PINNIPED ENTANGLEMENT IN SYNTHETIC MATERIALS IN THE SOUTHERN CALIFORNIA BIGHT

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ABSTRACT

The California sea lion, *Zalophus californianus*, the northern fur seal, *Callorhinus ursinus*, the harbor seal, *Phoca vitulina richardsi*, and the northern elephant seal, *Mirounga angustirostris*, that haul out or breed on the southern California Channel Islands, become entangled in synthetic debris at various rates. The percentages of California sea lions entangled, primarily in monofilament gillnet fragments, varied from about 0.08% in 1983 to about 0.16% from 1985 through 1988, while those of northern elephant seals, primarily in packing straps, declined from about 0.15% in 1983 to about 0.10% in 1989. The entanglement rate of harbor seals has varied from 0.0% in 1983-84 to 0.06% in 1986. Entangled northern fur seals have rarely been observed.

Inter- and intraspecific differences in entanglement rates are likely the result of age, sex, and species differences in animal size, diving behavior, and foraging areas. Although entanglement in synthetic materials contributes to mortality of some animals, our studies suggest prevailing entanglement rates have not significantly influenced pinniped demography and population trends in the Southern California Bight.

INTRODUCTION AND METHODS

Pollution of marine environments with nonbiodegradable plastic debris has become an issue of increasing concern during the past several years, especially with regard to entanglement of marine mammals and seabirds in synthetic debris (e.g., see Shomura and Yoshida 1985; Wolfe 1987).

Since 1978 we have studied the incidence of entanglement of pinnipeds in synthetic materials at San Nicolas and San Miguel Islands. We have attempted to distinguish between entanglement in floating marine debris and that resulting from direct interactions of seals and sea lions with commercial fishing and sportfishing operations (Stewart and Yochem 1985, 1987).

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Below we summarize the results of our surveys made between October 1986 and March 1989, and incorporate our previous surveys to assess trends in pinniped entanglement in the Southern California Bight since 1983.

We quantified rates of entanglement of the California sea lion, *Zalophus californianus*, the harbor seal, *Phoca vitulina richardsi*, the northern elephant seal, *Mirounga angustirostris*, and the northern fur seal, *Callorhinus ursinus*, using methods described earlier (Stewart and Yochem 1985, 1987). Briefly, we surveyed pinniped populations at San Nicolas Island once each month and those at San Miguel Island periodically whenever we visited there to conduct other research. Using binoculars or a spotting telescope, we systematically examined small groups of pinnipeds on rookeries and hauling grounds and recorded the number examined (by sex and relative age whenever possible), the number entangled (and the type of entangling material), and the number scarred (presumably from prior entanglement); only those animals whose bodies could be seen clearly were sampled during those entanglement surveys.

RESULTS AND DISCUSSION

From March 1988 through February 1989, 30 (0.12%) of 24,731 California sea lions surveyed at San Nicolas and San Miguel Islands were entangled and another 25 (0.10%) were scarred from previous entanglement, slightly fewer than from October 1986 through February 1988 (Tables 1, 2). Slightly more northern elephant seals were entangled but slightly fewer scarred in 1988-89 than in 1986-88 (Tables 1, 3). Relatively few (0.03%) harbor seals were entangled in 1988-89 and none was scarred (Tables 1, 4), and we observed no scarred or entangled northern fur seals (Tables 1, 5). Neither of two Guadalupe fur seal bulls that we observed at San Nicolas Island in summer 1988 was entangled or scarred.

The percentage of California sea lions observed entangled increased from 1983 through 1987 but declined in 1988, while the percentages of entangled northern elephant seals and harbor seals have declined since 1984 (Table 1). The percentages of scarred sea lions and elephant seals observed have remained relatively constant since 1983 and 1984, respectively (Table 2). We have not observed a scarred harbor seal since 1984 nor a scarred northern fur seal since July 1987.

As in previous years (Stewart and Yochem 1985, 1987), the primary material entangling California sea lions in 1988-89 was monofilament gillnet (Table 6); no floats were attached to the entangling monofilament. Since monofilament is negatively buoyant and sinks without the support of floatation devices, we believe that sea lions that were entangled in monofilament became entangled in operational gillnets and were cut out of the nets, leaving some net remaining around the animals' necks. If sea lions (especially young animals) are capable of breaking out of gillnet panels by snapping mesh lines, then some animals may have been entangled in derelict nets (i.e., debris) which were still attached to floats as well as operational, nonderelict nets. Clearly, larger animals, particularly adult males, are capable of breaking free of gillnets once they become entangled (R. DeLong pers. commun.).

Table 1.--Entanglement and scarring rates of pinnipeds in southern California waters by synthetic materials.

Years surveyed	California sea lions	Northern elephant seals	Harbor seals	Northern fur seals
1983-84				
Surveyed	13,174	6,815	1,809	--
% entangled	0.08	0.15	0.00	--
% scarred	0.10	0.09	0.06	--
1985-86				
Surveyed	35,824	17,338	3,342	826
% entangled	0.16	0.16	0.06	0.00
% scarred	0.11	0.20	0.03	0.24
1986-88				
Surveyed	27,733	12,846	3,324	353
% entangled	0.16	0.09	0.03	0.00
% scarred	0.11	0.19	0.00	0.28
1988-89				
Surveyed	24,731	9,775	2,816	422
% entangled	0.12	0.10	0.03	0.00
% scarred	0.10	0.18	0.00	0.00

The observations that we present here, as well as our earlier ones (Stewart and Yochem 1985, 1987), indicate that sea lions become entangled primarily during the first 2 or 3 years of life. Our observations of scarred juveniles and adults indicate that some animals are freed from the entangling material, presumably monofilament, and survive. Others probably die as a result of entanglement either directly through blood loss or indirectly from infection and secondary complications. The magnitude of that mortality is difficult to assess, as many may die at sea, and an insignificant number of tagged sea lions are entangled, preventing an assessment of survival.

For the following discussions we limit the use of the term synthetic marine debris to material other than monofilament. Whether entangling monofilament is obtained during interactions with active fishing gear or from floating derelict nets or net fragments remains difficult to assess. Observations during commercial fishing operations or studies of captive sea lions might clarify whether or not these cases of entanglement are actually related to floating marine debris.

Nevertheless, the increase in numbers of sea lions observed entangled in monofilament in recent years is interesting, considering the restrictions placed in 1983 on the shark and swordfish drift gillnet fishery around the southern California Channel Islands, a fishery that accounted

Table 2.--Entanglement and scarring rates of California sea lions at San Nicolas and San Miguel Islands.

Years surveyed	Adult males	Subadult males	Females/ juveniles	Yearlings	Pups
1983-84					
Surveyed	345	803	7,206	771	4,049
% entangled	0.00	0.12	0.03	0.91	0.02
% scarred	0.58	0.75	0.07	0.00	0.00
1985-86					
Surveyed	1,577	2,272	30,548	1,427	--
% entangled	0.00	0.18	0.15	0.42	--
% scarred	0.44	0.48	0.07	0.00	--
1986-88					
Surveyed	1,384	987	17,619	2,872	4,871
% entangled	0.00	0.00	0.20	0.24	0.02
% scarred	0.14	0.40	0.14	0.00	0.00
1988-89					
Surveyed	710	833	18,670	1,347	3,171
% entangled	0.00	0.12	0.12	0.30	0.13
% scarred	0.70	0.84	0.07	0.00	0.00

for most of the sea lion entanglement and mortality in recent years. Perhaps sea lions became entangled in gillnets north of Point Conception, where the fishery has recently expanded.

In 1988 and early 1989, we were able to confirm that only about 7% of the entangled sea lions observed were entangled in synthetic debris (rubber bands, Table 6). We have no information yet about the survival of sea lions entangled in such debris, and we have not observed any dead sea lions entangled in anything except monofilament gillnet fragments.

All but one entangled northern elephant seal were entangled in synthetic debris (packing bands, Table 6). Elephant seals appear to become entangled during the first 1 or 2 years of life, probably because the circumferences of most packing band debris are too small for the bands to go over the heads of older seals. Scars around the necks of older seals indicate that some seals survive entanglement, although the type of material that entangled those seals is not known. None of the seals that we have observed entangled were tagged, preventing assessment of the influences of various kinds of debris on seals' survival. Five of the adult females that we observed with severely constricting packing bands around their necks gave birth and successfully weaned their pups in 1988.

Since 1983 we have observed only four entangled harbor seals (all juveniles, each with a packing band around its neck), suggesting that they

Table 3.--Entanglement and scarring rates of northern elephant seals at San Nicolas and San Miguel Islands.

Years surveyed	Adult males	Subadult males	Females/ juveniles	Yearlings
1983-84				
Surveyed	1,019	875	4,410	511
% entangled	0.00	0.34	0.07	0.19
% scarred	0.00	0.11	0.07	0.00
1985-86				
Surveyed	1,776	1,485	13,686	391
% entangled	0.00	0.34	0.18	1.02
% scarred	0.28	0.81	0.06	0.51
1986-88				
Surveyed	1,239	1,045	9,802	760
% entangled	0.00	0.00	0.12	0.00
% scarred	0.32	0.77	0.13	0.00
1988-89				
Surveyed	989	658	7,726	402
% entangled	0.00	0.45	0.08	0.25
% scarred	0.81	1.06	0.04	0.00

rarely encounter potentially entangling debris in southern California waters. As it has been speculated that large numbers of harbor seals are incidentally killed each year in gillnet fisheries in southern California, it is surprising that we have seen no harbor seals entangled in gillnets, especially in comparison to the number of California sea lions that are. If young California sea lions that become caught in gillnets are, in fact, capable of breaking out of gillnets, the lack of observations of harbor seals entangled in gillnet fragments may suggest that they are incapable of breaking free. We speculate that such differences may be due to the different modes of propulsion of these two species and consequent differences in potential force generated to permit them to break mesh strands. Harbor seals may then simply die in active or derelict gillnets rather than break free. Clearly, additional observations are needed to sort among these speculations.

Of all cases of pinniped entanglement observed, we can only confirm that 27% were due to marine debris in 1986-88 and 22% in 1988-89, with much of the remainder (perhaps as much as 73%) evidently related to interactions of pinnipeds (especially juvenile sea lions) with commercial gillnet fisheries (see Stewart and Yochem 1987 for additional discussion).

Because relatively few pinnipeds are observed entangled in synthetic material, analysis of trends in entanglement rates (especially debris-related) is difficult. It is clear, however, that relatively large samples

Table 4.--Entanglement and scarring rates of harbor seals at San Nicolas, San Miguel, and Santa Rosa Islands.

Years survyed	Adults	Immatures
1983-84		
Surveyed	1,445	364
% entangled	0.00	0.00
% scarred	0.07	0.00
1985-86		
Surveyed	2,757	585
% entangled	0.00	0.34
% scarred	0.00	0.17
1986-88		
Surveyed	2,021	1,303
% entangled	0.00	0.08
% scarred	0.00	0.00
1988-89		
Surveyed	1,900	916
% entangled	0.00	0.11
% scarred	0.00	0.00

Table 5.--Entanglement and scarring rates of northern fur seals at San Miguel Island.

Years surveyed	Adult males	Subadult males	Females/ juveniles
1985-86			
Surveyed	58	108	660
% entangled	0.00	0.00	0.00
% scarred	0.00	0.92	0.15
1986-88			
Surveyed	15	63	275
% entangled	0.00	0.00	0.00
% scarred	0.00	1.59	0.00
1988-89			
Surveyed	35	59	328
% entangled	0.00	0.00	0.00
% scarred	0.00	0.00	0.00

Table 6.--Types of synthetic material observed entangling pinnipeds at San Nicolas and San Miguel Islands, 1988-89.

Pinnipeds entangled	Monofilament gillnet	Packing bands	Other debris[a]	Total
California sea lions				
Adult females/juveniles	20	--	2	22
Yearlings	15	--	--	15
Pups	3	--	1	4
Total	38	--	3	41
Northern elephant seals				
Subadult males	--	2	1	3
Adult females	--	6	--	6
Juveniles	--	1	--	1
Yearlings	1	--	1	2
Total	1	9	2	12
Harbor seals				
Adults	--	1	--	1
Total	--	1	--	1

[a]Includes rubber bands, polyfilament rope and line, and items other than trawl or gillnet fragments or nylon monofilament line.

(i.e., systematic observations of large numbers of pinnipeds ashore) are necessary to evaluate properly the true rates of entanglement.

Populations of all pinnipeds have been increasing rapidly in the Southern California Bight during the past two decades (e.g., Stewart 1989; Stewart et al. 1990), indicating that entanglement of pinnipeds in marine debris has had only minor influence on population trends.

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