°20.4'W

[a] Direction of retrievals is approximate bearings calculated from positions of the Storis which was within 2,000 m of the squid boat at start and end of retrieval.
[b] Vessel not fishing; enroute to Kodiak for medical assistance.
[c] Master of vessel said he would be transiting east for 2 or 3 days before fishing again.
[d] Observed complete retrieval.
[e] Vessel returning to Japan with full load of squid.
[f] Did not observe start of retrieval.
[g] Vessel stopped retrieving net for 52 minutes after the first section, apparently waiting for us to board.
[h] Vessel just arrived from Japan and was transiting eastward to commence fishing in 2 or 3 days.
[i] Vessel apparently did not deploy a complete 30-mile set; we could not board this vessel due to fog and seas.
[j] Vessel set only 13 nmi of her 19.4 nmi net.
[k] Vessel was not boarded due to fog and inclement weather; we did not observe end of retrieval.

wind and currents caused convolutions, of the net. The. net was hauled aboard on the port side using two hydraulic power blocks to pull the lead and corklines. On most vessels-, the fishing deck, or well deck, was positioned forward of the pilot house, but the converted trawlers used the trawl deck, located behind the pilot house, as the fishing deck. Squid and fish were pulled or flipped from the net, which was then pulled through a tube on the starboard side and stacked in the stern net well. To accomplish this task, two- roller blocks, one for the leadline and one for the corkline, were mounted on scaffolding above the net well. The target species (squid and usually tuna) were transferred from the fishing deck by a chute or conveyor system to a processing area. Processing continued after retrieval was completed., Undesired species, such as pomfrets, sharks, and sunfish, were frequently flipped from the net into the ocean, or they were brought aboard and discarded immediately or after retrieval was completed. On one vessel, a long-handled, four-pronged gaff was used to snare target species, particularly tuna, that fell, from the net into the water. Another vessel was equipped with a pole that attached a cable around the tail of large swordfish to ensure landing of the fish.

The ships were well-illuminated for retrieving nets before sunrise. Incandescent and halogen deck lights fully illuminated the work deck, and a spotlight mounted above the pilot house lit the net in the water. Most of the corkline floats appeared reflective and produced a "beaded necklace" appearance ahead of the ship.

The quantity of reserve fishing equipment aboard was difficult to determine because of the language barrier. Some vessels had a small quantity of new net tied in one-tan bundles and stored atop the pilot

house or in an unused hold, and some vessels 'held in reserve an entire section of net in the net well. 'There was also some storage of damaged net also tied in one-tan bundles. Observations indicated that some large damaged sections were deployed despite their reduced efficiency.

Processing the Catch

Masters of most squid boats said it took 10-11 hours to process the daily catch. Squid are prepared for freezing and transport by separating the mantles from the head and tentacles. Usually only the mantles minus the fins were saved. Mantles were removed by one man on the well deck or by a processing crew below deck, and placed in freezer trays that were 55-58 cm long, 32-35 cm wide, and 7-9 cm deep. About 10-18 squid-mantles were placed in each tray. The frozen blocks weighed about 12-20 kg. On some boats, squid tentacles were saved and placed in freezer pans.

Tuna were frozen and retained on all squid boats except the Hokutatsu Maru, No. 88. Tuna were prepared by removing the tails. Carcasses were then frozen whole and neatly stacked in the hold. On one vessel, tuna bellies were frozen in pans. On most vessels, some of the largest pomfrets were kept but usually not in large. quantities. We speculate that some pomfrets were kept for use in the galley on the ship, and for personal consumption. The largest sharks, marlin, and swordfish that we saw were all retained. The Kiyo Maru No. 8 had a few blocks of frozen shark fins, and the 21 R Ho had dried shark fins hanging from a line over the pilot house.

FEASIBILITY OF MONITORING SQUID FISHERIES

Most objectives were achievable using the Storis as a base of operations. With the aid of USCG C-130 aircraft spotters, we located a large number of Japanese squid boats. We estimated numbers of fish caught and noted the presence or absence of birds and mammals in squid gill nets, under a wide variety of sea and weather conditions.

Observations from the bridge wing of the Storis and from a motor launch were not possible. in Beaufort 5 or worse seas. Persistent wind, high seas, rain, and fog in the western part of the study area twice prevented us from observing net retrievals and once from boarding a squid vessel. When fog reduced visibility to one-half mile, the motor launch was unsafe to use. By contrast, mild weather and little fog occurred in the east end of the study area.

Accurate catch data are only obtainable when -observations are taken from launches about 10 m long. These small vessels had the ability to observe fishing operations at close quarters. Gill-netters, change direction frequently and rapidly, which requires large survey vessels to keep a safe distance of at least 400 m. However, inclement weather restricts the use of small vessels, and we found that gill-netters could fish in weather and sea conditions in which we could not safely observe their operations.

Observations of gill-net catches under nearly ideal weather conditions should not be considered equal in quality to data that could be collected by an observer on board the fishing vessel. We found it impossible to count continuously for more than a few minutes at a time, using binoculars on a pitching boat. It was never possible to maintain

vessel position relative to the squid boa-t so that observers could have a continuously clear view of an entire retrieval from, an acceptable viewing distance. This was true of the small boat as well as the Storis.

Without information obtained by USCG boarding parties, our survey method would have had several additional problems:

1. Estimates on the length of net fished, derived from LORAN or satellite fixes, are imprecise. Therefore, CPUE estimates based on such information would be inaccurate.
2. Total counts of fish and squid are impossible unless the observer is aboard the gill-net vessel. Much of the net retrieval occurs before sunrise, and during daylight hours, weather and vessel movements prevent continuous sampling of catch.

We- found the 'Japanese squid fishermen to be extremely friendly, polite, and cooperative; The language barrier, however, hindered the acquisition of data. For example, information on hold capacities was difficult to obtain. Usually printed tables gave hold sizes in' cubic meters or vessel capacities in tons, but it was sometimes difficult to determine how these dimensions might relate to the quantities of squid and tuna being transported to Japan..

If additional information is needed on the flying squid fisheries, the-first priority should be to place observers on board squid boats. However, even if a nation allows observers, trip lengths of these vessels average about 3 months, which, in a practical sense, may be too long for an observer to be on board a vessel such as this.

Another alternative is to place observers on board squid gill-netters for 1 or 2 days, long enough to observe one or two retrievals. This would, of course, require permission from the vessels' masters. A research vessel could transfer observers from fishing vessel to fishing vessel. Several observers could work simultaneously on separate fishing vessels in the same general area. The research vessel would not only function as a support vessel for observers but also conduct research activities as time permits.

Placement of observers on squid vessels is more cost effective and would greatly improve the system we used this year. Choice of gill-net vessels and survey area remains under the control of the researcher. This is important for ensuring the integrity of the data. Note that any research planned should consider possible year-to-year variability in the distribution of fish, marine mammals, and squid. During this study, we encountered unusually warm water that undoubtedly influenced the distribution of marine life.

Observation of squid vessels also requires information on their locations. We were totally dependent on USCG C-130 overflights to find most vessels. Japanese squid boats often fished inclusters of three to nine or more boats. This left a considerable distance between possible locations of squid boats. We apparently missed sighting one cluster of nine boats by only a few miles and returned to find them after a new report from the aircraft. This dependency will remain unless individual nations offer to disclose specific locations of their vessels.

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ACKNOWLEDGMENTS

We especially thank the officers and crew of the Storis for a successful cruise in support of NMFS. The high level of interest and enthusiastic participation by every individual on the Storis was appreciated. The crew maintained their interest and support to the very end of the cruise, resulting in a spirit of cooperation and helpfulness, and conduct that was extraordinary. We also appreciate the spirit of friendliness that was exhibited- by Japanese fishermen. Their helpfulness was always evident and their cooperation exceptional.

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APPENDIX

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Table A.--Itinerary and daily highlights of the USCG cutter Storis, during the National Marine Fisheries Service squid research cruise in the North Pacific Ocean, 15 August-19 September 1985.

Date	Time	Remarks
15 Aug	1600 ADT	Left Kodiak aboard Storis
16 Aug	-	Southbound on Storis
17 Aug.	-	USCG boarded northbound Japanese gill-
18 Aug	2242 ADT	Sighted 2 or 3 gill-netters running eastward at 11 knots
19 Aug	0046 ADT	Ran parallel to. squid, gill-netters until they split into three directions. We followed one.
	0812 ADT	Caught up to squid boat 21 R Ho at 49°09'N 150°13'W. USCG boarded same.
20 Aug		USCG boarded a Japanese squid gill-netter, Eikyu-Maru No. 12 at 43°45'N 141°54'W and monitoxd deloyment of gill net.
21 Aug	-	Monitored retrieval of gill net by Eikyu Maru No. 12 at 43°48'N 152°OO'W. USCG boarded a Japanese, squid gill-netter, Hatsue Maru No. 68, at 43°57'N 151°53'W. Monitored deployment of gill net by Hatsue Maru No. 68. Found a 30 m x 115 mm mesh piece of drifting gill net at 43°48.0'N 152°00.2'W, with one live and two dead yellowtails caught in it.
22 Aug	-	Monitored retrieval of gill net by Hatsue Maru No. 68, while in transit to another squid gill-net fleet to the west.
23 Aug	-	In transit westward to 44°OO'N 165°OO'W. Found an 18.5 m x 120 mm mesh piece of drifting gill. net at 44°17.4'N 156°27.1'W.
24 Aug	-	In transit westward.

Table A.--Continued.

Date	Time	Remarks
25 Aug	-	Arrived at 44°00'N 165°00'W. One gill-netter reported by USCG C130 spotter aircraft 180 miles from us. Proceeded to gill-netter location.
26 Aug	-	Began search and rescue (SAR) mission for sailboat caught in gill net 800 miles away at the east end of the study area. SAR mission was called off. Ordered to proceed 700 miles eastward to survey Japanese squid boats fishing north of 44°00'N. Picked up a 40 m x 115 mm mesh piece of gill-net debris with a dead fur seal in it at 44°46.6'N 166°07.1'W.
27 Aug	-	In transit eastward. Picked up a 13 m x 115 mm mesh piece of floating gill-net debris at 45°05.6'N 162°21.3'W.
28 Aug	-	USCG boarded Japanese squid boat Ominato Maru No. 38 at 46°06'N 153°47'W. Transiting eastward to find more squid boats.
29 Aug		C-130 reported squid boats west of us.
30 Aug	-	USCG boarded the Japanese squid boat Kairyu Maru No. 5 at 46°46'N 153°22'W and remained on board getting total counts of catch in the last three sections of net while we observed retrieval of net from the Storis.
31 Aug	-	Monitored retrieval of gill net by the Miyagi Maru. USCG boarded same at 46°15'N 154°15'W.
1 Sep	-	Found a log with a 30 m x 105 mm mesh piece of gill-net debris at 45°38.9'N 158°11.1'W.
2 Sep	-	Found a 12 m x 140 mm mesh piece of trawl net debris at 44°15.8'N 163°39.6'W. Found a piece of corkline, no net at 44°15.8'N 163°39.6'W

Table A.--Continued.

Date	Time	Remarks
3 Sep	-	Arrived at 44°N 165'W, last reported location of squid boats. Transiting northward to newly reported location of squid boats.
4 Sep	-	Boarded the Japanese squid boat Hiyoshi Maru No. 11 at 46°25.7'N 163°43.5'W.
5 Sep	-	USCG boarded the Japanese squid boat, Shoshima Maru No. 15 at 45°54'N 167°40'W.
6 Sep	-	Attempted observations of gill-net retrieval by Japanese squid boat, Enami Maru No. 15 under Beaufort 6 sea conditions. Observations yesterday and today demonstrate that fish catches cannot be counted from a U.S. vessel under sea conditions of Beaufort 5 or greater. Sighted but did not pick up a five-float piece of gill-net debris.
7 Sep	-	Transiting eastward; found a 75.3 m x 115 mm mesh piece of gill net drifting at 46°00.2'N 165°39.7'W with one pomfret and two pelagic hammerhead sharks in it. Air drop from C130 aircraft to the Storis at 45°58.4'N 159°15.2'W.
8 Sep	-	Transiting eastward; intercepted a Japanese stern trawler that had been converted to squid gill-netter, Ryuon Maru No. 21, at 45°38.3'N 158°53.6'W.
9 Sep	-	Transiting eastward; found a 86 m x 115 mm mesh, two-tan piece of drifting gill net with three blue sharks, a yellowtail, and a sunfish in it at 45°59.4'N 153°56.6'W.
10 Sep	-	Boarded the Japanese squid boat, Kiyo Maru No. 8 at 46°28'N 149°16'W.
11 Sep	-	Monitored retrieval of gill net by Kiyo Maru No. 8. Rendezvous with Japanese squid boat Kashima Maru No. 58.

Table A.--Continued.

Date	Time	Remarks
12 Sep	-	Monitored retrieval of gill net by Kashima Maru No. 58. Located end of a gill net at 46°38.4'N 147°43.1'W and followed it to the squid boat Sankichi Maru No. 23 at 46°36.8'N 148°55.5'W.
13 Sep	-	Monitored retrieval of gill net by Sankichi Maru No. 23 and then boarded same. Transiting in search of other vessels that had nets set within visual contact of Sankichi Maru No. 23 last night. We found a squid boat at about 1030 hours.
14 Sep	-	Monitored part of the retrieval of gill net set by the Japanese squid boat Wakashio Maru No. 22, then boarded same at 46°21.0'N 147°25.9'W.
15 Sep	-	Monitored part of the retrieval of gill net set by the Japanese squid boat, Hokutatsu Maru No. 88, then boarded same at 45°59.5'N 150°37.1'W.
16 Sep	-	Monitored part of the retrieval of gill net set by the Japanese squid boat Hull No. 7-624. Heavy fog settled in at 0900 hours and prevented further observations today. We waited until 1430 hours and fog persisted, so we turned north towards Kodiak.
17 Sep	-	Transiting northward towards Kodiak.
19 Sep	-	Arrived in Kodiak at noon.