A SURVEY OF PLASTICS ON WESTERN ALEUTIAN ISLAND BEACHES AND RELATED WILDLIFE ENTANGLEMENT

Albert M. Manville II
Defenders of Wildlife and the
Entanglement Network Coalition
Washington, D.C. 20036, U.S.A.

ABSTRACT

A 10-day survey of 25 beaches (mean length of beach surveys = 149 m (162 yd)) on seven different islands (Attu, Agattu, Shemya, Buldir, Kiska, Little Kiska, and Adak) in the outer Aleutian Islands was conducted 12-20 July 1988, using the U.S. Fish and Wildlife Service's research vessel MV *Tiglax* as a base. Sites were randomly selected, and beaches were surveyed for all plastic from sea level to high storm tide level. Representative plastic samples were collected and all beaches photographed. Of the total 3.7 km (2.3 mi) of beach observed, 3,153 plastic objects were counted, representing 67 different finished plastic products. Debris was identified from Japan, the U.S.S.R., South Korea, People's Republic of China, Taiwan, Norway, and the United States. Most prevalent were items from Japan; of those that were identifiable, most were fishing related.

A precipitous decline in the Steller's sea lion, *Eumetopias jubatus*, was noted on Attu Island (77% decrease since 1979), where pinniped surveys were conducted. The results coincide with a reported 65% overall reduction in the western Aleutian Islands population of Steller's sea lions over the past 10 years. Plastics are suspected of contributing to their decline. An adult bull sea lion on Buldir Island was photographed with a strapping band and massive entanglement scar around its neck, with reports of two other entangled, scarred, but live sea lions on Kiska Island, and one on Agattu Island. Some two dozen dead seabirds were discovered during the beach surveys wrapped in plastic although exact cause of death could be ascertained for only one. The *Tiglax* was temporarily entangled in rope from an apparently active brown king crab, *Paralithodes camtschaticus*, pot.

There was a statistically significant difference in the amount of plastic found on beaches in protected coves versus that discovered on open, unprotected beaches. There was also a statistically significant difference in fishing-related versus

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non-fishing-related plastics spotted on the beaches surveyed. If the amount of plastic located on these beaches is at all indicative of that found elsewhere on Alaska's 57,924 km (36,000 mi) of shoreline, plastic debris poses a serious potential problem for fish and wildlife.

INTRODUCTION

Worldwide, plastics in the marine environment alone have been suggested to be as great a cause of mortality to marine mammals, seabirds, and sea turtles as are oil spills, pesticide poisoning, or contaminated run-off (Schneidman 1987). It is postulated that if all dumping and discarding of plastics were to stop immediately, plastics would continue to wash ashore for at least another 100 years (R. J. Wilber, Sea Education Association, Woods Hole, Mass., pers. commun.).

Reports of the presence and impacts of plastic debris in the North Pacific Ocean are fairly common in the recent scientific, popular, and governmental literature (Manville 1988). From the standpoint of origin, plastic debris can be classified as either land-based or ocean-going. Although attempts have been made to quantify at-sea plastic debris in the North Pacific and elsewhere, these attempts are difficult and yield only rough estimates. Dahlberg and Day (1985), for example, found more than 80% of the debris sighted at sea in the North Pacific to be plastic, with over 33% of this consisting of pieces of expanded polystyrene (e.g., cups, floats, boxes). Their observations were limited to floating debris, however, which does not include plastic materials denser than seawater.

Ignell and Dahlberg (1986) surveyed 7,337 km (3,960 mi) of the central and western North Pacific Ocean, and located 1,802 man-made objects adrift on the sea surface, 61 and 26% of these plastic and Styrofoam, respectively. The proportion of plastic materials they found was consistent with that found by Venrick et al. (1973), Shaw and Mapes (1979), and Dahlberg and Day (1985).

Because of the growing concerns about the aesthetic deterioration of our nation's coastline--including beaches in the North Pacific Ocean--a number of recent beach cleanup surveys have been conducted (e.g., Centaur Associates and the Center for Environmental Education (CEE) 1986), but their findings tend to emphasize floatable plastics while often excluding those plastics denser than seawater.

Ghost nets--lost or discarded nets or net fragments, especially drift gillnets--which can continue to fish for years, were reported by Manville (1988) as among the most damaging forms of plastic debris that entangle fish and wildlife in the North Pacific Ocean and elsewhere. The nets sometimes sink from the weight of dead animals, seaweed, or barnacles, and continue to catch fish on the oceans' bottoms. They also may ball up and continue to float, or wash ashore. Also reported were packing bands, six-pack yokes, nets, net fragments, and other plastics which bind and/or strangle virtually every species of marine mammal, sea turtle, seabird,

many varieties of fish, and numerous invertebrates (such as lobsters and crabs).

Fowler (1982, 1987) and Fowler and Merrell (1986) reported that perhaps the best documentation of the results of entanglement in the North Pacific involves northern fur seal, *Callorhinus ursinus*. Extensive data, including the incidence of entanglement scars, were collected from 1967 through 1984 from young male seals killed in the annual commercial seal harvest on the Pribilof Islands, Alaska. These and other data indicated an alarming trend. The population is declining annually at 4-8%; its numbers are now less than half those of 30 years ago. Entanglement, particularly in trawl net fragments, plastic packing bands, and other plastic trash, is believed to be a contributing and perhaps even significant factor in the species' decline. Northern fur seals are presently listed as "depleted" under the Marine Mammal Protection Act, and were recently petitioned for listing as "threatened" under the Endangered Species Act.

While the studies by Fowler (1982, 1987) and others provide the best evidence of wildlife entanglement in plastic debris--especially northern fur seals--and while there is clear evidence that marine debris affects individuals of many species (Manville 1988), Heneman and CEE (1988) felt that evidence of serious population effects on marine wildlife is inconclusive. They cited the fact that few studies had been done on derelict nets or traps, and that while there was clear evidence that entanglement in marine debris kills or injures seabirds, there is no evidence that this is a significant problem for any seabird population. Heneman and CEE's research, however, was not conducted in the North Pacific Ocean.

The Japanese claim that the problem of lost driftnets in the North Pacific is negligible, estimating that only 0.05% of their net sets are lost per operation (the National Marine Fisheries Service estimate is 0.06% (Hinck 1986)). When applied to the setting of more than 32,985 km (20,500 mi) of net per night, plus an additional 16,090-32,180 km (10,000-20,000 mi) of driftnet from Taiwan, South Korea, and others (S. LaBudde, Earthtrust, Honolulu, Hawaii, pers. commun.), a 0.06% loss of net means at least 29-39 km (18-24 mi) of net are lost each night and some 1,542-2,058 km (959-1,279 mi) of net each season. These figures do not account for discarded nets or net fragments.

The northern (Steller's) sea lion, *Eumetopias jubatus*, was reported to have declined by about 50% in the eastern Aleutian Islands between 1957 and 1977 (Braham et al. 1980; King 1983), while western Aleutian populations were reported fairly stable or experiencing only moderate declines during that period (Early et al. 1980; Loughlin et al. 1984). Since 1977, declines continued in the eastern Aleutian Islands (Merrick et al. 1986), but no surveys had been conducted in the western Aleutians from 1979 until 1988. Results from five sites surveyed there in the mid-1970's compared with the 1988 study indicated a 65% reduction in sea lions in the western Aleutians (Byrd and Nysewander 1988). Entanglement was suggested as a possible contributing factor to declines in the eastern Aleutians (Loughlin et al. 1986), but few incidences were reported in the western islands.

Less well known is the status of seabird populations in the Aleutian Islands, and the role plastics may play in affecting these species. Commercial fishing continues to be the largest human activity in the Bering Sea. Factory ships with their fleets of catcher boats stay on location for months processing million of tons of seafood and dumping their wastes in the process (S. LaBudde, Earthtrust, Honolulu, Hawaii, pers. commun.). In Kotzebue Sound north of the Aleutians, data collected in 1977, 1981, and 1987 indicate that the horned puffin, *Fratercula corniculata*, may be experiencing a dramatic 75% decline on Chamisso Island (A. Sowls, Alaska Maritime National Wildlife Refuge, Homer, Alaska, pers. commun.). The cause of the decline is as yet unknown.

While plastic debris has been reported on the beaches of southern Alaska (Cottingham 1988), on the Pribilof and eastern Aleutian chain (Byrd 1984), and as far out in the Aleutians as Amchitka Island (Merrell 1980, 1984), no plastics beach surveys were reported in the literature from the far western Aleutian Islands prior to July 1988.

METHODS

Twenty-five beach surveys were conducted on seven outer Aleutian Islands from 12 to 20 July 1988 using the U.S. Fish and Wildlife Service's (FWS) research vessel MV *Tiglax* as a base. Surveys were undertaken on beaches in the westernmost U.S. islands located in the Near Islands group (Attu, Agattu, and Shemya Islands), Buldir Island, the Rat Islands (Kiska and Little Kiska Island), and the Andreanof Islands (Adak Island, Fig. 1). Surveys were conducted on an opportunistic basis when the *Tiglax* was either at anchor or was able to stop long enough to deploy us, and when weather and seas were sufficiently favorable to allow beach landings in a motorized, Zodiac inflatable. Beach sites to be surveyed were then randomly selected, and beaches were walked and scanned for all plastic from existing sea level to the storm high tide level/upper wrack line (Wilber 1987). Representative plastic samples were collected and all beaches were photographed. No attempt was made to assess the amounts by weight or volume of plastics present on the beaches, although the numbers of complete trawl nets and relative amounts of driftnets were noted.

Attempts were made to identify the source of plastic items by linking origin of the product, item, or piece by identifiers which were often embossed, stamped, or molded into the plastic.

Five open-water plastic surveys were conducted while the *Tiglax* was steaming between islands (Fig. 1). Surveys were conducted from either the bridge of the vessel or the flying bridge, looking for floating or drifting plastic visible from the bow of the ship while it cruised at speeds of 8-10 kn. Surveys were conducted for approximately 30-min intervals.

Particular attention was paid to wildlife entangled in plastic. Where such animals were spotted, they were photographed. Carcasses were carefully examined for external evidence of plastic or for plastic entanglement scars. Rough necropsies were conducted on dead seabirds whose crops were intact to determine if plastics had been ingested.

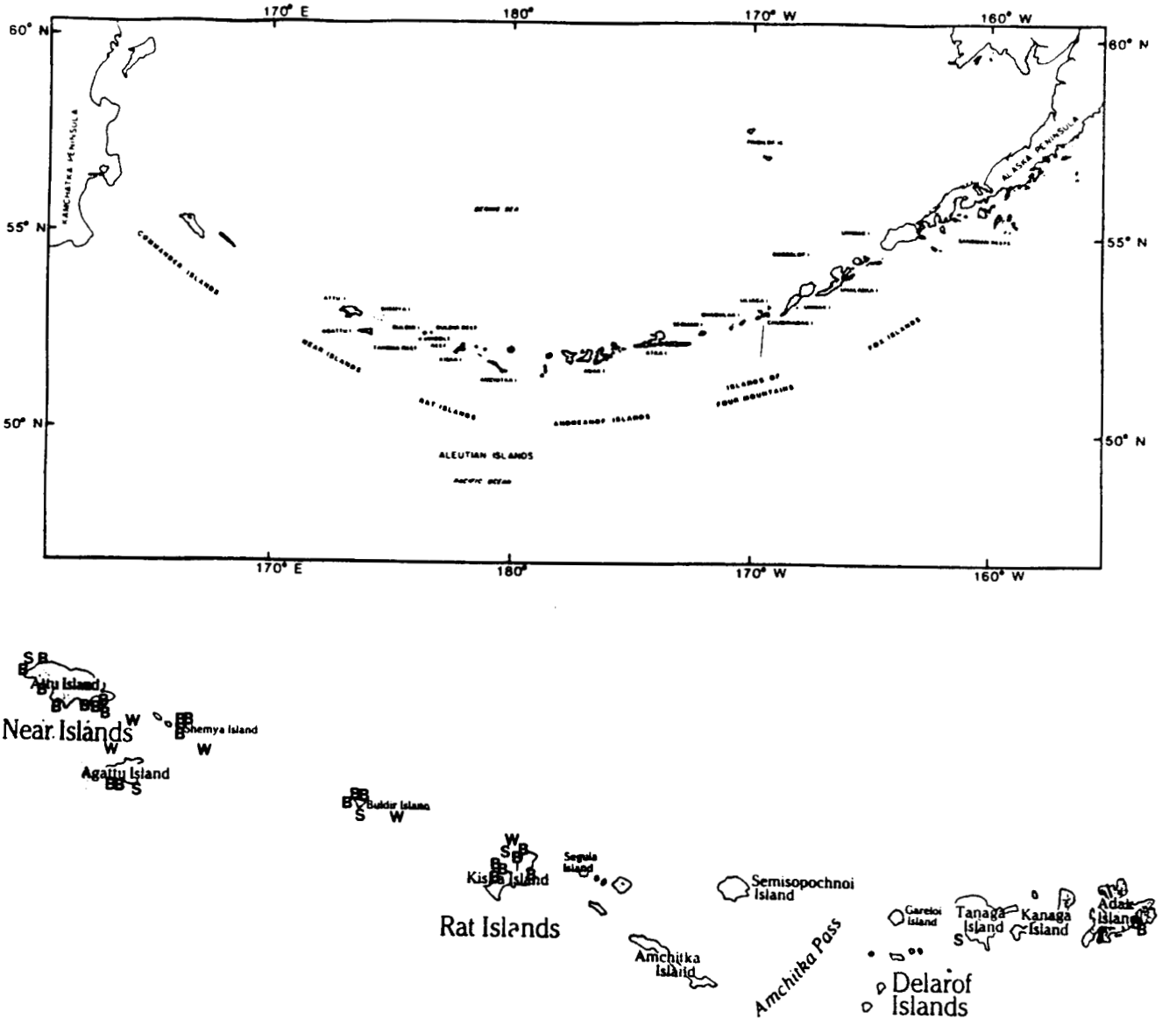

Figure 1.--Locations of 25 beach surveys conducted on 7 outer Aleutian Islands from 12 to 20 July 1988 (B), 5 Steller's sea lion surveys conducted from late June to mid-July 1988 (S), and 5 open-water plastics surveys conducted from 12 to 20 July 1988 (W). Map after Byrd and Day (1986).

Beaches were classified as protected, located in coves, bays, or harbors; or as unprotected, located on promontories, points, or similar areas facing the open ocean. In addition to the presence or absence of protective physical barriers, beach classification also was based on the likelihood of prevailing storm tracks, waves, and weather conditions which could augment accumulation of debris.

The randomization test for two independent samples (for large samples) was used to test the statistical difference in the amount of plastic found on protected beaches versus that discovered on open, unprotected beaches (Siegel 1956). This test was also used to examine the difference between fishing-related and nonfishing-related plastics located on the beaches. Fishing-related debris consisted of material specifically used for fishing, material used in the packaging of fish and fish products, or material used by fishermen during the capture and processing of fish.

Northern sea lion counts were conducted either from land or at sea between approximately 1000 and 1800 on five islands during late June and early July (Fig. 1). This enabled peak bull, cow, and pup counts (Loughlin et al. 1986; Byrd and Nysewander 1988). When counts were made on land within the rookeries, numbers of sea lions were assessed "using spook counts" where one or two researchers drove bulls and cows into the water to facilitate counting the pups still on land. All animals were carefully assessed for signs of entanglement using binoculars and a telephoto-equipped 35-mm camera. Where haul sites and rookeries could be seen from headlands above, such as on Kiska Island, counts were made from land by one researcher using binoculars. Where counts were made from the water, three or four observers stationed 30-75 m (33-82 yd) offshore in a Zodiac inflatable counted all pinnipeds. Where counts were made by more than one observer, replicated tallies were averaged to provide the most representative value for each site. Counts were conducted on Attu, Agattu, Buldir, Kiska, and Gramp Rocks. Counts made in 1988 were compared with those made in 1977 (Day et al. 1978) and 1979 (Early et al. 1980).

RESULTS AND DISCUSSION

Beach Surveys

Twenty-five beach surveys were conducted on seven outer Aleutian Islands from 12 to 20 July 1988. Beach surveys averaged 148 m (162 yd) in length. On the 3.7 km (2.3 mi) of beach observed, 3,153 plastic objects were discovered, representing 67 different finished plastic items. No raw polyethylene pellets (nibs), or spheres or spherules of polystyrene were discovered, although due to time limitations attempts were not made to look carefully for them in the high wrack lines. On the average, 126 different plastic items were found per survey. All beaches examined, including the most protected, contained plastic; at least 15 items were deposited on the cleanest (a protected cove on the south side of Shemya Island).

Most prevalent of the plastic items found on the beaches were rope, Styrofoam driftnet buoys, fishing net (mostly trawl nets, but some driftnet segments), and bottles (Table 1). Like the beaches of Bermuda and the

Table 1.--Types and incidence of plastics found on 25 beaches of 7 islands in the outer Aleutian Islands, Alaska, July 1988.

No.	Plastic item	Count	No. of beaches with item	Type[a]
1	Rope (piece, complete coil)	706	24	F
2	Styrofoam buoy	535	15	F
3	Fishing net (mostly trawl)	360	24	F
4	Bottle (other plastic)	331	21	N
5	Hard plastic buoy	215	17	F
6	Plastic piece	157	15	N
7	Piece of Styrofoam	148	23	F/N
8	Cap and lid	111	17	N
9	Strapping band	102	21	F/N
10	Fish-sorting basket	61	12	F
11	Bottle (green plastic)	55	15	N
12	Japanese beer crate	49	8	N
13	Bag	35	15	N
14	Shoe	27	10	N
15	Cup, spoon, fork, plate	23	12	N
16	Sheeting (large plastic)	19	11	F/N
17	Sheeting (small plastic)	18	9	F/N
18	Tub	16	2	N
19	Milk jug	15	9	N
20	Jug	14	5	N
21	Glove	12	8	F/N
22	Bucket	11	9	F/N
23	Polyvinyl chloride pipe	11	7	N
24	Soda bottle	9	8	N
25	Monofilament fishing line	9	4	F
26	Hard hat	7	4	F/N
27	Packaging	7	1	N
28	Styrofoam fast food container	6	4	N
29	Insulation for cable	6	3	N
30	Disposable lighter	5	2	N
31	Styrofoam egg carton	4	3	N
32	Styrofoam cup	4	2	N
33	Cable liner	4	2	N
34	Reflector	4	2	N
35	Boot (with plastic parts)	4	1	F/N
36	Brush	3	3	N
37	Six-pack holder	3	3	N
38	Styrofoam cooler	3	2	F/N
39	Insulation	3	2	N
40	Slipper	3	2	N
41	Toy	3	2	N
42	Drift card[b]	3	1	N
43	Container top	3	1	N
44	Gas can	2	2	F/N
45	Styrofoam life ring	2	2	F/N

Table 1.--Continued.

No.	Plastic item	Count	No. of beaches with item	Type[a]
46	Electrical tape	2	2	N
47	Pen	2	1	N
48	Tooth brush	2	1	N
49	Bowl	1	1	N
50	Indoor-outdoor carpet	1	1	N
51	Caulking tube	1	1	N
52	Counter top	1	1	N
53	Dishwasher sprayer	1	1	N
54	Electrical fixture	1	1	N
55	Filter	1	1	N
56	Garbage can lid	1	1	F/N
57	Ice tray	1	1	N
58	Mylar food pouch	1	1	N
59	U.S. Navy sonabuoy container	1	1	N
60	Plug	1	1	N
61	Pump	1	1	N
62	Ring	1	1	N
63	Shower curtain	1	1	N
64	Soap dish	1	1	N
65	Thermos top	1	1	N
66	Trash can	1	1	F/N
67	Watering jug for plants	1	1	N
	Subtotal	3,153		
1	Crab buoy attached to rope[c]	2	--	F
2	Piece of floating Styrofoam[c]	4	--	F/N
	Subtotal[c]	6		
	Grand total	3,159		F = 7 N = 48 F/N = 13

[a]F indicates item is fishing-related; N indicates that it is non-fishing-related; F/N indicates that it is both.

[b]National Marine Fisheries Service drift card.

[c]Items discovered during open-ocean survey while departing north end of Kiska Island, 19 July 1988.

Bahamas, which are heavily littered with plastic delivered from a large Atlantic Ocean circulation pattern known as the central gyre (Wilber 1987), the Aleutian Islands act as "sieves" for plastics circulated by waters from the Japanese and Bering Sea currents. Nevertheless, if the amount of plastic located on these Aleutian Island beaches is indicative of that found elsewhere on Alaska's 57,924 km (36,000 mi) of shoreline, there is tremendous opportunity for entanglement or ingestion by wildlife.

Litter was identified from Japan, the U.S.S.R., South Korea, the People's Republic of China, Taiwan, Norway, and the United States, although most of the plastic could not be specifically related to country of origin. Most prevalent were items from Japan; those identifiable were mostly fishing related.

There was a statistically significant difference in the amount of plastic found on protected beaches versus that discovered on unprotected beaches ($P < 0.001$, df = 23, 22,502; Table 2). There also was a statistically significant difference in the amount of fishing-related versus non-fishing-related plastics located on beaches examined ($P < 0.001$, df = 24, 14,083; Table 1).

Although beaches varied considerably in composition, ranging from sandy to pebbly to rocky to boulder-covered, accumulations of plastic litter were not consistently different among the beaches (Table 2). These findings were consistent with those reported by Merrell (1980, 1984).

When comparing the total amount of plastic (N = 2,457 items) versus Styrofoam (N = 696 items) found on the 25 beaches, non-Styrofoam plastic made up 78% of the waste stream while Styrofoam consisted of about 22%.

Of particular interest was the discovery of a six-pack beverage yoke on each of three remote beaches (Table 2), since I had been asked to look for and testify about them before a joint congressional hearing held after my return to Washington, D.C., on 26 July (U.S. Government Printing Office (GPO) 1988). One of these yokes was a Hi Cone Eco photodegradable beverage ring (manufactured by Illinois Tool Works), which had not then begun to show any signs of embrittlement.

Open Water Surveys

Five open-water plastic surveys were conducted while the *Tiglax* was underway between islands. One open-water survey on 19 July off the north end of Kiska Island produced two buoys from a brown king crab, *Paralithodes camtschaticus*, pot, one rope from the pot, and four pieces of floating Styrofoam over an 8 km (5 mi) course (Table 1). Even the *Tiglax* was not immune to entanglement plastics. Her hull became ensnared in the rope from an apparently active brown king crab fishing set.

Dead Seabirds

During the 25 beach surveys, some two dozen dead seabirds were located wrapped in, lying next to, or partially entangled in plastic debris,

Table 2.--Amounts of plastic found on 9 protected and 16 unprotected beaches of 7 islands in the outer Aleutian Islands, Alaska, July 1988.

No.	Beach location[a]	No. of plastic items discovered[b]
	Protected	
1	South Side Beach, Shemya Island	15 (s)
2	Scotts Cove, southwest side, Shemya Island	34 (s)
3	Casco Bay, Inlet Beach, southwest side, Attu Island	19 (r)
4	Casco Bay, small subbay, southeast side, Attu Island	18 (s)
5	Casco Bay, small subbay, southeast side, Attu Island	22 (p/r)
6	Casco Bay, another subbay, Attu Island	19 (s/r)
7	Alcan Harbor, northwest boat dock, Shemya Island	37 (r)
8	Sweeper Cove, Adak Harbor, Adak Island	22 (b)
9	Sweeper Cove, Adak Harbor, Adak Island	21 (b)
	Unprotected	
1	Temnac Beach, south side inlet, Attu Island	37 (s/p)
2	Etienne Cove, southwest side, Attu Island	184 (s)
3	Wrangell Beach, Wrangell Point, Attu Island	511 (p/r)
4	Earle Cove, north side, Attu Island	45 (s/p)
5	Karab Cove, south central, Agattu Island	286 (p)
6	Karab Cove, south central, Agattu Island	48 (s/p)
7	North Bight Beach, near base camp, Buldir Island	329 (r)
8	North Bight Beach, sea lion rookery, Buldir Island	63 (r)
9	North Bight Beach, near base camp, Buldir Island	235 (r)
10	Dark Cove, Kiska Island	284 (s/r)
11	Dark Cove, Kiska Island	379 (s/r)
12	Rock beach, north side, Little Kiska Island	64 (r/b)
13	Three-Mile Beach, Kiska Island	31 (b)
14	Three-Mile Beach, Kiska Island	113 (b/s)
15	Three-Mile Beach, Kiska Island	174 (b/s)
16	North Three-Mile Beach, Kiska Island	170 (b)

[a]Beaches designated as protected were located in coves, harbors, or bays, while those designated as unprotected were located on points, promontories, or areas subject to direct wave action from the open ocean, prevailing storm tracks, and weather conditions which likely augmented the accumulation of debris.

[b]b = boulder beach, p = pebble beach, r = rock beach, s = sand beach.

[c]A six-pack beverage yoke was discovered on each of these three beaches, but at Karab Cove, Agattu Island, the yoke was a Hi Cone Eco photodegradable carrier.

including trawl nets, a piece of driftnet, and plastic rope. With the exception of one dead sooty shearwater, *Puffinus griseus*, wrapped in a piece of trawl net that appeared to strangle it, it usually was impossible to determine the cause of death, given the decomposition of the majority of the carcasses. A Leach's storm petrel, *Oceanodroma leucorhoa*, however, was discovered in August 1988 on Buldir Island entangled in monofilament fishing line which apparently killed the bird (G. V. Byrd, Alaska Maritime National Wildlife Refuge, U.S. Fish and Wildlife Service, Nome, pers. commun.).

Field necropsies revealed no ingested plastics in the few birds (a tufted puffin, *Lunda cirrhata*, two glaucous-winged gulls, *Larus glaucescens*, a sooty shearwater, two crested auklets, *Aethia cristatella*, a least auklet, *A. pusilla*, and a common murre, *Uria aalge*, whose crops were intact. More research on seabird mortality needs to be conducted in the outer Aleutian Islands. Plastics are of special concern since seabirds tend to concentrate in areas where current upwellings reach the surface or where tidal rips occur (J. F. Piatt, Alaska Fish and Wildlife Research Center, FWS, Anchorage, Alaska, pers. commun.)--the same areas where ghost nets, drifting plastic debris, and other flotsam may also occur. Although the impacts of lost or discarded fishing gear and other plastic debris have been difficult to quantify, the few data available suggest that lost gear may be as efficient at killing birds and mammals as is active gear (DeGange and Newby 1980; Jones and Ferrero 1985; Piatt and Nettleship 1987).

Northern Sea Lion Counts

Attu Island

Although counts were made for northern (Steller's) sea lions on 8 and 14 July, the second count was made at a more appropriate hour and therefore was considered more representative. A comparison of this 1988 count with the one made in 1979 (Early et al. 1980), shows a precipitous 77% decline from about 5,700 animals to approximately 1,300 (Byrd and Nysewander 1988). Cause of the decline is unknown.

Agattu Island

Counts were made in mid-June when harem bulls were at their peak and on 9-11 July after most pups were born. The estimated 1988 count of 3,000 sea lions was less than half the number counted in 1979 (Byrd and Nysewander 1988). One bull was seen with a piece of trawl net fragment wrapped around its neck.

Buldir Island

Twenty-two areas were identified for sea lion surveys at Buldir Island, and June and July counts were made for most of these sites. Less than 1,900 sea lions were counted in 1988, 70% fewer than the 1979 survey (Byrd and Nysewander 1988). I photographed a harem bull with a massive entanglement scar around its neck and the strapping band apparently still present. The animal appeared robust and generally healthy, and maintained

a territory with one cow (but no pups) several hundred meters west of the Bull Point Beach sea lion rookery.

Kiska Island

Earlier single counts on Kiska and Tanadak Islands were followed by a mid-July count from land. The overall total for Kiska and Tanadak Islands in 1988 was 2,414 sea lions, a 64% decline from the total seen in 1979 (Byrd and Nysewander 1988). A bull and a cow were seen with deep scars around their necks from previous apparent plastic entanglement.

Gramp Rocks

In 1977, Day et al. (1978) reported sighting over 2,200 sea lions on Gramp Rocks. In late June 1988, over 900 pinnipeds were observed from land, representing a 59% decrease in the population.

Although it was certainly possible that some entangled sea lions were overlooked, those observed represented only a tiny fraction of total population examined. Sea lion populations have declined, probably drastically, in the western Aleutian Islands in the past decade--an overall 65% reduction for the five sites examined--but the reasons for this decline remain unclear. Entanglement has been suggested as a possible contributing factor, especially in the eastern Aleutian Islands (Loughlin et al. 1986; Byrd and Nysewander 1988), but it needs much closer examination in the western Aleutians.

Since pups and juvenile sea lions, like their northern fur seal counterparts, are curious, inquisitive, and playful (King 1983), they may suffer much higher mortality due to entanglement in plastic fishing debris than observed. Since so little research has been done on the sea lions in the western Aleutians, mortality due to plastic entanglement--although suspected by this author to be a contributing factor to their decline--needs more detailed study and analysis.

Presentation of Survey Data at Congressional Hearing

Using data from this study, information was presented at a joint congressional hearing on six-pack yoke legislation on 26 July 1988 (U.S. GPO 1988). Those bills, H.R. 5117 and S. 1986, requiring that six-pack beverage yokes be made degradable within 24 months, were passed by Congress and signed into law late in 1988 by President Reagan.

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