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SEABIRD MORTALITY IN THE JAPANESE SALMON MOTHERSHIP FISHERY,
SUMMER 1982.

Anthony R. DeGange ✓

Key Words: Seabirds, Short-tailed Shearwaters, Thick-billed Murres,
Tufted Puffins, Horned Puffins, gillnets, mortality,
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Sea, Marine Birds

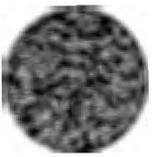
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INTRODUCTION

Recent studies have demonstrated a serious conflict between certain kinds of fishing gear, particularly gillnets, and seabirds. The problem is widespread in the northern hemisphere as exemplified by studies in the northeast Atlantic (Brunn 1979, Whilde 1979, Myberget 1980), off of Greenland (Tull, Germain and May 1972, Evans and Waterston 1976, Christensen and Lear 1977, Piatt and Reddin in press) in Newfoundland (Piatt et al. in press), off California (Heneman 1982), in British Columbia (Sealy and Carter in press) and in the North Pacific Ocean and Bering Sea (Sano 1978, King et al. 1979, Ainley et al. 1981).

The Japanese currently operate three driftnet fisheries in the North Pacific: a recently developed squid fishery in the central and western North Pacific, a land based salmon fishery that operates south of 46°N and west of 175°E and a mothership salmon fishery that operates north of 46°N between 170°E and 175°E and in the central Bering Sea. The first two fisheries remain enigmas to us, especially concerning their impacts on marine birds, mammals and turtles. The latter fishery however has gained increasing notoriety. This fishery is responsible for the deaths of thousands of seabirds each year during the brief fishing season, from early June to late July (Sano 1978, Ainley et al. 1981).

Other than data gathered in 1981 by American Dall's porpoise observers in the mothership fleet (L.L. Jones unpubl. data), our knowledge of the incidental seabird kill relied on data gathered by American and Japanese observers on Japanese research vessels in 1977, 1978 and 1979 (Sano 1978, Ainley et al. 1981). These vessels not only usually fished outside

of the commercial fishing zone but used nets with variable mesh sizes. Ainley et al. (1981) demonstrated that not only did catch rates of seabirds vary geographically, principally with distance from land, but also that catch rates of seabirds in nets of small and large mesh sizes were lower than catch rates in mesh sizes used by the commercial fishery (primarily 110-130mm). Because of these limitations in the existing data and our desire to compute more realistic estimates of mortality, we undertook a study of seabird mortality in the mothership salmon fishery in 1982.

MATERIALS and METHODS

Data upon which this study is based were gathered by 3 American observers in each of the 4 mothership fleets. The 12 observers varied widely in their seabird expertise; only 3 had extensive experience with seabirds in the North Pacific. A brief training exercise in Seattle, prior to the fishing season, familiarized all the observers with the birds they might encounter on the high seas.

The 3 observers in each fleet worked a staggered rotation of 3 days on the mothership followed by 6 days on a catcherboat. Thus at any given time there was one observer on the mothership and two observers on individual catcherboats per fleet. The duty of the observer on the mothership was to dissect any net-killed Dall's porpoise that were returned to the mothership; the observers on the catcherboats were charged with observing set and retrieval of gillnets and recording observations of marine mammals at sea. Data from 270 gillnet sets forms the basis of this

paper.

Through prior agreement with the Japanese, seabirds which were normally thrown overboard during the retrieve were saved by Japanese fishermen and later identified and counted by the American observers. Several observers also tallied the depth in the net where birds were caught and sorted the Tufted Puffins (scientific names appear in Table 1) into 3 age groups: 1 year olds, sub-adults and adults. Dissections were performed by DeGange in the MEIYO MARU fleet. Sex, age and breeding condition were noted for about 200 birds. Stomachs were collected for later analysis.

THE FISHERY

The salmon mothership fishery of Japan is one of the most complex fisheries in the world. Each of the four motherships currently operating in the North Pacific is associated with 43 catcherboats. Within each fleet, the entire fishing operation is orchestrated from the mothership which is owned by one of a few large fishing companies. Each catcherboat, which is owned by a smaller fishing company, is under contract to the mothership's company. Five of the 43 catcherboats in each fleet are scoutboats. Scoutboats are continually searching for new fishing grounds and as they frequently fish far from the mothership, their salmon catch is often salted. The remainder of the catcherboats however, return to the mothership each day to deposit their catch.

Each catcherboat is positioned in an orderly set array (Figure 1) and all nets are set in parallel, usually in a compass bearing of 20° or

200°. Running time from fishing sites to the mothership typically ranged from 1 to 6 hours. The catcherboats that returned to the mothership the earliest usually had the longest running time to the next fishing site.

Gillnets are 15 km long and are composed of 330 fifty meter sections (tans) that are laced together. At two equally spaced intervals in the net, the tans are tied together at the corkline instead of laced together. This separates the net into 3 panels which usually break apart in moderate to rough seas, presumably to prevent tangling. Each section is marked with radio buoys to aid in its' relocation. The beginning and end of the net are also marked with additional hardware such as light buoys, flags and radar buoys.

Gillnets are set whenever the catcherboat reaches the site assigned by the fleet commander on the mothership but usually no later than 1900 hrs (JST). Net deployment usually takes 1 hour. Catcherboats then set a storm anchor and drift for the night. Net retrieval begins early in the morning usually between 0400 hrs and 0500 hrs (JST). It takes about 3 hours to retrieve the net. Once at the mothership, crew members offload salmon and any Dall's porpoise caught that day and take on supplies, fuel and water.

RESULTS

This report is based on 6016 seabirds of 16 species caught in 270 gillnet sets observed by American Dall's porpoise observers (Table 1). Shearwaters, primarily Short-tailed Shearwaters, predominated in the catch; the latter accounting for over 41% of the total seabird take. Sooty Shearwaters

were infrequently taken, accounting for only 0.4% of the total. Admittedly, identification of the shearwaters was a problem to several of the observers and Sooty Shearwaters may be slightly underestimated in the total. Tufted Puffins were the second most abundant species in the gillnet catch, almost equalling Short-tailed Shearwaters in total numbers taken. Tufted Puffins however were taken more consistently than Short-tailed Shearwaters, appearing in 97% of the sets compared to 77% for the Short-tailed Shearwater. Horned Puffins appeared in 64% of the sets but only accounted for 7% of the total take. Murres were present in 38% of the sets and accounted for 4.6% of the bird kill. Of the two murre species, Thick-billed were taken more frequently but again, several observers had difficulty distinguishing between the two species. The remaining species were infrequently caught in the nets (Table 1).

An additional 66 birds were caught in the nets but were released alive. Thirty-nine (59%) of these birds were Short-tailed Shearwaters although most of the species caught were represented in this group. The majority of the released birds were caught at the floatline although a few alcids, obviously caught moments before being landed on deck, were as deep as 5 m in the net.

Ainley et al. (1981) working on research vessels found a relationship between a birds method of foraging and its susceptibility to being caught in gillnets which our results corroborate. Surface feeders such as Northern Fulmars, Fork-tailed Storm-Petrels and Laysan Albatrosses were caught infrequently or not at all. These species are the principal scavengers in the North Pacific and most were caught while feeding on fish already in the net. As expected, these birds were entangled at the surface (Table 2). All species that feed by pursuit plunging or

diving that were observed in the fishing zone were caught at least once. Shearwaters and alcids were caught at all depths of the net although shearwaters were most frequently caught in the upper 1/3 of the net (Table 2). Data from 2 observers indicate that 18-40% of all shearwaters were caught at the floatline. Ainley et al. (1981) report that a small percentage of shearwaters (ca. 5%) were caught while feeding on net entangled fish. Alcids, which are adept divers, were more widely distributed in the net (Table 2).

Ages of Seabirds And Breeding Condition

Short-tailed Shearwaters

Ages of shearwaters were determined primarily by the presence or absence of a bursa of frabricius, which is an outpocketing of the dorsal side of the cloaca. The presence of this structure is commonly used as an indicator of immaturity in many water birds. Dissection was necessary to determine its presence and all data is from one observer.

Of the 40 Short-tailed Shearwaters dissected, 34 had bursas and were presumed to be immatures. Presence or absence of a bursa and flight feather molt was closely related. Thirty-three of the birds with bursas were not molting flight feathers and all of the birds without bursas, presumed to be older birds, were molting. If individuals with bursas were birds of the year, then they recently would have acquired new flight feathers as nestlings and would have no need to undergo wing molt while on the wintering grounds. Older birds however should delay wing molt until they reach their food-rich wintering grounds in the North Pacific. The limited data on hand suggests that many of the shearwaters caught in

the nets were immatures. These results concur with Serventy (1967) and Serventy et al. (1971) who in an extensive banding program found that most band recoveries in the Japanese fishery were from yearling birds.

Information we have on age and breeding condition of alcids is limited to 14 Thick-billed Murres, 22 Horned Puffins and 714 Tufted Puffins. All 14 Thick-billed Murres had bursas and were presumed to be immatures. Horned Puffins were aged by plumage. Of the 22 Horned Puffins examined, 9% were 1 year olds, 68% were subadults and 23% were adults. One Horned Puffin had a re-feathering brood patch which suggests that it had at least attempted to breed in 1982. Tufted Puffins were also aged by plumage and of the 714 birds studied 26% were 1 year olds, 54% were sub-adults, and 20% were adults. All observers who tried to age puffins were not equally skilled and I believe the results are skewed to favor adults. In the MEIYO MARU fleet I accurately classified 143 Tufted Puffins and found that 26% were 1 year old, 69% were sub-adult, and only 4% were adult. Because the MEIYO MARU fleet tended to fish farther offshore than the other fleets, the latter figure represents a minimal estimate of the adult Tufted Puffin contribution to the total kill. None of the Tufted Puffins I examined showed evidence of breeding that summer although even most sub-adults had enlarged gonads.

Sexes of Birds

For Short-tailed Shearwaters caught in the MEIYO fleet, males and females were killed about equally (48.6% vs. 51.4%, n=37). For Tufted Puffins caught in the MEIYO fleet there was a significant disparity between males and females (60.5% vs. 39.5%, n=124, $\chi^2=5.46$, $p < .025$). Explanations for

this difference are not clear and the problem deserves further study. Examination of additional specimens may reveal whether these numbers are representative of the non-breeding population of Tufted Puffins summering south of the western Aleutian Islands.

CATCH STATISTICS

For the 270 sets observed by Americans, the number of birds killed per set ranged from 1 to 191 [$\bar{X} = 22.3 \pm 1.6(1 \text{ SE})$ or .067 birds/tan]. In only 7 sets were over 100 birds taken and in these sets shearwaters made up the majority of the incidental take. One of the major findings of Ainley et al.'s (1981) work was that catch rates of seabirds varied with mesh size. The use of strictly commercial gear on the vessels we observed from allowed us to discount that factor. Ainley et al.'s results showing that catch rates of seabirds varied logarithmically with distance from shore led us to look at how catch rates varied with distance from the narrow continental shelf of the Aleutian Islands (Figure 2). It is apparent that catch rates of seabirds were significantly higher 0-50 km from the 2000 m curve of the shelf than further offshore (ANOVA, $F=7.95$, $p < .01$). This reflects greater densities of seabirds closer to land probably as a result of higher primary productivity near the Aleutian Islands associated with upwelling and water mixing.

Much of the mothership fishery in 1982 was concentrated south of the Aleutian Islands, specifically in the eastern part of the FCZ between $172^{\circ}30'E$ and $175^{\circ}E$ (Figures 3 and 4). This led us to look at catch rates in this area over time for the principal species affected by the fishery. For murre and puffins, catch rates tended to decrease over the course

of the fishing season (Figure 5). For shearwaters, we observed two peaks in catch rates, one in June and the other in July (Figure 6). These peaks probably correspond to movements of shearwaters into the fishing zone. These results are consistent with our knowledge of these species' natural history. Murres and puffins are relatively poor fliers and as most of these birds in the fishing zone were immatures, we would expect little large scale movement. Thus their populations might be subject to depletion by an intensive fishery. Shearwaters on the other hand are highly mobile even during molt and are capable of moving in and out of the fishing zone. In addition, they are suspected to migrate in waves (Guzman 1981) which also might explain the erratic pattern of catch rates for this species.

ESTIMATES OF MORTALITY

For the first time, this study enabled me to calculate total mortality of seabirds in the mothership fishery using data collected in that fishery. Previous estimates relied on data from research vessels (DeGange 1978, Sano 1978, Ainley et al. 1981). This study showed that catch rates of seabirds varied with distance from the continental shelf and over the course of the fishing season. I attempted to take these factors into account when computing mortality estimates. There were eight possible methods using various permutations of distance and time by which to calculate mortality. Five of these are included here. All estimates are based on the 8957 sets made by the commercial fleet in 1982 and the catch rate data gathered by American porpoise observers. These five methods are described below.

1. Total gillnet sets multiplied by the mean number of birds caught per set as observed by Americans.
2. Number of sets in June and the number of sets in July multiplied by the mean number of birds caught per set for each month.
3. Number of sets in 1° latitude x 5° longitude blocks multiplied by the mean number of birds caught per set for each block.
4. Number of sets in 1° latitude x 5° longitude blocks per June and July multiplied by the mean number of birds caught per set in each block per month.
5. Number of sets in 1° latitude x 2.5° longitude blocks multiplied by the mean number of birds caught per set for each block.

Ideally, I would have preferred to calculate mortality using 1° latitude x 2.5° longitude blocks by month, however such a method reduced sample sizes per block and increased variances. For the same reason I chose not to calculate overall mortality using the other methods.

The five mortality estimates are relatively consistent and range from about 183,670 to 199,741 (Table 3). The smallest confidence interval was obtained using the first method which also was the least refined. Any attempt to account for geographical variation in catch rates or variation in catch rates over time slightly lowered the mortality estimate but widened the confidence interval.

Earlier estimates of mortality from research vessels (Sano 1978) did not account for birds that dropped from the net before reaching the deck and

presumably could have resulted in an underestimate of mortality.

Ainley et al. (1981) found that between 5 and 13% of the birds caught in nets of research vessels dropped out. In this study DeGange and Tsunoda recorded drop-out rates of only 1.5% and 0.7% of the birds caught respectively. As many of the other American observers apparently missed dropouts, the estimates of mortality presented here should be revised upward by about 1%. Thus the lowest estimate presented here, 183,670 should be revised to 185,506. I suspect the difference in dropout rates between variable mesh research nets and commercial nets is real and attribute it to birds becoming more thoroughly entangled in nets of 121 and 131 mm mesh as opposed to smaller and larger mesh sizes.

How do these estimates of total mortality compare with existing published estimates? They are in fairly close agreement with the estimate presented by Ainley et al. (1981) of 206,000 birds which is based on data gathered on research vessels but corrected for lower catch rates in meshes smaller than 96 mm. These estimates are also in close agreement with the estimates provided by Sano (1978) for the mothership fishery during the 1977 fishing season.

IMPACT OF THE FISHERY

Although we now have an understanding of the magnitude of the incidental seabird take in the Japanese mothership salmon fishery it is difficult to assess the impact of the Japanese driftnet fisheries on North Pacific seabird populations. Our difficulties are four fold: 1) We know little about the incidental take of seabirds in the squid driftnet

fishery or in the land-based fishery; 2) our lack of baseline data on seabird populations in Alaska, particularly the western Aleutian Islands, before the fisheries inception; 3) our lack of effort in monitoring seabird populations in Alaska and the difficulty in detecting real changes in populations once monitoring is initiated; 4) our poor understanding of where birds caught in the fishery come from.

Both the land based salmon fishery and the squid fishery are large. The land based salmon fishery in fact uses more boats and deploys more net than the mothership fishery. The area this fishery operates in includes the marine ranges of several species taken in the mothership fishery, notably Tufted and Horned Puffins, and Short-tailed and Sooty Shearwaters. The only estimates of mortality for this fishery are 185,000-227,000 birds taken during the 1977 season (Sano 1978). The relatively new squid fishery (begun in 1978) included 534 vessels in 1981 which use up to 600-800 tans (30-40 km) of 115 mm gillnet (Court 1981); double the length of net used in the salmon fishery. The 1982 season was projected to run for 7 months, from June to December. The fishery encompasses a large area, north to 50°N and east to 160°W. This fishery is probably also responsible for large numbers of seabird deaths annually.

An important outcome of ours and Ainley et al.'s (1981) work is the discovery that catch rates of seabirds increase with decreasing distance to the Aleutian Islands. We found 50 nautical miles from the 2,000 m curve of the continental slope to be a crucial distance. However, significantly higher catch rates within 50 nm of the continental slope were offset by little fishing effort close to the islands in 1982. In fact only 31 of 8957 sets (0.3%) were made between 52°N and 53°N or

within 40 nm of land in 1982. In contrast, in the early to mid 1970's when 7 motherships and over 300 catcherboats were active in the fishery up to 500 sets were made in the same area. There is probably considerable variation from year to year in where the fishing fleets concentrate but whatever the case, fishermen probably dislike fishing close to the islands because of the increased likelihood of fouling their nets in the swift currents.

Preliminary results, based only on birds examined aboard catcherboats suggest that few breeding birds were taken in the mothership fishery in 1982. Many of the birds we classified as adults may have been reproductively mature but non-breeding in 1982. If most of the alcids caught in 1982 were immature it is difficult to assess the impact on the population. I suspect that many of the birds caught in the fishery originated not only from colonies in the western Aleutian Islands but possibly from colonies in the eastern Aleutians and along the Alaska Peninsula as well. Puffins and other alcids swimming out to sea from colonies in these areas may be swept westward in the Alaska Stream, a westerly flowing current.

Tufted Puffins and Short-tailed Shearwaters are clearly the most heavily affected of the species taken in the mothership fishery. Estimated numbers of other species taken in the fishery are low and are not discussed further.

Currently the population of Tufted Puffins breeding in Alaska is crudely estimated at 4,000,000 birds (Sowls et al. 1978). Tufted Puffins from colonies in Asia may also be affected by the mothership fishery but we don't have any data to support this contention nor are we aware of the sizes of these colonies in Asia. In Alaska, Tufted Puffins produce

on the average about 1,000,000 young per year surviving to fledging. Survivorship of immature alcids from year to year is unknown and it has been estimated for adults for only a few species (Birkhead 1974, Lloyd and Perrins 1977, Steventon 1979). If we assume a first year mortality of 50%, then about 500,000 Tufted Puffins would survive to year 1 and theoretically be susceptible to getting caught in gillnets. Approximately 26% or 18,200 birds of the 70,000 Tufted Puffins taken in 1982 in the mothership fishery (Table 4) were 1 year olds. Therefore a maximum of 3.6% of the available 1 year old Tufted Puffins would be killed in the mothership fishery. This estimate assumes that Alaskan birds are caught to the exclusion of all Asian birds, an unlikely assumption. Survivorship undoubtedly increases for older birds. Of the 3 age classes of Tufted Puffins examined, sub-adults absorb the bulk of the mortality from the fishery, about 70% or 49,000 birds. However this total would be distributed over 2 or 3 age classes which probably survive at a much better rate than 50%. Although I do not suspect that the mothership fishery is seriously affecting Alaskan populations of Tufted Puffins, the effects on colonies in the western Aleutian Islands could be more serious. In addition, while levels of mortality in the mothership fishery may be regarded as biologically insignificant, the cumulative effects from the 3 driftnet fisheries could be substantial.

The world population of Short-tailed Shearwaters numbers over 16,000,000 birds (Naarding 1980). This population supports a commercial and non-commercial harvest of nestlings on the nesting grounds that in recent years has ranged from 685,000 to 849,000 birds. Naarding (1980) presents life tables which indicate that colonies of Short-tailed Shearwaters can

sustain an enormous harvest of young. Even when 95% of all nestlings from a colony are taken, 2.5% of the young survive to breeding (50% survivorship to breeding). Naarding suggests that ultimately destruction of the nesting grounds through erosion caused by recreational "birders" and mortality from domestic cats may have a greater impact on the shearwaters.

The question remains what additional strain the removal of 77,000 birds in the mothership fishery (Table 4) might have on the population. Estimates of survivorship of Short-tailed Shearwaters used by Naarding were those made by Serventy (1967) based on data collected since the inception of the mothership fishery and when the fishery was considerably larger than today. Serventy's estimates of survivorship already take into account fishery induced mortality on the wintering grounds.

New Zealand authorities presently believe that the population of Short-tailed Shearwaters is holding its own except for a number of colonies which are heavily "birded" non-commercially or illegally. Additional mortality from the three driftnet fisheries in the North Pacific may exacerbate this situation on these heavily exploited colonies. A newly developed management plan proposes to close several of these intensively "birded" colonies for 1 year to allow a normal escapement of fledglings.

At this time we can only guess at what might be a reasonable estimate of mortality for the 3 driftnet fisheries. Based on current information about 400,000 birds per year is not an unreasonable estimate for the two salmon fisheries. If the squid fishery is included then mortality of seabirds in excess of 500,000 birds per annum is likely.

FUTURE EFFORT

Remaining to be completed this winter is an examination of about 300 birds taken in the mothership fishery that were brought back to Anchorage, AK. After examining these specimens we should have a much better idea of the age and sex composition of the various species in the fishery zone. Next year similar kinds of data will be gathered by twelve American observers in the Japanese mothership fishery. In addition Fish and Wildlife personnel will conduct seabird surveys south of Agattu and Attu Islands to better delineate what might be critical offshore distances for seabirds in the area.

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Table 1. Species Composition of Seabirds Caught in Gillnets of The Japanese Salmon Mothership Fishery, Summer 1982.

<u>Species</u>	<u>No.</u>	<u>Percent</u>
Northern Fulmar (<u>Fulmarus glacialis</u>)	59	1.0
Sooty Shearwater (<u>Puffinus griseus</u>)	24	0.4
Short-tailed Shearwater (<u>Puffinus tenuirostris</u>)	2516	41.8
Unidentified Shearwater (<u>Puffinus sp.</u>)	194	3.2
Fork-tailed Storm-Petrel (<u>Oceanodroma furcata</u>)	25	0.4
Pomarine Jaeger (<u>Stercorarius pomarinus</u>)	1	---
Black-legged Kittiwake (<u>Rissa tridactyla</u>)	2	---
Common Murre (<u>Uria aalge</u>)	41	0.7
Thick-billed Murre (<u>Uria lomvia</u>)	104	1.7
Unidentified Murre (<u>Uria sp.</u>)	97	1.6
Ancient Murrelet (<u>Synthliboramphus antiquus</u>)	78	1.3
Cassin's Auklet (<u>Pytoramphus aleuticus</u>)	6	0.1
Parakeet Auklet (<u>Cyclorhynchus psittacula</u>)	30	0.5
Least Auklet (<u>Aethia pusilla</u>)	9	0.1
Crested Auklet (<u>Aethia cristatella</u>)	92	1.5
Unidentified small alcid	12	0.2
Rhinoceros Auklet (<u>Cerorhinca monocerata</u>)	1	---
Tufted Puffin (<u>Fratercula cirrhata</u>)	2290	38.1
Horned Puffin (<u>Fratercula corniculata</u>)	429	7.1
Unidentified Bird	6	0.1
Total	6015	99.9

Table 2. Depth in Salmon Net Where Birds Were Caught (n=1370).

Species	Depth In Net (m)							
	1	2	3	4	5	6	7	8
Northern Fulmar	10							
Short-tailed Shearwater	454	110	39	22	6	4	1	1
Fork-tailed Storm-Petrel	4	1						
Murres	22	7	5	6	3	3	1	
Tufted Puffin	122	142	103	105	31	40	16	4
Horned Puffin	21	17	14	16	7	7	1	1
Small Alcids	14	7	2		1			
Totals	647	284	163	149	48	54	19	6
% of total	47.2	20.7	11.9	10.9	3.5	3.9	1.4	0.4

Table 3. Estimates of Seabird Mortality in the Japanese Mothership Salmon Fishery, Summer 1982.

METHOD ¹	NUMBER OF BIRDS (includes 95% CI)
1	199,741 ± 28,214
2	197,844 ± 40,272
3	183,677 ± 49,201
4	188,489 ± 67,514
5	183,765 ± 56,607

¹ As described in text

Table 4. Approximate mortality of seabirds in the Japanese mothership salmon fishery in 1982 by species¹.

Species	Number
Northern Fulmar	1836
Sooty Shearwater	734
Short-tailed Shearwater	76776
Unidentified Shearwater	5877
Fork-tailed Storm-Petrel	734
Pomarine Jaeger	trace
Black-legged Kittiwake	trace
Common Murre	1285
Thick-billed Murre	3122
Unidentified Murre	2938
Ancient Murrelet	2387
Cassin's Auklet	183
Parakeet Auklet	918
Least Auklet	183
Crested Auklet	2755
Rhinoceros Auklet	trace
Tufted Puffin	69980
Horned Puffin	13041

¹ uses minimal 1982 estimate of total mortality

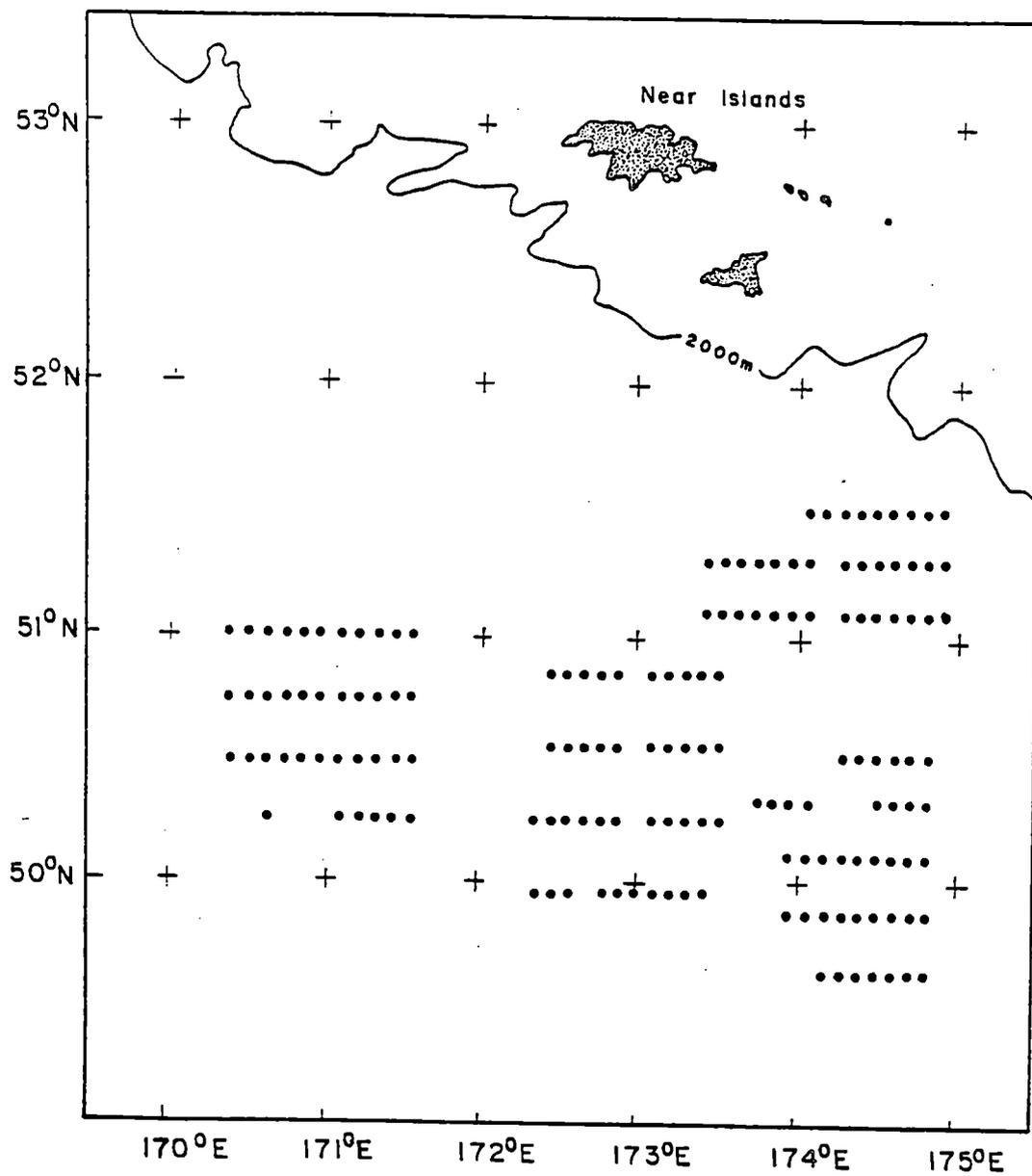


Figure 1. Set Arrays of Catcherboats For The Four Japanese Mothership Fleets On The Night of 12 June, 1982. Not Shown are Positions of 16 of 20 Scoutboats.

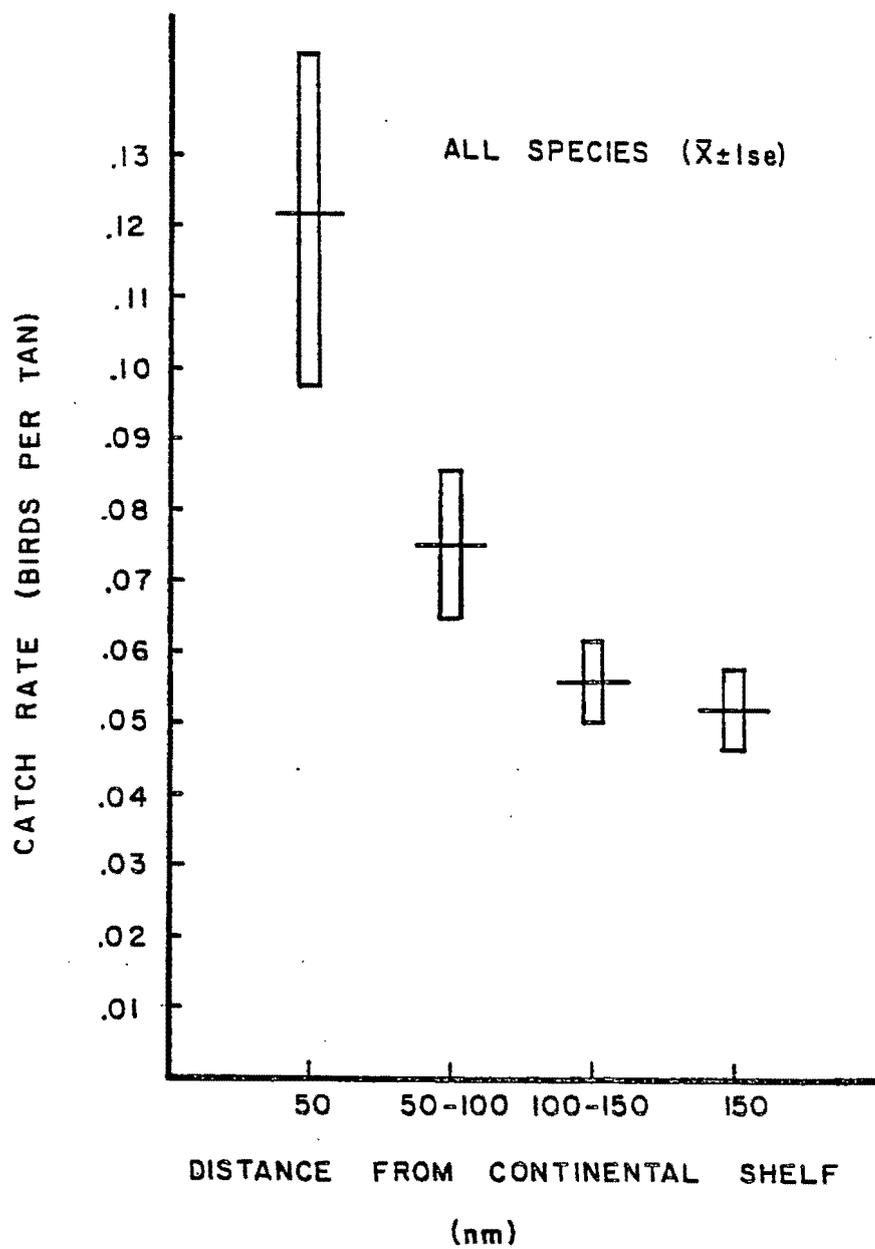


Figure 2. Relationship Between Catch Rates of Seabirds And Distance From The Continental Shelf.

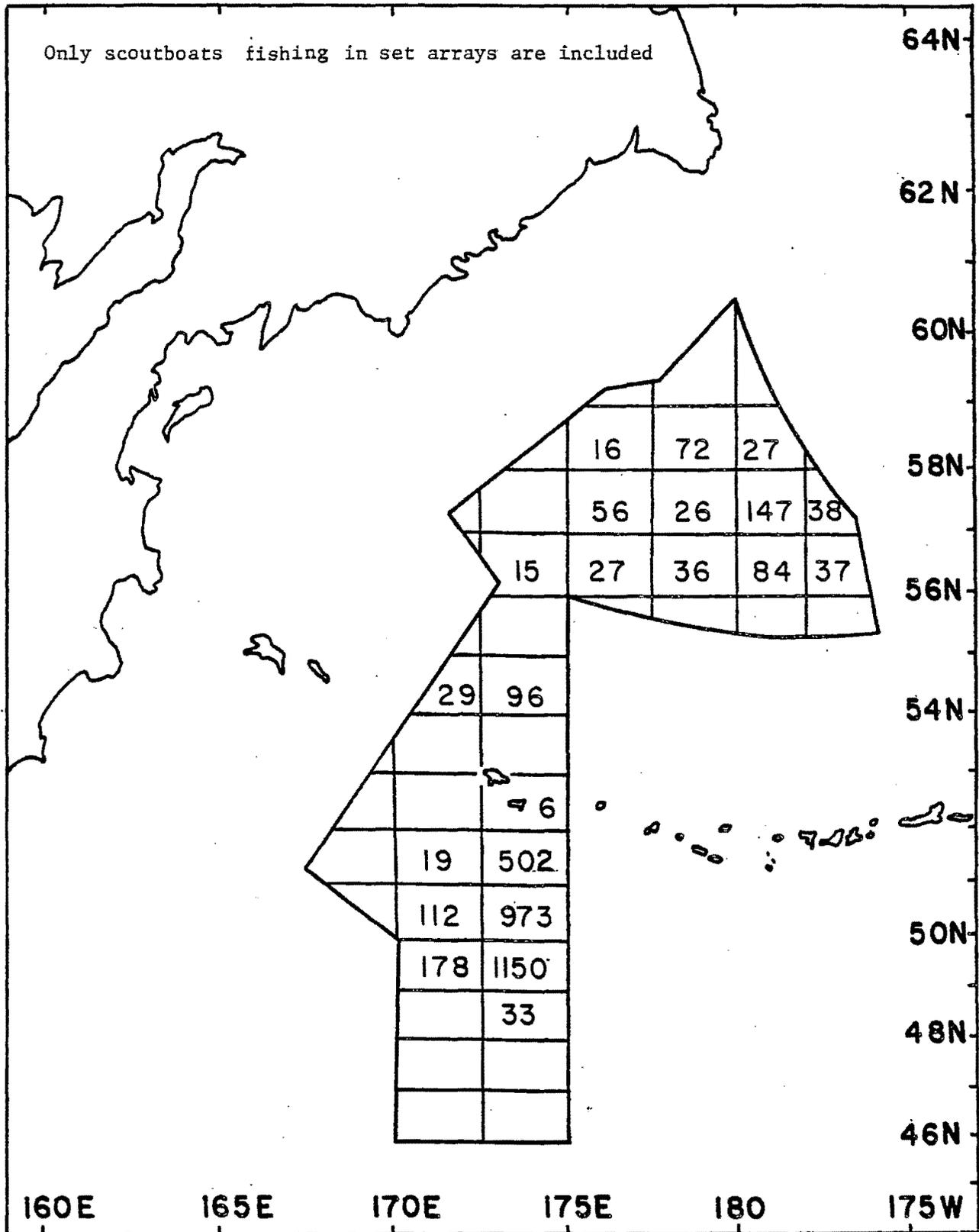


Figure 4. Number of Gillnet Sets In July, 1982 By 1° Latitude X 2.5° Longitude Blocks. Excludes Data From Two Mothership Fleets In The Bering Sea.

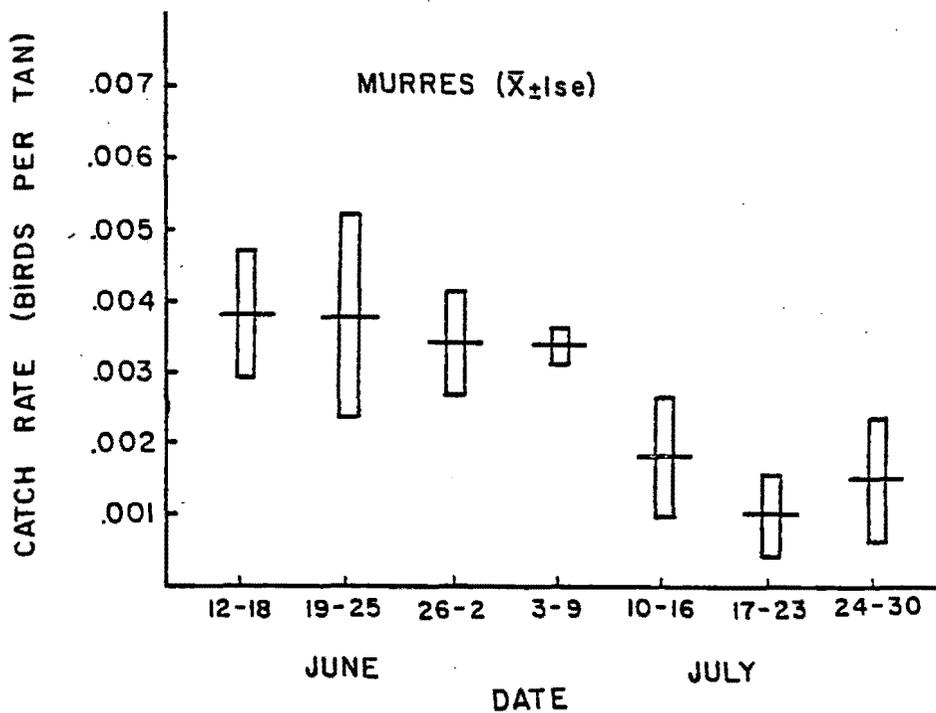
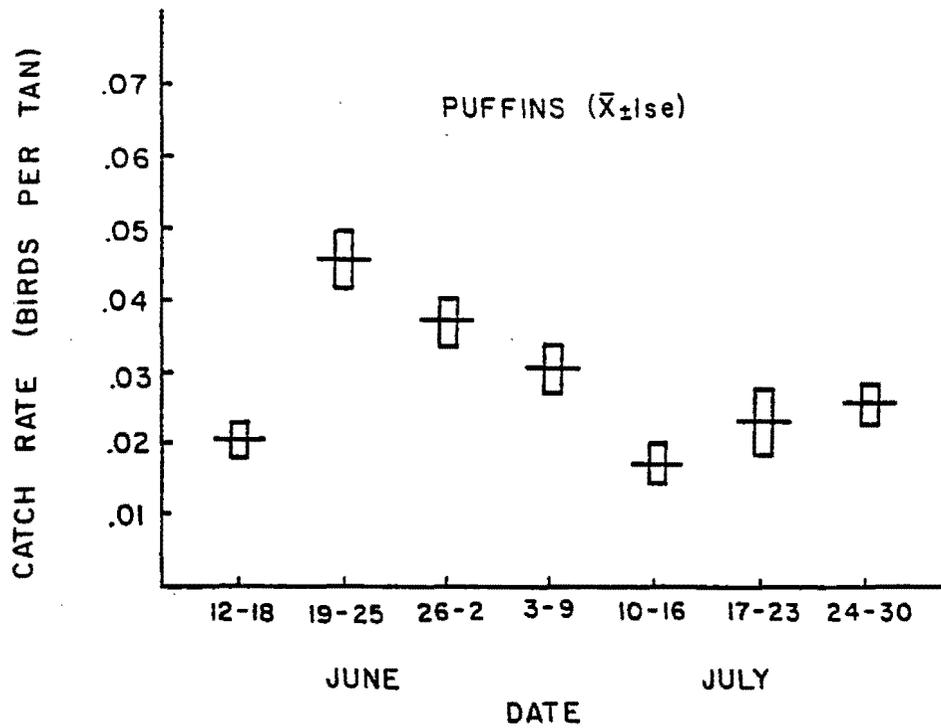


Figure 5. Catch Rates of Puffins and Murres In The Japanese Mothership Fishery During 7-Day Periods In 1982.

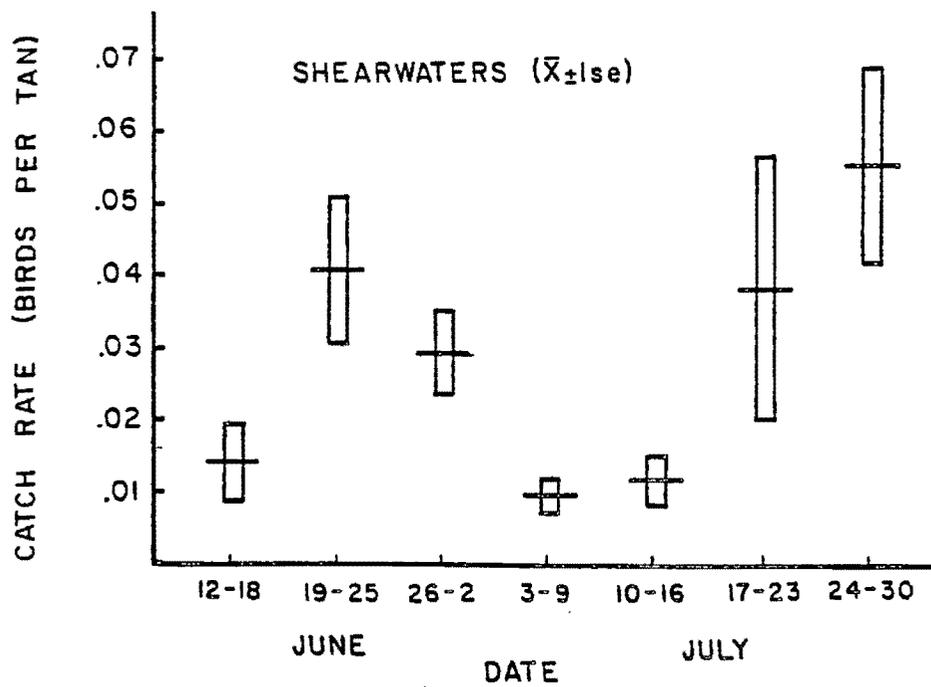


Figure 6. Catch Rates of Shearwaters In The Japanese Mothership Fishery During 7-Day Periods In 1982.