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on Alaskan Beaches,  
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**ENTANGLEMENT DEBRIS ON ALASKAN BEACHES, 1989**

by

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**ABSTRACT**

In 1989, 14 Alaskan beaches were surveyed to determine deposition rate, fate, and trends in abundance of entanglement debris and other plastics that washed ashore. Eight beaches near Yakutat were surveyed in April and September, and six beaches on Middleton Island were surveyed in June. Types of plastics found at Yakutat and at Middleton Island were similar; approximately 75% of the plastics consisted of bottles, caps/lids, bags, floats, and rope. Entanglement debris decreased from previous years and included, in decreasing order of abundance, rope, trawl web, packing straps, and monofilament gill net. The deposition rate (6.5 fragments/km/yr) of trawl web at Yakutat was the lowest observed since 1985. Much of the trawl web washed ashore appears to remain there: at Middleton Island, 32% of the trawl web fragments tagged in 1987 were still there in 1989, and some of those not found were probably buried or washed inland off the beach. On a 1-km section of beach on Middleton Island cleared of all entanglement debris in 1987, the number of debris items in 1989 was 38% of that in 1987.

## INTRODUCTION

The amount of plastic debris found at sea and on beaches has become an international problem (Business Week 1987; Newsweek 1988; Time 1988). Plastic debris mars the scenic quality of beaches, can be hazardous to human health, and endangers marine animals. Marine mammals can become entangled in fragments of trawl web, packing straps, and rope (Scordino 1985; Fowler 1987); seabirds and fish can become entrapped in derelict gill nets (Degange and Newby 1980); and seabirds and sea turtles can ingest pieces of plastic that block their digestive tracts (Balazs 1985; Day et al. 1985).

Plastic debris washed ashore represents, to some degree, the types and quantities lost or discarded at sea. Therefore, beach surveys can provide information on the magnitude of the debris problem at sea, and may be the best method of evaluating the effectiveness of recent legislation, MARPOL Annex V, to reduce the input of plastics into the sea.

In 1989, the National Marine Fisheries Service continued Alaskan beach surveys that have been conducted periodically since 1972. Although many types of plastic debris were found, only those commonly associated with entanglement of marine animals in Alaska are discussed in detail in this paper: trawl web, rope, monofilament gill net, and packing straps (Merrell 1985; Johnson and Merrell 1988). Special emphasis was on trawl web because a major trawl-fishery for groundfish operates off Alaska (Low et al. 1985), and substantial amounts of trawl web are lost or discarded each

year (Berger and Armistead 1987; Johnson 1989). Trawl web is also the predominant item in which northern fur seals (Callorhinus ursinus) are found entangled on the Pribilof Islands, Alaska (Fowler et al. 1985). Specific objectives of the 1989 study were to determine the 1) deposition rate of entanglement debris on beaches, 2) fate of debris stranded ashore, and 3) trends in abundance of debris.

#### METHODS

The 1989 survey sites were eight beaches near Yakutat on the Alaska mainland and six beaches on Middleton Island in the central Gulf of Alaska (Fig. 1). Beaches near Yakutat were surveyed in April and September, and beaches on Middleton Island were surveyed in June. The beaches had last been surveyed near Yakutat in September 1988 and on Middleton Island in July 1987.

Survey methods were similar for all beaches (Merrell 1985). Beach sections sampled were 1 km in length. The survey area for each beach included the intertidal zone between the water's edge and the seaward limit of terrestrial vegetation. All plastic debris visible from walking height was counted (i.e., pieces  $\geq 5$  mm and trawl web and monofilament gill-net fragments with five or more complete meshes). Rope of any diameter was counted if it was  $\geq 1$  m in length.

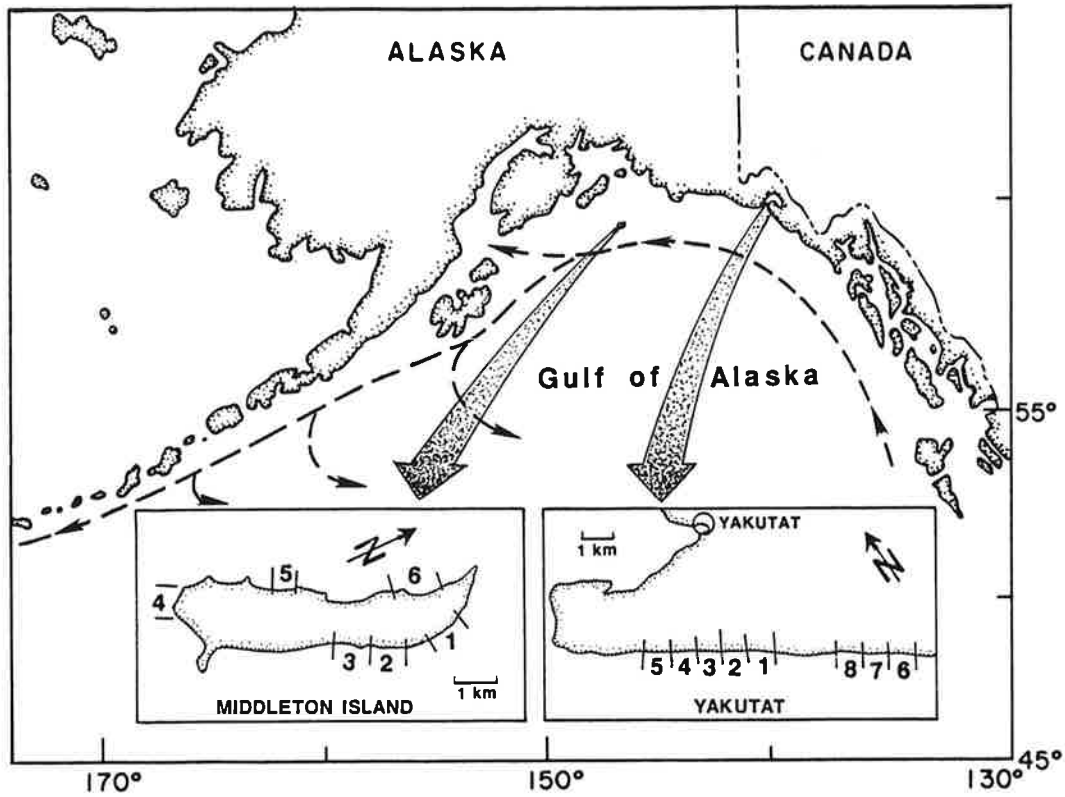


Figure 1.--Location of 1989 study beaches on mainland Alaska (Yakutat) and in the Gulf of Alaska (Middleton Island). Beach 2 on Middleton Island was cleared of all debris in 1987. Broken lines with arrows indicate approximate locations of major ocean currents (Day et al. 1985).

To determine the deposition rate (number of pieces of debris deposited/1 km of beach/yr) of entanglement debris on beaches near Yakutat, pieces of trawl web, rope, monofilament gill net, and packing straps were counted and removed from beaches during surveys in September 1988, and April and September 1989. Debris was moved to areas above the high-tide zone. Debris too large to move, partially buried, or snarled on drift logs, was marked with paint, surveyors tape, or tags for identification in future surveys. Small plastic debris (bottles, etc.) was not removed because it usually disappeared during winter storms (Johnson and Merrell 1988).

To determine the deposition rate and fate of entanglement debris on Middleton Island, one of the 1-km beach sampling sections was cleared of all debris in 1987 and resurveyed in 1989. On the five other beaches, trawl web fragments were left in place and tagged with a small metal tag in 1987 so that during the 1989 survey, they could be distinguished from untagged fragments that washed ashore during the two-year period.

## RESULTS

On beaches near Yakutat, 170 pieces of entanglement debris were deposited ashore from September 1988 to September 1989; 62% was rope, 31% trawl web, 6% closed strap, and 1% monofilament gill net (Table 1). One hundred and fourteen



Table 1.--Seasonal accumulation of entanglement debris on eight 1-km beach sections at Yakutat, Alaska, September 1988-1989.

Beach	Number of pieces									
	September 1988 - April 1989					April 1989 - September 1989				
	Trawl web	Rope	Gill net	Strap	Total	Trawl web	Rope	Gill net	Strap	Total
1	6	10	1	2	19	2	5	0	0	7
2	3	8	0	1	12	1	9	0	1	11
3	1	9	0	1	11	2	13	0	0	15
4	7	24	0	4	35	2	10	0	0	12
5	4	12	1	1	18	2	6	0	0	8
6 <sup>a</sup>	3	-	-	-	3	1	-	-	-	1
7 <sup>a</sup>	7	-	-	-	7	1	-	-	-	1
8 <sup>a</sup>	3	-	-	-	3	1	-	-	-	1
Total	40 <sup>b</sup>	63	2	9	114	12	43	0	1	56

<sup>a</sup> Sampled for trawl web only.  
<sup>b</sup> Six pieces added to total--had been removed from beach by local resident.

pieces washed ashore during the fall-winter months (September 1988-April 1989;  $\bar{x}$  = 16 pieces/mo), approximately twice the 56 pieces that washed ashore during the spring-summer months (April-September 1989;  $\bar{x}$  = 11 pieces/mo).

The deposition rate at Yakutat for the 1-yr period was 21.2 pieces for rope, 6.5 for trawl web, 2.0 for closed strap, and 0.4 for monofilament gill net. The seasonal accumulation of trawl web in 1988-1989 followed a pattern similar to previous years: more trawl web was deposited ashore during the fall-winter months than during the spring-summer months. The total number of pieces of trawl web deposited ashore, however, declined approximately 30%--from a three year average of 75 pieces (Johnson in press) to 52 pieces (Fig. 2).

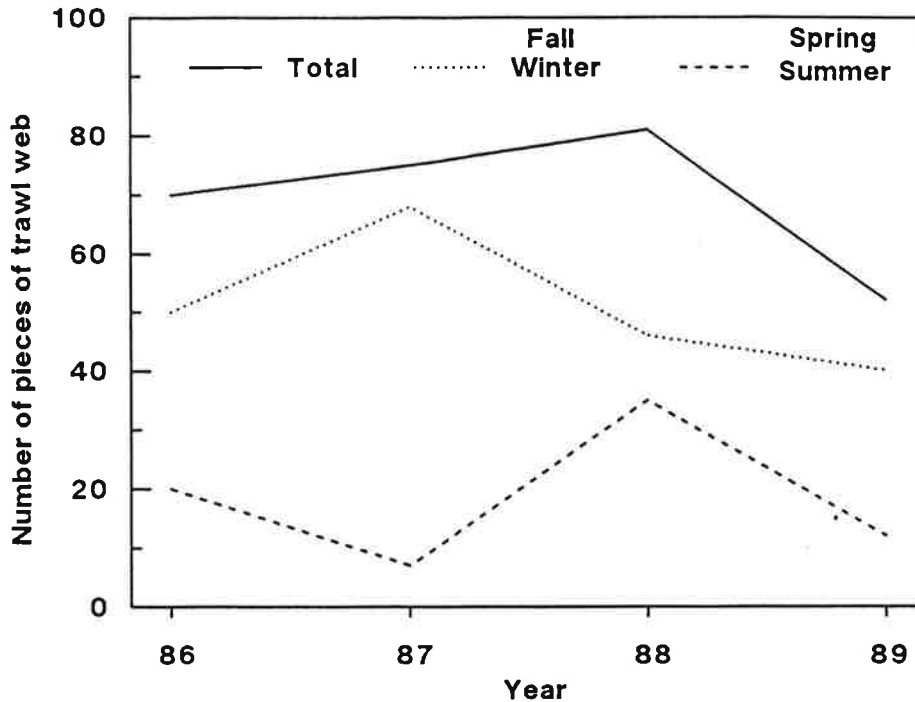


Figure 2.--Total and seasonal deposition of trawl web on eight 1-km beach sections near Yakutat, Alaska, from 1986 to 1989.

Total plastics (all types) on beaches near Yakutat declined 26% from September 1988 to September 1989. Approximately 75% of all plastics washed ashore included: bags, bottles, caps/lids, floats, and rope (Table 2). The remaining 25% of total plastics was comprised primarily of miscellaneous items such as pails, six-pack yokes, styrofoam cups, etc.

On Middleton Island beaches, entanglement debris declined from 297 pieces in 1987 to 205 pieces in 1989 (Table 3). In 1989, rope accounted for 68% of the debris, trawl web 23%, closed strap 8%, and monofilament gill net 1%. Three of the four entanglement debris items declined from 1987 to 1989: trawl web declined 38%, rope 27%, and gill net 88%.

Table 2.--Plastic debris items found on a 1-km beach section at Yakutat, Alaska, in September 1988 and 1989.

Item	Number of pieces deposited ashore	
	March 1988 - September 1988	April 1989 - September 1989
Plastic bags	120	56
Caps/lids	108	59
Plastic bottles	101	89
Gill-net floats	33	56
Rope	26	10
Trawl web	10	2
Miscellaneous	90	80
<b>Total</b>	<b>488</b>	<b>352</b>

Table 3.--Entanglement debris found on six beaches (5.5 km total) on Middleton Island, Alaska, in July 1987 and June 1989.

Beach	Number of pieces deposited ashore									
	July 1986 - July 1987					July 1987 - June 1989				
	Trawl web	Rope	Gill net	Strap	Total	Trawl web	Rope	Gill net	Strap	Total
1 <sup>a</sup>	21	41	4	4	70	19	57	0	7	83
2 <sup>b</sup>	21	51	5	7	84	11	19	1	1	32
3 <sup>c</sup>	25	53	3	1	82	14	39	0	6	59
4 <sup>a</sup>	7	35	4	1	47	4	20	1	2	27
5 <sup>a</sup>	3	8	1	0	12	0	3	0	0	3
6 <sup>a</sup>	0	2	0	0	2	0	1	0	0	1
<b>Total</b>	<b>77</b>	<b>190</b>	<b>17</b>	<b>13</b>	<b>297</b>	<b>48</b>	<b>139</b>	<b>2</b>	<b>16</b>	<b>205</b>

- <sup>a</sup> Beaches were not cleared, but most debris items were marked or removed.  
<sup>b</sup> Cleared in 1987.  
<sup>c</sup> Cleared in 1986.

In 1987, 57 pieces of trawl web were tagged on beaches at Middleton Island and 18 (32%) of these tagged fragments were recovered in 1989. Most (16) of the tagged fragments recovered remained on the same beach where they were originally tagged. Two fragments were recovered inland from the beach where they were originally tagged, presumably washed there by storms. The fate of the missing 39 tagged fragments is unknown; none were found during searches of areas adjacent to or inland from the beaches. Some tagged fragments were probably washed inland and covered by vegetation or buried in drift logs.

The 1-km beach section on Middleton Island, cleared of all surface debris in 1987 and sampled in 1989, had 38% of the amount of entanglement debris found in 1987 (Fig. 3). The relative amounts of entanglement debris were about the same in both years; rope fragments were the most numerous and gill-net fragments the least.

Total plastics (all types) on Middleton Island increased 12% from 1987 to 1989 (Table 4). Most (>80%) of the plastics washed ashore included floats, bottles, caps/lids, rope, and bags. The remaining 20% of total plastics was comprised of miscellaneous items similar to those found on Yakutat.

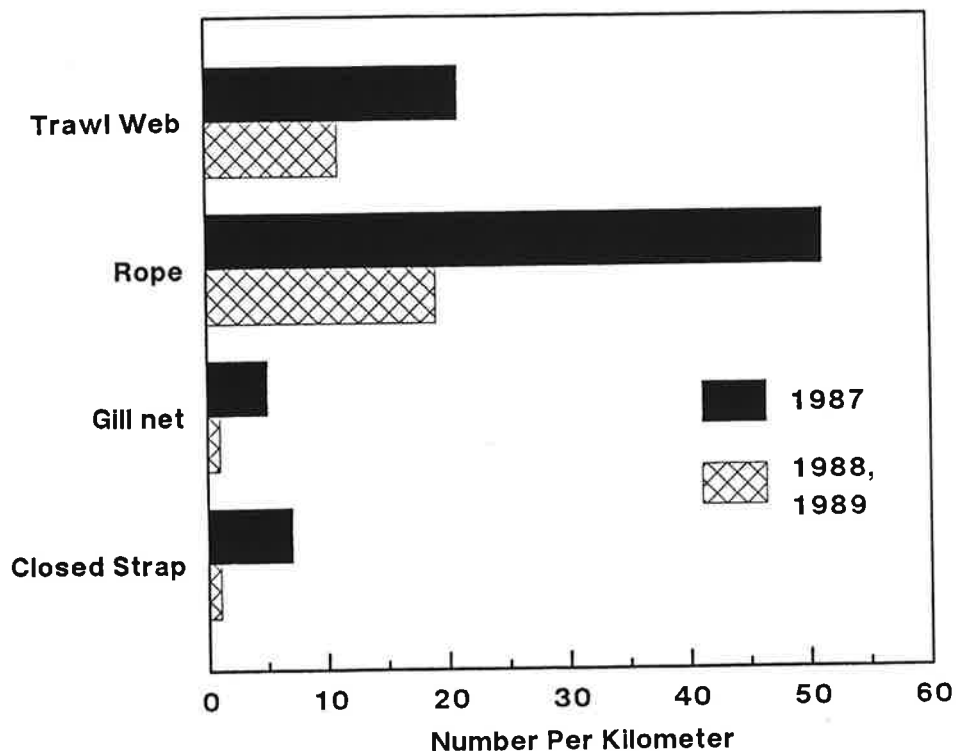


Figure 3.--Entanglement debris found in 1989 on a 1-km beach section on Middleton Island cleared of debris in 1987.

Table 4.--Plastic debris items found on a 1-km beach section on Middleton Island, Alaska, July 1987 and June 1989.

Item	Number of pieces deposited ashore	
	July 1986 - July 1987	July 1987 - June 1989
Gill-net floats	483	439
Plastic bottles	190	210
Caps/lids	92	97
Floats (trawl, etc.)	60	50
Rope	41	57
Trawl web	21	19
Plastic bags	4	33
Miscellaneous	97	199
<b>Total</b>	<b>988</b>	<b>1104</b>

## DISCUSSION

### Total Plastics

The rate of deposition of plastic debris on beaches is largely controlled by storms and the orientation of the beach to prevailing winds. More entanglement debris, and presumably other plastics, washed ashore at Yakutat during the fall-winter months than during the spring-summer months. Increased deposition of plastic debris on beaches in winter has also been reported in the Bering Sea (Merrell 1980). Orientation of a beach to storm winds is also important--beaches on the northeast side of Middleton Island, exposed to prevailing southeasterly winds, had five times the amount of debris as other beaches on the island. Therefore, to monitor trends over time, beaches that consistently accumulate debris should be surveyed.

Types of plastic debris washed ashore at both Yakutat and Middleton Island were remarkably similar. Approximately 75% of all plastics at both locations included bottles, caps/lids, bags, floats, rope, and trawl web. By limiting the input of plastic bottles, caps/lids, and plastic bags into the ocean, the amount of plastics washed ashore on these beaches could be reduced by 30 to 50%. Limiting input of plastics into the ocean is the ultimate goal of MARPOL Annex V, and in conjunction with the development and use of degradable plastics, should greatly reduce the plastics problem at sea.

### Entanglement Debris

In 1989, entanglement debris, especially rope and trawl web, was again common on surveyed beaches at Yakutat and Middleton Islands, although a decreasing trend was evident from earlier years. In particular, the number of pieces of trawl web deposited ashore declined 30% at Yakutat from 1988 to 1989 and 38% at Middleton Island from 1987 to 1989. The deposition rate of trawl web at Yakutat in 1989 (6.5 fragments deposited/km of beach/yr) was the lowest rate observed since studies began at Yakutat in 1985 (Johnson 1989; Johnson in press). Although trawl web declined on beaches in 1989, the detrimental effects on marine life were still evident--two northern fur seals were found entangled in separate pieces of trawl web on Middleton Island.

Once trawl web is deposited ashore, much appears to remain stranded. On Middleton Island beaches, 32% of the trawl web fragments tagged in 1987 were recovered in 1989. In a similar study on beaches near Yakutat, only 5% of trawl web fragments tagged in September 1985 were recovered in September 1987 (Johnson 1989). More tagged fragments were recovered at Middleton Island than Yakutat after a two year period, probably because Middleton Island beaches are generally not as sandy and there is less chance of fragments getting buried and lost. At Yakutat, 22% of the total number of tagged fragments recovered (from several tagging periods) in September 1987 were missing for 5 to 19 months and then recovered, presumably

after being buried and re-exposed (Johnson 1989). Some of the tagged fragments not recovered (68%) on Middleton Island were probably washed inland and buried in drift logs or terrestrial vegetation, as evidenced by the recovery of two tagged fragments inland from the beach. Similarly, several tagged fragments were recovered inland in studies at Yakutat (Johnson 1989). Possibly, some fragments were washed back to sea--to quantify this, however, would require further studies, such as radio-tagging fragments of trawl web.

Entanglement debris accumulated more slowly on a beach cleared of all debris than in previous years. Only 38% of the total amount of entanglement debris found on the 1-km beach on Middleton Island in 1987 was found in 1989. An adjacent beach cleared of entanglement debris had a 43% accrual of debris from 1984 to 1985 and a 130% accrual from 1985 to 1986 (Merrell and Johnson 1987; Johnson and Merrell 1988). The apparently slower accumulation of entanglement debris observed in 1989, in conjunction with the decline in trawl web deposited ashore on beaches near Yakutat and Middleton Island, may be an indicator that less entanglement debris is adrift at sea in the Gulf of Alaska.



In summary, entanglement debris, especially trawl web, decreased on beaches at Yakutat and Middleton Island in 1989. The deposition rate of trawl web at Yakutat in 1989 (6.5 fragments deposited ashore/km of beach/yr) was the lowest observed since studies began in 1985. Continuing the beach surveys at Yakutat, Middleton Island, and other locations in Alaska for the next several years should help to determine if mitigating legislation is reducing the entry of entanglement debris and other plastics into the ocean.

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