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Entanglement Studies, St. Paul Island, 1992 Juvenile Male Northern Fur Seals

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ENTANGLEMENT STUDIES, ST. PAUL ISLAND, 1992
JUVENILE MALE NORTHERN FUR SEALS

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ABSTRACT

During July and early August of 1992, entanglement of juvenile male northern fur seals (Callorhinus ursinus) in marine debris was studied on St. Paul Island, Alaska, in the Bering Sea. Estimates of entanglement-caused mortality, incidence of entanglement, and the kinds and sizes of debris were determined for seals in 94 roundups.

The proportion of entangled seals observed in 1992 was greater than in 1991 but was comparable to that observed during the previous several years. The entanglement rate since 1987 has remained lower than that observed during 1967-86. The proportion of juvenile males observed entangled in 1992 was 0.29%. Although the proportion of entangled animals found in fragments of trawl webbing increased over that observed in 1991, the frequency of occurrence of trawl webbing among entangling debris in 1992 was about one-half that observed prior to 1988. The proportion of seals entangled in other types of debris did not change.

The 1992 studies confirm earlier estimates that the annual survival of seals entangled in small debris is about one-half that of nonentangled seals. Seals from which debris was removed had significantly higher survival than those which remained entangled.

During the 1992 roundups, 10 entangled male seals too large to be part of the entanglement study were captured and the debris was removed.

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INTRODUCTION

Entanglement in marine debris, specifically in plastics associated with the commercial fishing industry, has been implicated as a significant factor contributing to, or causing, population trends observed for northern fur seals (Callorhinus ursinus) on the Pribilof Islands, Alaska (Fowler 1982, 1987, 1988; Fowler et al. 1990b). The effects of entanglement on northern fur seals have been examined at the population level (Fowler 1982, 1985, 1987) and at the level of the individual (Fowler 1988). Fur seal entanglement has been studied since the early 1980s by the National Marine Mammal Laboratory, in cooperation with the National Research Institute of Far Seas Fisheries of Japan (Fowler and Baba 1991, Fowler et al. 1992).

Research objectives are 1) determination of the proportion of the seal population entangled, 2) classification of the entangling debris, 3) determination of the effects of entanglement on mortality, especially at the population level, and 4) determination of the effects of debris removal on survival. We also remove debris from entangled seals.

This report presents the results of our 1992 research on the entanglement of northern fur seals. Results of this and previous work focus on juvenile males (aged 2 to 5 years) from St. Paul Island, Alaska (in the eastern Bering Sea). Studies in 1992 examined the incidence of entanglement and its effects on survival, characterized the entangling debris found on the seals,

and compared the frequency of repeated sightings for entangled and nonentangled seals.

METHODS

Juvenile male northern fur seals were observed during roundups as described in Fowler et al. (1990a), Fowler and Ragen (1990), and Fowler and Baba (1991). Seals were herded into a group and allowed to pass between observers who watched for animals with tags or entangling debris. When an entangled or tagged seal was sighted, the flow of seals was stopped while the seal was captured and the relevant information (e.g., tag number, tag type, degree of wound, and type of debris) was recorded. Entangled seals and control animals were tagged. All work was conducted during the breeding season when animals congregate near breeding rookeries along the shoreline of the island.

Entanglement research is focused on juvenile (subadult) male seals judged to be of the size historically taken in the commercial harvest (approximately 105-125 cm in total length). Unless indicated otherwise, data in this report apply to male seals of this size. The total count and the count of entangled animals are used to estimate the incidence of entanglement.

As in all years since 1989, entangled seals were tagged and entangling debris was removed (prior to 1989, entangling debris was left on the animals). Characteristics of the entangling debris, including the type, color, and weight were recorded. The

mesh and twine size were determined for net fragments and the length of materials such as packing bands and ropes was recorded. Samples were retained for future analysis. Two nonentangled seals about the same size as each entangled animal were also tagged to serve as controls when comparing rates of return.

The removal of debris was taken into account when comparing results from studies conducted before and after 1989. This was particularly important in calculating the proportion of seals entangled. Since we removed debris from seals encountered after 1988, the increased survival of these seals resulted in larger numbers being resighted, thus artificially inflated the proportion entangled. To account for this, and to make the data comparable, we used the estimated relative survival of seals entangled in small debris (0.5 relative to controls from past studies: Fowler 1984, 1985, 1987; Fowler et al. 1989, 1990a,b; Fowler and Ragen 1990, Fowler et al. 1992). The number of seals resighted after having had debris removed in 1991 was multiplied by this value. In other words, half of the resighted seals from which debris had been removed in 1991 were assumed to have been seals that would have been resighted as entangled seals in 1992 and would thus contribute to the observed proportion of the population entangled.

To calculate the entanglement rate, the growth of seals was also taken into account, as some of the surviving tagged seals were too large to meet the size criteria above. In 1992, the size of seals tagged in 1989-1991 was recorded. Thus, the

estimate for incidence of entanglement only included tagged seals within the designated size criteria in the count of entangled seals. This differs from procedures for estimation of survival where seals that were previously tagged were counted regardless of size (i.e., entangled seals and controls both grow and both are recounted).

Because some animals are observed more than once, both control and entangled seals are sampled with replacement. This differs from the method used in estimating the incidence of entanglement from the commercial harvest (prior to 1985) in which both entangled and nonentangled seals were killed.

Analytical methods used to analyze resight data to estimate the survival rate of entangled seals are from Fowler and Baba (1991).

RESULTS AND DISCUSSION

Roundups

Ninety four roundups of subadult male northern fur seals were completed on St. Paul Island during July and early August of 1992 (Table 1). During these roundups, 17,630 male seals judged to be of the size historically taken in the commercial harvest were counted.

In 1992, 22.2% of all sightings of entangled or control were seals that had already been seen in the same season (34 out of the total of 153). This estimate of repeat sightings is slightly

Table 1.--Summary of roundups of juvenile (subadult) northern fur seal males conducted on St. Paul Island, Alaska, during July and August of 1992, including the number of both the control and entangled seals in the total tagged.

Date	Location	Total ^a in roundup	Tagged seals ^b resighted	Total seals tagged
7/3	Zapadni Reef Sands	82	6	0
7/3	Polovina	83	2	0
7/3	Zoltoi Sands	165	6	0
7/4	Zapadni Sands	349	11	0
7/5	Tolstoi	126	11	0
7/5	Tolstoi	28	1	0
7/5	Lukanin	53	3	0
7/5	Kitovi	218	15	0
7/6	Morjovi	1	0	0
7/6	Morjovi	106	5	0
7/6	Morjovi	247	7	1
7/6	Morjovi	97	6	0
7/7	Vostochni	189	4	6
7/7	Vostochni	135	9	3
7/7	Vostochni	100	1	6
7/8	Vostochni	77	4	5
7/8	Vostochni	178	13	0
7/9	Gorbatch	237	10	6
7/9	Reef	127	5	0
7/9	Reef	36	1	0
7/9	Reef	65	3	0
7/9	Zapadni Reef Sands	587	27	3
7/10	Tolstoi	186	22	0
7/10	Tolstoi	26	4	3
7/11	Zapadni	138	8	3
7/11	Zapadni	212	7	0
7/11	Zapadni	221	11	3
7/12	Polovina	224	10	0
7/12	Polovina	181	9	0
7/12	Zoltoi Sands	280	14	3
7/13	Lukanin	251	11	3
7/13	Kitovi	130	9	0
7/14	Morjovi	142	5	3
7/14	Morjovi	142	7	2
7/14	Vostochni	187	8	0
7/14	Vostochni	157	3	0
7/14	Vostochni	122	6	3
7/14	Vostochni	117	6	0
7/16	Gorbatch	284	16	0
7/16	Reef	89	5	0
7/16	Reef	105	8	0

Table 1.--Continued.

Date	Location	Total ^a in roundup	Tagged seals ^b resighted	Total seals tagged
7/17	Zapadni Reef Sands	252	13	0
7/17	Tolstoi	159	9	3
7/18	Zoltoi Sands	321	17	0
7/18	Polovina	383	16	6
7/19	Lukanin	66	0	0
7/19	Kitovi	95	8	0
7/20	Zapadni Sands	243	9	0
7/20	Zapadni	158	7	6
7/20	Little Zapadni	22	1	0
7/21	Morjovi	127	7	0
7/21	Morjovi	118	6	0
7/21	Vostochni	263	12	0
7/21	Morjovi	137	7	0
7/22	Vostochni	77	5	0
7/22	Vostochni	258	12	0
7/23	Gorbatch	229	9	2
7/23	Reef	178	10	4
7/23	Reef	45	3	0
7/23	Reef	138	6	0
7/24	Zapadni Reef Sands	221	5	3
7/24	Zapadni Reef	295	13	1
7/24	Tolstoi	322	14	0
7/25	Zoltoi Sands	469	13	0
7/25	Polovina	117	6	0
7/26	Kitovi	306	16	3
7/26	Lukanin	104	5	0
7/27	Zapadni	251	14	0
7/27	Zapadni	179	10	0
7/27	Zapadni	230	9	0
7/28	Morjovi	136	9	0
7/28	Morjovi	84	4	3
7/28	Little Zapadni	128	5	3
7/29	Vostochni Sands	295	13	3
7/29	Vostochni	322	11	6
7/30	Zapadni Reef Sands	220	10	0
7/30	Tolstoi	229	14	3
7/30	Zapadni Reef	180	8	5
7/31	Gorbatch	139	7	0
7/31	Reef	278	11	0
7/31	Reef	120	5	0
7/31	Zoltoi Sands	429	17	3
8/1	Lukanin	152	7	3
8/1	Kitovi	176	13	0
8/1	Polovina	174	6	6

Table 1.--Continued.

Date	Location	Total ^a in roundup	Tagged seals ^b resighted	Total seals tagged
8/2	Morjovi	92	5	0
8/2	Northeast Point	39	6	0
8/3	Vostochni Sands	289	17	0
8/3	Vostochni	368	25	3
8/4	Zapadni Sands	297	26	0
8/4	Zapadni	382	12	0
8/5	Gorbatch	363	18	0
8/5	Reef	244	12	0
8/5	Reef	251	12	0
	Totals	17,630	854	118

^aSeals that are judged to be of the size that were taken in the commercial harvest prior to 1985.

^bSeals which had any kind of tag (including monel tags applied to pups in 1987, 1988, or 1989, or in Russian research) in either foreflipper and that were successfully restrained to read the tag. Includes tags that were resighted more than once this year.

less than the values (25-30%) calculated from previous years (Fowler et al. 1992). Thirty-nine entangled subadult male seals judged to meet the size criteria were captured and double-tagged with numbered blue Allflex¹ tags bearing the address of the National Marine Mammal Laboratory (Table 2). One entangled seal tagged with a monel tag (number A07073, not replaced by an Allflex tag) was also captured and released after removing the debris. Eighty similarly sized control seals with no entangling debris were also tagged (Table 2).

Tagged Seals from Previous Years

Sixty-seven seals which had been tagged during entanglement research in previous years were resighted in 1992 (Table 3). Of these, 7 had tags applied in 1985, 1986, and 1988. Six of the 7 resighted seals were tagged in previous years as controls. One had been entangled when tagged and had lost its entangling debris. The debris that was lost had been noted as being small (less than 150 g in estimated weight) at the first sighting of the seal.

Twenty-four male seals with 1991 tags were resighted. Over 70% of these seals (n = 17) had been tagged as controls and the remainder (n = 7) had been tagged after being disentangled. Twenty-six seals were resighted with tags applied in 1990. Eighteen of these (69.2%) had been tagged as controls and 8 had

¹Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

Table 2.--List of blue broad-banded Allflex tags applied to juvenile male northern fur seals during roundups conducted on St. Paul Island, Alaska, 1992. Debris was removed from entangled seals prior to their being released.

Tag number	Date	Location	Entangled (e) Control (c)
1501	7/6	Morjovi	e
1502	7/7	Vostochni	e
1503	7/7	Vostochni	e
1504	7/7	Vostochni	c
1505	7/7	Vostochni	c
1506	7/7	Vostochni	c
1507	7/7	Vostochni	c
1508	7/7	Vostochni	c
1509	7/7	Vostochni	e
1510	7/7	Vostochni	c
1511	7/7	Vostochni	c
1512	7/7	Vostochni	c
1513	7/7	Vostochni	c
1514	7/7	Vostochni	e
1515	7/7	Vostochni	e
1516	7/7	Vostochni	c
1517	7/8	Vostochni	c
1518	7/8	Vostochni	c
1519	7/8	Vostochni	c
1520	7/8	Vostochni	c
1521	7/8	Vostochni	e
1522	7/9	Gorbatch	e
1523	7/9	Gorbatch	e
1524	7/9	Gorbatch	c
1525	7/9	Gorbatch	c
1526	7/9	Gorbatch	c
1527	7/9	Gorbatch	c
1528	7/9	Zapadni Reef Sands	e
1529	7/9	Zapadni Reef Sands	c
1530	7/9	Zapadni Reef Sands	c
1531	7/10	Tolstoi	c
1532	7/10	Tolstoi	e
1533	7/10	Tolstoi	c
1534	7/11	Zapadni	c
1535	7/11	Zapadni	c
1536	7/11	Zapadni	e
1537	7/11	Zapadni	c
1538	7/11	Zapadni	e
1539	7/11	Zapadni	c
1540	7/12	Zoltoi Sands	c

Table 2.--Continued.

Tag number	Date	Location	Entangled (e) Control (c)
1541	7/12	Zoltoi Sands	c
1542	7/12	Zoltoi Sands	e
1543	7/13	Lukanin	e
1544	7/13	Lukanin	c
1545	7/13	Lukanin	c
1546	7/14	Morjovi	e
1547	7/14	Morjovi	c
1548	7/14	Morjovi	c
1549	7/14	Morjovi	c
1550	7/14	Morjovi	c
1551	7/14	Vostochni	e
1552	7/14	Vostochni	c
1553	7/14	Vostochni	c
1554	7/17	Tolstoi	e
1555	7/17	Tolstoi	c
1556	7/17	Tolstoi	c
1557	7/18	Polovina	e
1558	7/18	Polovina	e
1559	7/18	Polovina	c
1560	7/18	Polovina	c
1561	7/18	Polovina	c
1562	7/18	Polovina	c
1563	7/20	Zapadni	e
1564	7/20	Zapadni	c
1565	7/20	Zapadni	e
1566	7/20	Zapadni	c
1567	7/20	Zapadni	c
1568	7/20	Zapadni	c
1569	7/23	Gorbatch	e
1570	7/23	Gorbatch	c
1571	7/23	Reef	c
1572	7/23	Reef	c
1573	7/23	Reef	e
1574	7/23	Reef	c
1575	7/24	Zapadni Reef Sands	e
1576	7/24	Zapadni Reef Sands	c
1577	7/24	Zapadni Reef Sands	c
1578	7/24	Zapadni Reef	e
1579	7/26	Kitovi	e
1580	7/26	Kitovi	c
1581	7/26	Kitovi	c
1582	7/28	Morjovi	e
1583	7/28	Morjovi	c
1584	7/28	Morjovi	c

Table 2.--Continued.

Tag number	Date	Location	Entangled (e) Control (c)
1585	7/28	Little Zapadni	c
1586	7/28	Little Zapadni	e
1587	7/28	Little Zapadni	c
1588	7/29	Vostochni Sands	c
1589	7/29	Vostochni Sands	e
1590	7/29	Vostochni Sands	c
1591	7/29	Vostochni	e
1592	7/29	Vostochni	e
1593	7/29	Vostochni	c
1594	7/29	Vostochni	c
1595	7/29	Vostochni	c
1596	7/29	Vostochni	c
1597	7/30	Tolstoi	c
1598	7/30	Tolstoi	c
1599	7/30	Tolstoi	e
1600	7/30	Zapadni Reef	c
1601	7/30	Zapadni Reef	c
1602	7/30	Zapadni Reef	c
1603	7/30	Zapadni Reef	e
1604	7/30	Zapadni Reef	c
1605	7/31	Zoltoi Sands	e
1606	7/31	Zoltoi Sands	c
1607	7/31	Zoltoi Sands	c
1608	8/1	Lukanin	c
1609	8/1	Lukanin	c
1610	8/1	Lukanin	e
1611	8/1	Polovina	e
1612	8/1	Polovina	c
1613	8/1	Polovina	c
1614	8/1	Polovina	c
1615	8/1	Polovina	c
1616	8/1	Polovina	e
1617	8/3	Vostochni	c
1618	8/3	Vostochni	c
1619	8/3	Vostochni	e

Table 3.--List of northern fur seals tagged with plastic tags as seen during July juvenile male roundups on St. Paul Island, 1992. Tags were seen on both foreflippers (where two numbers are reported the first is on the left) unless noted otherwise. Debris was removed from entangled seals. Monel tagged seals are to be reported elsewhere.

Date	Location	Tag number	Tag type	Tag color	Entanglement status*	Notes
7/3	Zoltoi Sands	1473	Allflex	White	c	Tagged July 29, 1990, on Polovina. The number 0745 was originally applied to the right side but not seen at this sighting. Tagged Aug 24, 1986, on Kitovi.
7/5	Kitovi	0744	Allflex	Orange	c	
7/5	Kitovi	1396	Allflex	White	e ^f	Tagged on July 22, 1990, on Vostochni. Too large to count.
7/5	Tolstoi	017-018	Allflex	Green	c	Tagged July 11, 1991, on Tolstoi.
7/5	Tolstoi	1260	Allflex	Orange	c	Right tag was the only one sighted. Tagged July 24, 1989, on Tolstoi. 13
7/6	Northeast Point	1331	Allflex	White	c	Tagged on July 13, 1990, on Polovina.
7/7	Vostochni	059-060	Allflex	Green	c	Tagged July 20, 1991, on Vostochni.
7/7	Vostochni	1320	Allflex	White	e ^f	Tagged July 11, 1990, on Zapadni. Too large to count.
7/8	Vostochni	1512	Allflex	Blue	c	Tagged on Vostochni, July 7, 1992.
7/8	Vostochni	1511	Allflex	Blue	c	Tagged on Vostochni, July 7, 1992.
7/8	Vostochni	1388	Allflex	White	c	Tagged July 22, 1990, on Vostochni.
7/8	Vostochni	1508	Allflex	Blue	c	Tagged on Vostochni, July 7, 1992.
7/9	Gorbatch	161-162	Allflex	Green	c	Only one tag noted, there may have been two present. Tagged July 29, 1991, on Gorbatch.
7/9	Reef	157-158	Allflex	Green	e ^f	Countable size. Only one tag noted, there may have been two present. Tagged July 29, 1991, on Gorbatch.

Table 3.--Continued.

Date	Location	Tag number	Tag type	Tag color	Entanglement status*	Notes
7/9	Zapadni Reef Sands	54	Allflex	Blue	c	Tagged on July 20, 1988, on Vostochni (with a radio tag).
7/9	Zapadni Reef Sands	075-076	Allflex	Green	c	Only one tag noted, there were two present. Tagged July 21, 1991 on Lukanin.
7/9	Zapadni Reef Sands	131-132	Allflex	Green	c	Tagged July 27, 1991, on Zapadni Reef Sands.
7/9	Zapadni Reef Sands	077-078	Allflex	Green	e ^r	Only one tag noted, there may have been two present. Tagged July 21, 1991, on Lukanin. Countable size.
7/9	Zapadni Reef Sands	007-008	Allflex	Green	c	Tagged July 7, 1991, on Zapadni Sands.
7/9	Zapadni Reef Sands	1398	Allflex	White	c	Only one tag noted, there may have been two present. Tagged July 22, 1990, on Vostochni.
7/10	Tolstoi	1525	Allflex	Blue	c	Tagged July 7, 1992 on Gorbatch.
7/10	Tolstoi	171-172	Allflex	Green	e ^r	Tagged July 30, 1991, on Zapadni Sands. Too large to count.
7/10	Tolstoi	029-030	Allflex	Green	c	Tag number on left not read but tag was sighted. Tagged July 15, 1991, on Vostochni.
7/11	Zapadni	1198	Allflex	Orange	e ^r	Tagged July 18, 1989, on Morjovi. Too large to count.
7/12	Zoltoi Sands	039-040	Allflex	Green	e ^r	Countable size. Tagged July 18, 1991, on Polovina.
7/12	Zoltoi Sands	1528	Allflex	Blue	e ^r	Tagged on July 9, 1992 on Zapadni Reef Sands. Too large to count.
7/12	Zoltoi Sands	1453	Allflex	White	c	Tagged on July 27, 1990 on Reef. Too large to count.
7/13	Lukanin	1528	Allflex	Blue	e ^r	Tagged on July 9, 1992 on Zapadni Reef Sands.

Table 3.--Continued.

Date	Location	Tag number	Tag type	Tag color	Entanglement status*	Notes
7/13	Lukanin	MH2742	monel			Russian tagged seal, weighed 70 lbs.
7/13	Lukanin	081-082	Allflex	Green	c	Tagged on July 21, 1991 on Zapadni Reef Sands.
7/13	Kitovi	MH1456	monel			Russian tagged seal, weighed 58 lbs.
7/13	Kitovi	0956-0957	Allflex	Orange	c	Tagged Oct. 8, 1986, on Morjovi.
7/14	Morjovi	1515	Allflex	Blue	e ^r	Tagged July 7, 1992 on Vostochni.
7/14	Morjovi	1354	Allflex	White	c	Tagged July 17, 1990 on Morjovi.
7/14	Vostochni	1511	Allflex	Blue	c	Tagged July 7, 1992, on Vostochni.
7/14	Vostochni	157-158	Allflex	Green	e ^r	Tagged July 29, 1991, on Gorbatch. Countable size.
7/14	Vostochni	1214	Allflex	Orange	e ^r	Tagged July 18, 1989, on Vostochni (Sands). Too large to count.
7/14	Vostochni	bH88	monel			Russian tagged seal, weighed 72 lbs.
7/14	Vostochni	1431	Allflex	White	e ^r	Tagged July 25, 1990 on Morjovi. Too large to count.
7/14	Vostochni	1521	Allflex	Blue	e ^r	Tagged July 8, 1992, on Vostochni.
7/14	Vostochni	1485	Allflex	White	c	Tagged August 2, 1990, on Vostochni.
7/14	Vostochni	1513	Allflex	Blue	c	Tagged July 7, 1992, on Vostochni.
7/14	Vostochni	1221	Allflex	Orange	c	Tagged July 19, 1989, on Vostochni.
7/16	Gorbatch	1457	Allflex	White	c	Tagged July 27, 1990 on Reef.
7/16	Reef	1438	Allflex	White	c	Tagged July 26, 1990 on Kitovi.
7/16	Reef	171-172	Allflex	Green	e ^r	Tagged July 30, 1991 on Zapadni Sands. Too large to count.
7/16	Reef	021-022	Allflex	Green	e ^r	Tagged July 13, 1991 on Lukanin. Too large to count.
7/16	Reef	1198	Allflex	Orange	e ^r	Tagged July 18, 1990 on Morjovi. Too large to count.

Table 3.--Continued.

Date	Location	Tag number	Tag type	Tag color	Entanglement status*	Notes
7/17	Tolstoi	027-028	Allflex	Green	c	Tagged July 15, 1991 on Vostochni. Too large to count.
7/19	Kitovi	1417	Allflex	White	c	Tagged July 6, 1990, on Lukanin.
7/20	Zapadni Sands	1401	Allflex	White	e ^r	Tagged July 1, 1990, on Tolstoi.
7/20	Zapadni	181-182	Allflex	Green	c	Tagged July 31, 1991, on Little Polovina.
7/20	Zapadni	MH2451	Monel		e ^r	Russian tag, weighed 62 lbs.
7/20	Little Zapadni	1190	Allflex	Orange	e ^r	Tagged July 16, 1989, on Zapadni Sands. Very large animal.
7/21	Morjovi	1547	Allflex	Blue	c	Tagged July 14, 1992, on Morjovi.
7/21	Morjovi	PB8433	Monel		e ^r	Russian tag.
7/21	Morjovi	79	Allflex	Blue	e ^r	Tagged July 25, 1988, on Tolstoi.
7/21	Vostochni	1552	Allflex	Blue	c	Tagged July 14, 1992, on Vostochni.
7/21	Vostochni	1519	Allflex	Blue	c	Tagged July 8, 1992, on Vostochni.
7/21	Morjovi	1448	Allflex	White	e ^r	Tagged July 26, 1990 on Zapadni.
7/21	Morjovi	1215	Allflex	Orange	c	Tagged July 18, 1989, on Vostochni.
7/22	Vostochni	MH2659	Monel		e ^r	Russian tag, missing right tag; weighed 67 lbs.
7/22	Vostochni	059-060	Allflex	Green	c	Tagged July 20, 1991, on Vostochni.
7/23	Gorbatch	1456	Allflex	White	c	Tagged on July 27, 1990 on Reef. Too large to count.
7/23	Reef	171-172	Allflex	Green	e ^r	Tagged July 30, 1991, on Zapadni Sands. Too large to count.
7/23	Reef	1505-1506	Allflex	Blue	c	Tagged July 7, 1992 on Vostochni.
7/23	Reef	1449	Allflex	White	c	Tagged on July 26, 1990 on Zapadni. Too large to count.
7/24	Zapadni Reef	1350	Allflex	White	c	Tagged on July 16, 1990 on Vostochni Sands. Too large to count.

Table 3.--Continued.

Date	Location	Tag number	Tag type	Tag color	Entanglement status*	Notes
7/24	Zapadni Reef	0466-0467	Allflex	Orange	c	Tagged Aug. 24, 1986, on Zapadni.
7/24	Tolstoi	1486	Allflex	White	c	Tagged on Aug. 2, 1990 on Vostochni.
7/24	Tolstoi	199-200	Allflex	Green	e ^f	Tagged Aug. 1, 1991, on Zapadni Sands. Too large to count.
7/24	Tolstoi	1385	Allflex	White	e ^f	Tagged on July 22, 1990 on Vostochni.
7/25	Zoltoi Sands	209-210	Allflex	Green	c	Tagged Aug. 3, 1991, on Gorbatch. Too large to count.
7/25	Zoltoi Sands	1570	Allflex	Blue	c	Tagged July 23, 1992 on Gorbatch.
7/26	Lukanin	1476	Allflex	White	e ^f	Tagged July 29, 1990 on Polovina.
7/27	Zapadni	209-210	Allflex	Green	c	Tagged Aug. 3, 1991, on Gorbatch. Too large to count.
7/27	Zapadni	055-056	Allflex	Green	c	Tagged July 19, 1991, on Zapadni Reef. Too large to count.
7/27	Zapadni	1577	Allflex	Blue	c	Tagged July 24, 1992, on Zapadni Reef Sands.
7/28	Morjovi	1352	Allflex	White	c	Tagged on July 17, 1990, on Vostochni.
7/28	Morjovi	1546	Allflex	Blue	e ^f	Tagged July 14, 1992 on Morjovi.
7/29	Vostochni Sands	1214	Allflex	Orange	e ^f	Tagged July 18, 1989, on Vostochni Sands after removing two pieces of debris from two 360 degree wounds. It was then noted as a stunted animal and continued to appear so in 1992 and showed scars from the wounds.
7/30	Tolstoi	031-032	Allflex	Green	e ^f	Tagged July 16, 1991, on Gorbatch. Too large to count.
7/30	Tolstoi	081-082	Allflex	Green	c	Tagged July 21, 1991, on Zapadni Reef Sands. Too large to count.
7/30	Tolstoi	1570	Allflex	Blue	c	Tagged July 23, 1992 on Gorbatch.

Table 3.--Continued.

Date	Location	Tag number	Tag type	Tag color	Entanglement status*	Notes
7/28	Little Zapadni	1586	Allflex	Blue	e ^r	Tagged July 28, 1992 on Little Zapadni.
7/30	Zapadni Reef	137-138	Allflex	Green	c	Tagged July 27, 1991, on Zapadni Reef Sands. Too large to count.
7/30	Zapadni Reef	199-200	Allflex	Green	e ^r	Missing the right tag. Tagged Aug. 2, 1991, on Zapadni Reef Sands. Too large to count.
7/30	Zapadni Reef	MA778	Monel		e ^r	Russian tag. Weighed 54 lbs.
7/31	Gorbatch	1524	Allflex	Blue	c	Tagged July 9, 1992, on Gorbatch.
7/31	Gorbatch	1242	Allflex	Orange	c	Tagged July 23, 1989, at Lukanin.
7/31	Reef	99-100	Allflex	Green	c	Tagged July 23, 1991 on Reef. Too large to count.
7/31	Reef	1232	Allflex	Orange	c	Tagged July 21, 1989, at Reef.
7/31	Reef	1317	Allflex	White	e ^r	Tagged July 11, 1990, on Zapadni Sands. Too large to count.
7/31	Reef	095-096	Allflex	Green	c	Tagged July 22, 1991 on Reef. Too large to count.
7/30	Reef	1572	Allflex	Blue	c	Tagged July 7, 1992, on Reef.
7/31	Reef	22	Allflex	Blue	c	Tagged on July 17, 1988, on Reef.
7/31	Zoltoi Sands	1576	Allflex	Blue	c	Tagged July 24, 1992, on Zapadni Reef Sands.
7/31	Zoltoi Sands	1428	Allflex	White	c	Tagged July 25, 1990, on Tolstoi Sands.
7/31	Zoltoi Sands	1163	Allflex	Orange	c	Tagged July 15, 1989, at Zoltoi Sands.
8/1	Kitovi	0956-0957	Allflex	Orange	c	Tagged Oct. 8, 1986, at Morjovi.
8/1	Kitovi	1549	Allflex	Blue	c	Tagged July 14, 1992 at Morjovi.
8/1	Kitovi	1595	Allflex	Blue	c	Tagged July 7, 1992, one Vostochni.
8/1	Kitovi	1417	Allflex	White	c	Tagged July 6, 1990, on Lukanin.
8/1	Kitovi	1598	Allflex	Blue	c	Tagged July 30, 1992, on Tolstoi.

Table 3.--Continued.

Date	Location	Tag number	Tag type	Tag color	Entanglement status*	Notes
8/2	Morjovi	084-083	Allflex	Green	c	Tagged July 21, 1991, on Zapadni Reef Sands. Too large to count.
8/2	Morjovi	1584	Allflex	Blue	c	Tagged July 28, 1992, on Morjovi.
8/3	Vostochni Sands	084-083	Allflex	Green	c	Tagged July 21, 1991, on Zapadni Reef Sands. Too large to count.
8/3	Vostochni Sands	1221	Allflex	Orange	c	Tagged July 19, 1989, on Vostochni.
8/3	Vostochni Sands	1486	Allflex	White	c	Tagged on Aug. 2, 1990 on Vostochni.
8/3	Vostochni	1443	Allflex	White	c	Tagged on July 26, 1990 on Zapadni Sands.
8/3	Vostochni	1593	Allflex	Blue	c	Tagged July 29, 1992 on Vostochni.
8/4	Zapadni Sands	141	Allflex	Blue	c	Tagged on July 30, 1988, on Zapadni.
8/4	Zapadni Sands	1511	Allflex	Blue	c	Tagged July 7, 1992, on Vostochni.
8/4	Zapadni	1419	Allflex	White	c	Tagged July 7, 1990, on Vostochni Sands.
8/4	Zapadni	1618	Allflex	Blue	c	Tagged Aug. 3, 1992, on Vostochni.
8/4	Zapadni	1619	Allflex	Blue	e ^r	Tagged Aug. 3, 1992, on Vostochni.
8/4	Zapadni	039-040	Allflex	Green	e ^r	Countable size. Tagged July 18, 1991, on Polovina.
8/4	Zapadni	1533	Allflex	Blue	c	Tagged July 10, 1992, on Tolstoi.
8/5	Gorbatch	091-092	Allflex	Green	c	Too large to count. Tagged July 21, 1991, on Zapadni Reef Sands.
8/5	Gorbatch	1521	Allflex	Blue	e ^r	Tagged July 8, 1992, on Vostochni.
8/5	Gorbatch	1507	Allflex	Blue	c	Tagged July 7, 1992, on Vostochni.
8/5	Reef	1182	Allflex	Orange	c	Right tag was the only one read, the left one was sighted. Tagged July 15, 1989, on Reef.
8/5	Reef	157-158	Allflex	Green	e ^r	Too large to count. Tagged July 29, 1991, on Gorbatch.
8/5	Reef	1554	Allflex	Blue	e ^r	Tagged July 17, 1992, on Tolstoi.

Table 3.--Continued.

Date	Location	Tag number	Tag type	Tag color	Entanglement status*	Notes
7/11	Zapadni	1198	Allflex	Orange	e'	Tagged July 18, 1989, on Morjovi. Too large to count.

*c = seals that were controls when tagged, e' = seals from which debris had been removed earlier.

been tagged after being disentangled. Ten were resighted with tags applied in 1989, the first year during which debris was removed. Of these, 7 (70%) had been tagged as controls and 3 had been tagged after being disentangled.

Incidence of Entanglement

We examined 40 entangled juvenile male seals in the 1992 roundups (37 seals were newly tagged, 1 was previously tagged with a monel tag that was left intact, and two were monel-tagged seals from which the tags were removed and replaced with blue Allflex tags). The entangling debris was removed and the nature of the debris was determined. The sizes and kinds of entangling debris, the extent of any wounds, and the tightness of the entangling debris on the animal are presented in Table 4.

Of the 40 entangled seals examined, 19 (47.5%) were in trawl webbing, 9 (22.5%) in plastic packing bands, and 7 (17.5%) in string, small line, cords, or rope. The remaining 5 (12.5%) were entangled in other debris.

The overall incidence of entanglement is estimated by the ratio of all (both initial and subsequent) entanglement sightings to the total number of seals examined (Bengtson et al. 1988, Fowler et al. 1990b). One-half of the harvestable-sized seals resighted in 1992 after having debris removed in 1991 were counted as entangled in 1992. All seals from 1989 and 1990 were too large to be included in the calculations. In all, 51.5 sightings were used to calculate the incidence of entanglement. These observations included 1) seals of harvestable size observed

Table 4.--List of juvenile male northern fur seals tagged as entangled animals during surveys conducted in July and August of 1992, St. Paul Island, Alaska, showing the nature of the debris on each animal. All tags were broad green Allflex unless indicated otherwise. The entangling debris was removed.

Tag number ¹	Date	Location (Rookery name)	Description of debris						Foot-note	
			Type	Wt. (g)	Color	Tight-ness ²	Wound (deg.)	Mesh size (cm)		Twine size (mm)
1501	7/6	Morjovi	trawl	97.3	grey	t	0	19.5	2	
1502	7/7	Vostochni	trawl	41.7	green	vt	0	20	3	
1503	7/7	Vostochni	seine	214.5	orange	vt	360	12	1	
1509	7/7	Vostochni	rope	16	grey	vt	360	22.8	5	
1514	7/7	Vostochni	trawl	1050.2	mixed	vt	0	22	5	3
1515	7/7	Vostochni	trawl	737.8	green	vt	0	22.2	3	
A07073	7/8	Vostochni	monofilament	3.4	-	vt	270	10.5	<1	4
1521	7/8	Vostochni	trawl	218.4	green	vt	180	23	4	5
1522	7/9	Gorbatch	packing band	2	blue	vt	180	24.3	4	
1523	7/9	Gorbatch	packing band	2.7	blue	t	0	21.1	12	
1528	7/9	Zapadni Reef	rope/twine	8.4	grey	vt	90	28.3	2	6
1532	7/10	Tolstoi	trawl	376.2	green	vt	0	21.5	2	
1536	7/11	Zapadni	trawl	194.1	orange	vt	300	18.5	5	7
1538	7/11	Zapadni	seine?	15.4	blue	vt	0	22.2	1	
1542	7/12	Zoltoi Sands	waxed twine	1.6	grey	vt	360	21.3	1	
1543	7/13	Lukanin	trawl	43.9	grey	t	0	19.5	2	
1546	7/14	Morjovi	packing band	0.5	yellow	t	0	20.8	5	
1551	7/14	Vostochni	packing band	2.4	yellow	vt	0	22	15	8
1554	7/17	Tolstoi	packing band	<1	black	t	0	22.4	5	

Table 4.--Continued.

Tag number ¹	Date	Location (Rookery name)	Description of debris					Mesh size (cm)	Twine size (mm)	Foot- note
			Type	Wt. (g)	Color	Tight- ness ²	Wound (deg.)			
1557	7/18	Polovina	trawl	318	blue	t	0	23.5	3.5	
1558	7/18	Polovina	string	<1	white	t	360	24	-	
1563	7/20	Zapadni	twine	2.5	green	vt	180	21	1	9
1565	7/20	Zapadni	trawl	137.4	yellow	vt	0	21	3	
1569	7/23	Gorbatch Reef	trawl	67.8	green	t	0	21	3	
1573	7/23	Reef	cord	3.9	green	vt	360	22.3	4	
1575	7/24	Zapadni Reef	twine	1.3	green	vt	360	23.1	2	10
1578	7/24	Zapadni Reef	packing band	0.7	blue	t	0	23.9	9	22
1579	7/26	Kitovi	trawl	103.9	green	vt	150	23	2	
1582	7/28	Morjovi	trawl	77	green	t	0	21	3	
1586	7/28	Little Zapadni	trawl	13.4	mixed	vt	180	21	7	11
1589	7/29	Vostochni	trawl	18	green	t	0	22.4	3	
1591	7/29	Vostochni	trawl	1.5	grey	t	60	23.4	2	
1592	7/29	Vostochni	rubber ring	5	black	l	15	21.2	4	
1599	7/30	Tolstoi	trawl	76.5	grey	t	240	20.3	2	
1603	7/30	Zapadni Reef	packing band	1.8	yellow	t	0	21.2	14	
1605	7/31	Zoltoi Sands	packing band	1.5	black	l	0	26.1	11	
1610	8/1	Lukanin	trawl	3.5	green	l	0	22.2	1.5	
1611	8/1	Polovina	trawl	59.6	orange	l	0	20.8	4	

Table 4.--Continued.

Tag number ¹	Date	Location (Rookery name)	Description of debris							Foot-note
			Type	Wt. (g)	Color	Tight-ness ²	Wound (deg.)	Mesh size (cm)	Twine size (mm)	
1616	8/1	Polovina	plastic ring	14.8	white	t	360	37	9	
1619	8/3	Vostochni	packing band	3.5	blue	t	0	22.1	13	

¹Tag number for tag placed on both flippers (See Table 2).

²l = loose, m = moderately tight, t = tight, vt = very tight.

³Debris was a combination of white with some blue repair twine.

⁴This monel tagged seal was entangled but not retagged with Allflex tags. Its weight was very light for a 5-year old animal (57 lb = 25.9 kg).

⁵On this seal there was a 6-inch wound behind the left flipper where the debris had worn into the skin and the flipper had become wrapped in mesh.

⁶When captured, this seal was tagged with monel number A22457; the monel tag was replaced with an Allflex tag numbered as indicated.

⁷The twine of this webbing was flat with the maximum width about 5mm and the minimum about 3mm.

⁸This seal appeared to have just recently become entangled.

⁹The wound on this seal had been 360 degrees but was grown over the debris in a few spots, leaving an open wound with a total of only about 180 degrees.

¹⁰The wound on this seal was very deep.

¹¹When captured, this seal was tagged with monel number A22303; the monel tag was replaced with an Allflex tag numbered as indicated.

entangled ($n = 40$), 2) the repeated sightings of animals disentangled in 1992 ($n = 9$), and 3) the seals resighted from 1991 after having had debris removed ($n = 2.5$). This value ($n = 2.5$) was obtained as follows: first, we determined whether the seals tagged in 1991 were of appropriate size. There were 13 observations of 7 individual seals tagged in 1991 after their debris had been removed, including the repeated sightings of these same seals in 1992. Five of these observations were of seals that met the size criteria. Of these 5, we assumed a 50% survival rate if the seals had remained entangled, yielding a total of 2.5.

The incidence of entanglement for 1992 was calculated as 0.29% ($51.5/17,630$), an estimate that is subject to slight upward bias as it assumes that the seals from which debris was removed would not have lost their debris. Thus, the 1992 incidence of entanglement is within the range observed from 1988 to 1991, although higher than last year's value of 0.21% (Table 5; Fig. 1). This reduction is continuing evidence of a decline in the observed incidence of entanglement from the 0.4% observed between 1976 and 1985 (Fig. 1; Fowler et al. 1990b, Table 5). However, with the addition of the incidence observed in 1992, no trend is evident in the period since 1988.

Compared with 1976-86, the lower incidence of entanglement among juvenile male seals is attributable to a reduction in the fraction entangled in trawl webbing. During 1982-86, the mean percent of seals entangled in trawl webbing was 0.27% (Fowler et

Table 5.--The percent of juvenile male northern fur seals from St. Paul Island, Alaska, entangled in marine debris as recorded from 1967 to 1984 during the commercial harvest (data from Kozloff et al. 1986) and from 1985 to 1992 during roundups (data updated from Fowler et al. 1992).

Year	Percent entangled
1967	0.15
1968	0.16
1969	0.20
1970	0.28
1971	0.41
1972	0.43
1973	0.48
1974	0.58
1975	0.71
1976	0.42
1977	0.35
1978	0.46
1979	0.40
1980	0.49
1981	0.43
1982	0.41
1983	0.43
1984	0.39
1985	0.51
1986	0.42
1987	--
1988	0.28
1989	0.29
1990	0.32
1991	0.21
1992	0.29

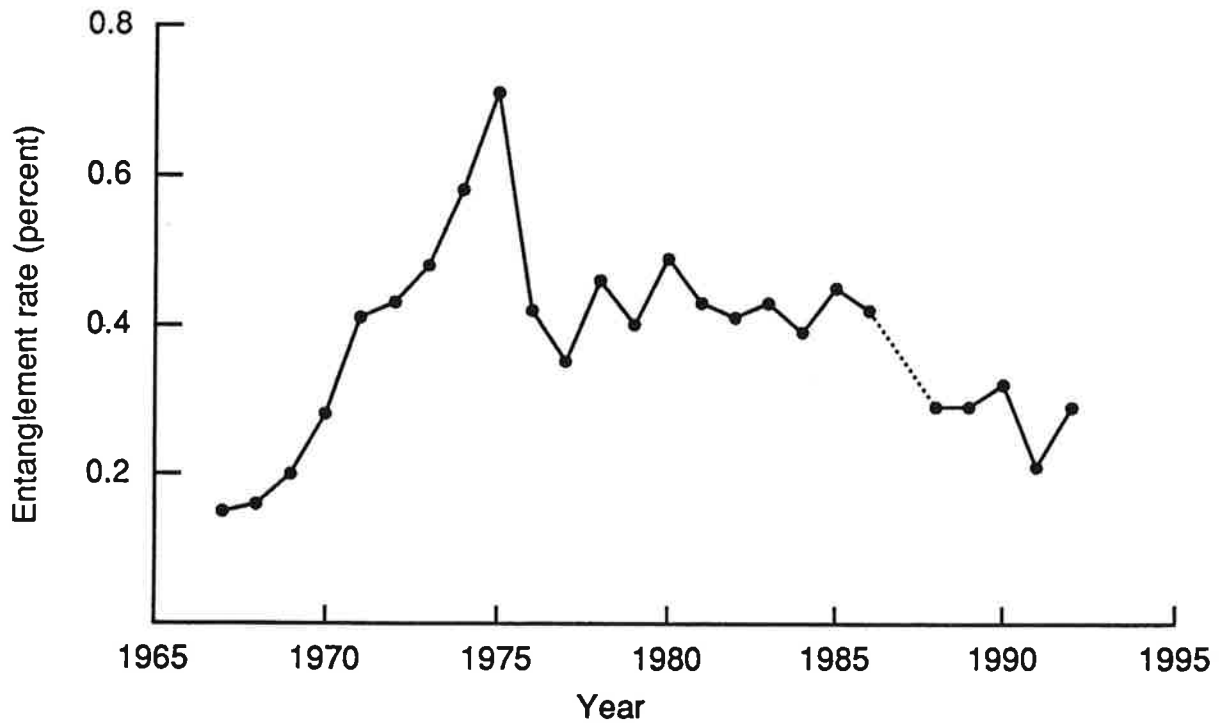


Figure 1. The percentage of juvenile male northern fur seals found entangled in the commercial harvest from 1967 to 1984 and in research roundups from 1985 to 1992 on St. Paul Island, Alaska (updated from Fowler et al. 1992).

al. 1990b). In 1988, the percent entangled in trawl webbing dropped to 0.15%; a reduction of 56% (Fowler et al. 1990b). This proportion remained low in 1989 and 1990, and became even lower in 1991 (0.06%, Table 6). In 1992, however, the rate of entanglement in trawl webbing was higher than in 1991 but remains about 50% of the levels observed for between 1982 and 1986.

Resightings and Survival

A summary of the number of tags applied to juvenile males and the number resighted in each subsequent year is shown in Table 7 for each year since 1985. No roundups were conducted in 1987. A total of 102 seals judged to be of harvestable size were tagged and released in 1991. Of these, 68 were controls and 34 were entangled when captured. In 1992, 17 of these controls (25.0%) were resighted. Seven (20.6%) seals tagged following removal of debris in 1991 ($n = 34$) were resighted in 1992. This implies that the resighting rate for disentangled seals after 1 year was 82.4% of that for the controls ($20.6/25.0 = 0.824$). This is not significantly different from a ratio of 1.0 (Chi-square test, $P > 0.05$). The resighting rate of disentangled seals relative to controls is significantly higher than that of entangled seals from previous years (Chi-square test, $P < 0.05$).

In 1992, 3 of the 279 "control" seals (1.1%) tagged in 1986 were resighted, whereas none of the group of 128 animals tagged as entangled in 1986 were resighted. Of the four seals resighted in 1992 and tagged in 1988, one had been originally tagged as an entangled seal.

Table 6.--Debris found on juvenile male northern fur seals from St. Paul Island, Alaska, 1981-92, expressed as the incidence of entanglement (observed percent) among juvenile males entangled by debris category (data for 1981-91 from Fowler and Ragen 1990, Fowler and Baba 1991, and Fowler et al. 1992).

Year	Trawl net fragments	Packing bands	Cord, rope, and string	Monofilament net fragments	Misc. items	Sample size*
1981	0.29	0.08	0.04	0.00	0.03	102
1982	0.24	0.10	0.04	0.01	0.01	102
1983	0.30	0.07	0.02	0.01	0.03	112
1984	0.22	0.09	0.05	0.02	0.01	87
1985	0.36	0.05	0.08	0.01	0.01	76
1986	0.27	0.06	0.07	0.01	0.01	70
1988	0.15	0.07	0.05	0.00	0.01	53
1989	0.12	0.10	0.06	0.02	0.01	47
1990	0.11	0.11	0.07	0.01	0.03	71
1991	0.06	0.08	0.06	0.01	0.00	38
1992	0.14	0.07	0.05	0.01	0.03	40

*Sample sizes occasionally include debris from seals larger than would be counted for determining the proportion of juvenile males that are entangled.

Table 7.--Comparison of numbers of tags applied (in parentheses) and resighted (percent resighted shown in brackets below the numbers resighted) by year for entangled and nonentangled male northern fur seals from 1985 through 1992 (none tagged in 1987). Each row corresponds to the tags released in the first year for that row*.

	Year						
	1985	1986	1988	1989	1990	1991	1992
	(172)	37 [21.5]	13 [7.6]	8 [4.7]	7 [4.1]	4 [2.3]	0 [0]
		(279)	40 [14.3]	32 [11.5]	25 [9.0]	5 [1.8]	3 [1.1]
			(104)	20 [19.2]	11 [10.6]	11 [10.6]	3 [2.9]
CONTROLS (nonentangled)				(86)	26 [30.2]	14 [16.3]	7 [8.1]
					(114)	39 [34.2]	18 [15.8]
						(68)	17 [25.0]
							(80)
	(85)	12 [14.1]	1 [1.2]	0 [0]	0 [0]	0 [0]	0 [0]
		(128)	6 [4.7]	4 [3.1]	1 [0.8]	0 [0]	0 [0]
			(52)	5 [9.6]	2 [3.8]	1 [1.9]	1 [1.9]
ENTANGLED (Disentangled after 1988)				(43)	11 [25.6]	4 [9.3]	3 [7.0]
					(57)	21 [36.8]	8 [14.0]
						(34)	7 [20.6]
							(40)

*Updated from Fowler et al. (1992).

Ratios of the portion of entangled seals resighted each year to that of controls are shown in Figure 2 (updated from Fowler et al. 1992). An increase in the survival attributable to removing debris is shown in data plotted for seals tagged in 1989 and 1991 (stars in Fig. 2). However, the combined data for 1989-92 indicate that seals freed of their debris may have a lower survival rate than that of controls. The weighted mean annual survival rate of disentangled seals for the data accumulated since 1989 is 0.93 of that for controls.

The approach of Fowler and Baba (1991; a weighted mean, assuming that the probability of resighting is the same for both categories of seals and that survival from entanglement in small debris is the same from year to year) may be used for estimating survival of entangled seals compared to controls. Using only the ratios for the 1992 resight data for seals tagged during 1985-1988 (Fig. 2), the estimated survival of entangled seals is 0.53 that of controls. Using juvenile male seals tagged, without removing debris, in 1986, 1988, and 1989 as resighted in all years through 1992, the estimated annual survival is also 0.53. This is to be compared with the 0.55 from Fowler and Baba (1991).

Thus, the results from 1992, as well as the cumulative data, as presented in Table 7 and Figure 2, continue to show that the probability of survival for an entangled seals in small debris is about half what it would be without the debris (Fowler et al. 1990b).

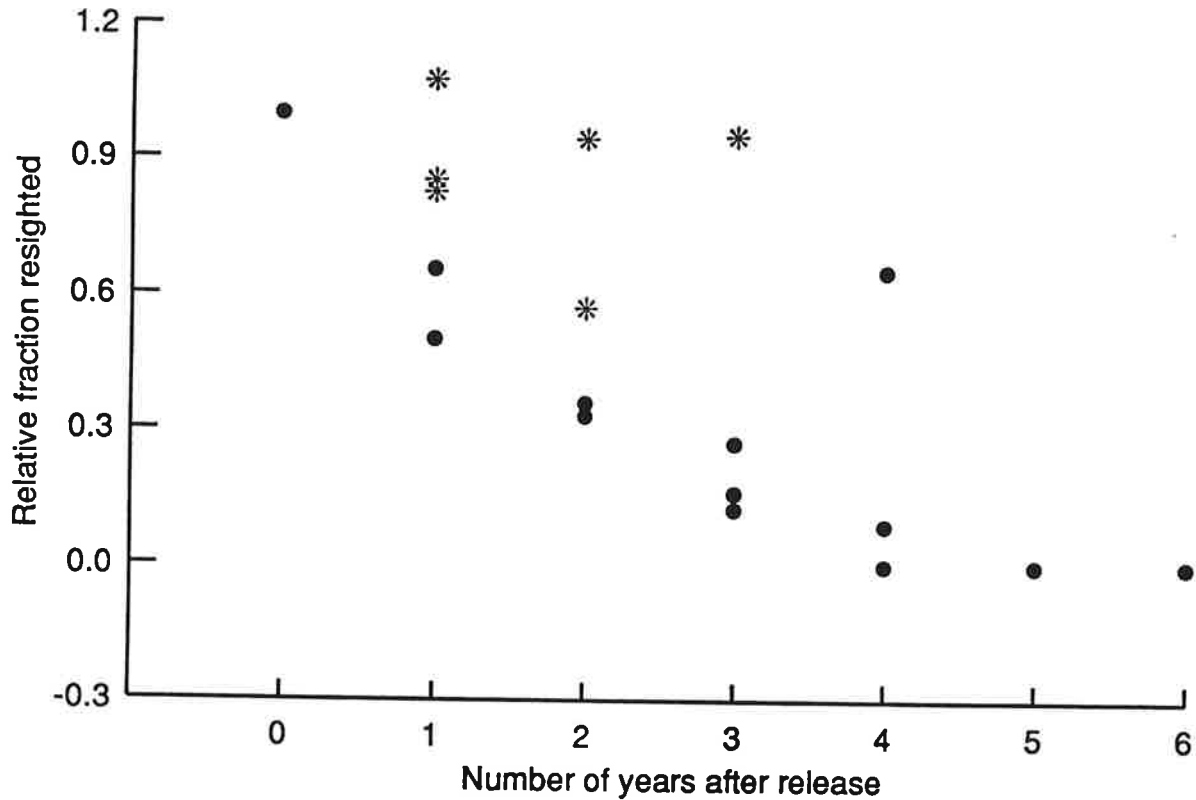


Figure 2. Relative rates of return for entangled juvenile male northern fur seals compared to controls (nonentangled tagged seals) for varying time intervals (Updated from Fowler et al. 1992, with the data from this report). Each data point represents the fraction of entangled seals resighted divided by the fraction of controls resighted (both from Table 7) for the corresponding time interval (for example, there are two data points for 3 years corresponding to the 1985-88 and 1986-89 intervals). The stars correspond to the relative return rate for seals with debris removed.

Characteristics of Entangling Debris

Weights and mesh sizes of debris removed from seals in 1992 are listed in Table 4. The data for trawl net fragments are shown by size category in Table 8 and indicate that debris distributions are very similar to those seen in previous studies. For the combined data since 1983, about 74% of the trawl debris found on seals weighed between 0 and 150 g, about 18% of the debris weighed between 150 and 500 g, and about 8% of the debris weighed over 500 g (Table 8).

Within-Season Resighting Rate

Although the collective data from 1985 to 1992 indicate similar intraseasonal resighting rates, there is a great deal of year-to-year variability (Table 9). Also, there is a higher intraseasonal resighting rate for entangled (or disentangled) seals than for controls in 5 of the 7 years. The resighted fraction for the overall mean has been close to 25% in both groups since 1985 (Fowler et al. 1990b).

Disentanglement of Large Males

During the 1992 roundups, 10 entangled male seals that were too large to be counted as part of the entanglement studies (i.e., larger than the seals taken in the commercial harvest prior to 1985) were captured to remove the debris. Some of these were full adult males. The date and location of debris removal for the large male seals are listed in Table 10.

Table 8.--Annual percentage frequency distribution of the size of measured trawl debris from entangled male northern fur seals that were tagged and released (updated from Fowler and Ragen 1990, and Fowler et al. 1992).

Year	n	<150 g (%)	150-500 g (%)	>500 g (%)
1983	84	53 (63)	19 (23)	12 (14)
1984	57	46 (81)	7 (12)	4 (7)
1985	78	56 (72)	16 (20)	6 (8)
1986	128	92 (72)	27 (21)	9 (7)
1988	53	38 (72)	8 (15)	7 (13)
1989	43	34 (79)	7 (16)	2 (5)
1990	71	59 (83)	10 (14)	2 (3)
1991	11	9 (82)	2 (18)	0 (0)
1992	19	13 (68)	4 (21)	2 (11)
Total	544	400 (74)	100 (18)	44 (8)

Table 9.--Comparison of numbers of tags applied to entangled and control juvenile male northern fur seals in 1985, 1986, and 1988 through 1992 with the numbers in each category resighted the same season. The numbers in parentheses are the percent of the tags applied that were resighted in the same season.

Year	Number of tags			
	Controls		Entangled	
	Applied	Resighted	Applied	Resighted
1985	170	35 (20.6)	76	21 (27.6)
1986	165	54 (32.7)	70	19 (27.1)
1988	104	21 (20.2)	52	15 (28.8)
1989	86	20 (23.5)	43	8 (18.6)
1990	114	56 (49.1)	57	18 (31.6)
1991	68	18 (26.5)	34	6 (17.7)
1992	<u>80</u>	<u>22</u> (27.5)	<u>40</u>	<u>7</u> (17.5)
Total	787	226 (28.7)	372	94 (25.3)

Table 10.--List of male northern fur seals from which entangling debris was removed in 1992 during roundups of juvenile males. Most of these seals were larger than would have been included in entanglement research (i.e., data on debris type and size would not have been recorded); some were adult males or of equivilant size.

Number	Date (July)	Location	Notes
3	17	Zapadni Reef Sands	
1	23	Reef	
2	24	Zapadni Reef Sands	
1	25	Polovina	This seal was about 7 years old with two very deep wounds which bled significantly. The debris was a large piece of green trawl webbing.
3	26	Kitovi	One of these seals was only slightly larger than would have been counted for entanglement studies. Of the other two, one may have been 6-7 years old, the other 8-9 years old.

Although the 1992 estimate of the incidence of entanglement was higher than that for 1991 (the lowest since the late 1960s), the incidence of entanglement estimated for 1992 is consistent with those for 1988 through 1990. The combined set of data continue to indicate that a decline occurred in the incidence of entanglement following 1986. The reduction for this period of time is attributable to less entanglement in trawl webbing, with that for 1991 being the lowest observed since 1982. An explanation for such a change cannot be conclusively established at this time. However, the difference between the incidence of entanglement for 1988-92 and that of previous years may be a result of changes in the rate of loss and discard of net fragments from fishing vessels. Consistent with the data for debris on northern fur seals, the abundance of trawl webbing debris observed on sampled beaches of several Alaskan islands has also declined in recent years (S. Johnson 1990). Various educational programs at the national and international level have been in place for several years, and international regulations prohibit the discard of such debris. Other studies are necessary to determine if less debris is actually entering the marine environment.

SUMMARY

Entanglement research on juvenile males in 1992 demonstrated:

- 1) A continued reduction of the overall incidence of entanglement from about 0.4% (1975-86) to 0.32% or less from 1988 through 1992;
- 2) The rate of entanglement in trawl webbing in 1992 increased over levels observed in 1991 but remain about one-half of entanglement levels observed for this kind of debris in previous years (1981-86) and very similar to that observed during 1988-90;
- 3) Data for relative rates of return of entangled seals for years in which debris was not removed continued to produce an estimated annual survival of entangled seals that is about one-half that of nonentangled seals; and
- 4) There is continuing evidence from the 1992 studies that the rate of return of tagged seals from which debris is removed is significantly higher than for tagged, entangled seals but not as high as for controls.

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