Seal callouts in the Kaikoura region involving the Department of Conservation

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ABSTRACT

Department of Conservation (DOC) staff spend considerable time attending callouts relating to seals, primarily New Zealand fur seals (*Arctocephalus forsteri*), in the Kaikoura region of New Zealand. This study analyses DOC data on 630 seal-related callouts, relating to 801 incidents, between July 1995 and October 2004. The most common DOC response was 'check only' (65.9%), with 'no action' taken in only 3.5% of incidents. Most seal-related incidents occurred on the northern side of the Kaikoura Peninsula (44%), with tourists (34%) the most likely to report an incident. The majority of incidents reported were unexplained deaths of seals (40.9%), followed by entanglements (21.5%). Most incidents (97.5%) involved fur seals. Unexplained death accounted for 84.2% of fur seal mortalities; other causes of death included illness/injury (2.4%), vehicle and train strikes (10.6%), direct human harassment (1.4%), and dog attacks (0.5%). Over 97% of vehicle strikes were fatal. Entanglement accounted for 0.8% of fur seal deaths, with 1.7% of these incidents fatal. DOC responded to 89.5% of entanglement-related incidents, with a 39.5% success rate in releasing entangled fur seals. DOC callout reports provide useful information on the frequency, outcomes and location of different types of seal-related incidents and baseline data against which to monitor trends and allocate resources. More emphasis on understanding the causes of unexplained deaths would be beneficial for population management. Monitoring of mortalities associated with entanglements, illness and road-related incidents is required as human and seal populations continue to increase in the region.

Keywords: New Zealand fur seal, *Arctocephalus forsteri*, Kaikoura coastline, human interactions, mortality, monitoring, New Zealand

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1. Introduction

The New Zealand fur seal (*Arctocephalus forsteri*) population of the Kaikoura region in the South Island of New Zealand has been increasing since its near extermination by the sealing industry in the late 1800s (Wilson 1981). Low numbers (200–500 individuals) of fur seals were observed along the Kaikoura coast in the 1950s–1960s (Sorenson 1964). Since then, numbers have increased from c. 1200 in 1990 to over 3000 in 2005 from the Waiau River in the south to the Clarence River in the north (M. Morrissey, Department of Conservation (DOC), pers. comm. 2005). The largest breeding colony in the region is Ohau Point, where nearly 600 pups were produced in 2005 (Boren, Muller et al. 2006). Southern elephant seals (*Mirounga leonina*) and leopard seals (*Hydrurga leptonyx*) are occasional visitors to the region.

The fur seal populations in Kaikoura lie in close proximity to an expanding human population. Kaikoura's major industries are eco-tourism, which includes seal watching (Boren 2001), and fisheries (Harris 1994). The largest fur seal breeding colony in the region, Ohau Point, is located adjacent to State Highway 1 (SH1)—the major north–south highway for the South Island—and is a popular stop for tourists (Simmons et al. 1998). In recent years, the region's expanding tourism industry in parallel with fur seal re-colonisation has raised concerns about a potential increase in human-influenced seal mortality in the region. Also of concern has been the increased potential for zoonotic transfer of disease between fur seals and humans (Hunter et al. 1998), and between fur seals and terrestrial mammals (e.g. dogs, possums, livestock; Cooke et al. 1999).

Staff in the DOC Kaikoura Field Centre spend a considerable amount of time attending callouts reported by various factions of the community. DOC has been keeping records about seal-related callouts (including callouts for elephant seals and leopard seals) since July 1995. Due to growing concern over the potential for increased human-influenced mortality (e.g. entanglements and vehicle strikes), the records between July 1995 and October 2004 were compiled and analysed in this study to determine trends in incident nature, location, seasonality and outcome.

1.1 OBJECTIVES

The objectives of this study were to:

- Determine trends in the reporting and occurrence of seal and fur seal incidents in the Kaikoura region
- Provide baseline information regarding the level and causes of mortality of fur seals being reported

2. Methods

2.1 STUDY SITES

Data were collected from the Kaikoura coastline (42°15′S, 173°50′E) on the South Island of New Zealand (Fig. 1). Fur seals occur along this coastline from Haumuri Bluff in the south (22 km south-southwest of Kaikoura Peninsula) up to Kekerengu in the north (53 km northeast of Kaikoura Peninsula) and breed at three locations: Ohau Point, Lynch's Reef and Barney's Rock (Fig. 1). The main non-breeding haul-out areas lie either side of Ohau Point, along much of the northern side of the Kaikoura Peninsula, beside SH1 near Barney's Rock, and at Haumuri Bluff (Fig. 1). Elsewhere, fur seals haul-out as individuals and in small groups.

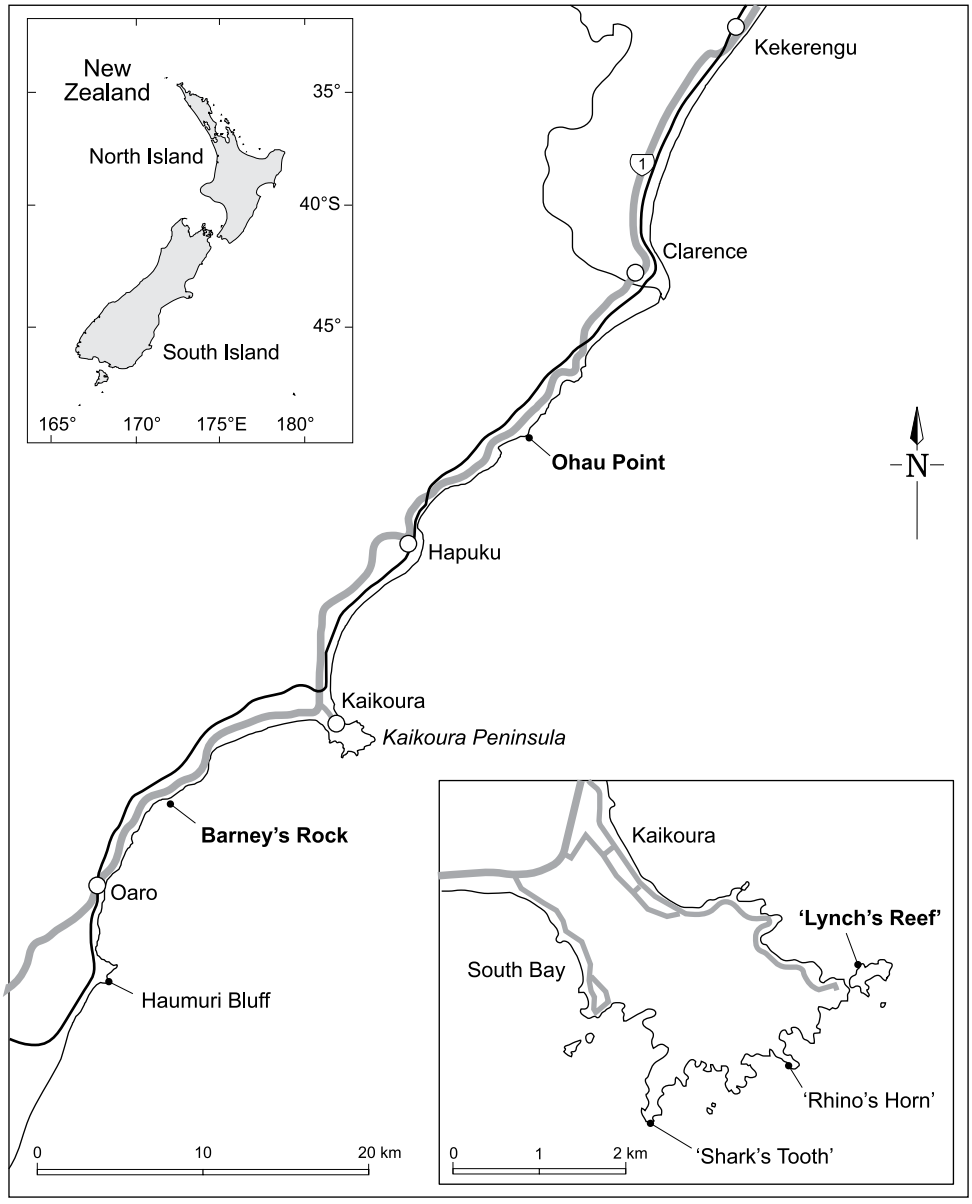

Figure 1. Map of the Kaikoura region coastline showing locations of the three main fur seal (*Arctocephalus forsteri*) breeding colonies (Ohau Point, Lynch's Reef and Barney's Rock). Fur seal haul-outs are mostly between Clarence and Haumuri Bluff.

State Highway 1 and the main trunk railway line run alongside much of the coastline frequented by fur seals (Fig. 1). The main human settlement is Kaikoura township, which is a popular tourist centre (population c. 3500). In the summer holiday period (late December to February), there is a large influx of visitors (873 000 estimated in 1998; Simmons et al. 1998).

2.2 REVIEW OF CALLOUT FORMS

For each seal-related callout since 1995, DOC's Kaikoura Field Centre staff have filled out a form detailing the type of incident and the follow-up action. These reports are logged over the DOC financial year (i.e. 01 July to 30 June) and summary statistics are calculated. Each callout may involve one or more seals, each with their own outcome. Each seal is counted as a separate incident and therefore there may be more than one incident per callout. The incidents reported are classified into 11 incident types, which are necessarily generalised because 75% of incidents are reported by the general public. Where possible, the incidents are then confirmed by DOC staff. The incident types are as follows:

- Unexplained death: a report of a dead seal where the cause of death was not apparent.
- Entanglement: a report of a seal 'entangled' in man-made debris. This could include nets, plastic, fish hooks, etc. and could include 'old' entanglements.
- Illness/injury: a report of a seal appearing sick, injured, not behaving normally, or distressed.
- Vehicle strike: a report of a seal being hit by a car, not necessarily fatal.
- Train strike: a report of a seal being hit by a train, not necessarily fatal.
- Boat strike: a report of a seal being hit by a boat, not necessarily fatal.
- Seal on road: a report of a seal on the road or road verge, but not actually hit by a vehicle.
- Wandering: a report of a seal somewhere other than the shore or roadside, e.g. at Ohau Stream waterfall, in someone's yard, etc.
- Public harassment: a report of a seal–human interaction; seal appears distressed/dead to the reporter.
- Dog attack: a report of a dog attacking a seal; may or may not result in injury or death to the seal.
- Non-fur seal sighting: sightings involving a leopard or elephant seal[1].

There were 15 non-fur seal sightings recorded between 1995 and 2004. Therefore, general trends on frequency, seasonality and location, etc. of callouts are reported for all seal species. However, details on specific callout categories are presented for fur seals only. All data were compiled into a database and classified as originating from one of four geographical areas: North Coast (Kaikoura township to Kekerengu), North Peninsula (Kaikoura township to Shark's Tooth), South Peninsula (Shark's Tooth to South Bay) and South Coast (South Bay to Haumuri Bluff) (Fig. 1). Incidents were also broken down by calendar year,

[1] Five non-fur seal incidents were additionally recorded as specific incident types (illness/injury and seal on road); see section 3.1 and Tables 2 & 4).

with 1995 and 2005 being only partial years (of 6 months and 4 months, respectively).

The responses by DOC staff to callouts were categorised as one of the following:

- No action taken: none needed, or no DOC presence possible.
- Check only: a site visit made; the seal may not have needed further assistance, might no longer have been there, or was dead and the body was removed.
- Mediate: a moderate level of intervention (e.g. DOC putting a sign up, talking to tourists, assigning a fine, or contacting necessary parties).
- Unsuccessful intervention: an attempt to capture and release a seal that was not successful at the time of the attempt (e.g. could not capture seal).
- Successful intervention: seal relocated, or captured and released by DOC staff.

The possible outcomes of incidents typically fell into one of five generalised categories:

- Death: the seal was found dead or needed to be euthanised.
- Poor: the seal was in poor condition; either emaciated or with a life-threatening wound. In some instances, a release from entanglement or treatment with antibiotics was carried out; however, the chance of survival was considered slim.
- Successful intervention: this could include a capture and release from man-made debris, physical relocation of seals away from the road or abnormal locations, or successful treatment by a vet with a high chance of survival.
- Normal: the seal was alright (i.e. callout was a false alarm) or had moved away by itself. In cases of entanglement, this could mean that the seal had freed itself from the debris, or that the reported entanglement was actually an old wound.
- Unknown: the status of the seal was unknown because it could not be found; or in the case of an unsuccessful attempt to release a seal from debris, the individual was not resighted.

3. Results

3.1 ALL SEAL-RELATED INCIDENTS

Between 01 July 1995 and 31 October 2004 there were 630 seal-related callouts in the Kaikoura region. This translated into 801 individual incidents. There was a mean of 92.4 ± 10.1 incidents per complete calendar year (range 63–129 incidents for January 1996 – December 2004; Table 1).

Seal incidents were reported from as far afield as Rarangi Beach (120 km northeast of Kaikoura township) and Amberley Beach (110 km south-southwest of Kaikoura township). Most (95%) occurred within 30 km of Kaikoura township, however. Forty-four percent of all reported incidents were from North Peninsula, 24% each from the North and South Coast areas, and 8% from South Peninsula (Table 2).

The total of 801 incidents involving all seals between July 1995 and October 2004 were reported by a wide range of parties, including tourists or the general public (34%), DOC staff (19%), local residents (15%), people in the tourism/ hospitality industry (15%), people from other organisations (police, Tranzrail, works infrastructure, etc.; 10%), and research and rescue groups (7%).

The majority of responses to incidents by DOC were 'check only' (65.9%), while 'mediate' typically occurred less than 5% of the time (Table 3). Successful interventions accounted for 15.1% of the incidents overall. Most incidents were responded to (710/801); however, over the study period there was an increase in the proportion of incidents in which no action was taken, to reach a maximum

TABLE 1. NUMBER OF SEAL-RELATED CALLOUTS AND INCIDENTS RECORDED IN THE KAIKOURA REGION BY DEPARTMENT OF CONSERVATION (DOC) STAFF PER DOC FINANCIAL YEAR AND NUMBER OF INCIDENTS PER CALENDAR YEAR.

FINANCIAL YEAR (01 JULY – 30 JUNE)			CALENDAR YEAR (01 JAN – 30 DEC)	
YEAR	CALLOUTS	INCIDENTS	YEAR	INCIDENTS
1995–1996	44	47	1995*	12*
1996–1997	111	125	1996	81
1997–1998	80	98	1997	128
1998–1999	58	92	1998	111
1999–2000	58	69	1999	63
2000–2001	68	82	2000	68
2001–2002	64	80	2001	88
2002–2003	57	114	2002	129
2003–2004	66	71	2003	71
2004–2005†	24†	23†	2004‡	50‡
Total	630	801	Total	801

* The calendar year 1995 includes only 6 months (July–December).

† The financial year 2004–2005 includes only 4 months in 2004 (July–October).

‡ The calendar year 2004 includes only 10 months (January–October).

of 28% in 2004. Although 2004 was not a complete year, it did include 10 out of 12 months and thus was still likely to have had the highest rate of 'no action' during the timeframe of the study. There was no obvious overall seasonal trend in the number of incidents reported between January 1996 and December 2000 (Fig. 2A). From January 2001 to December 2004 there was a bimodal pattern, with a small peak in late summer (February) and a larger peak in winter (July–August) through to early spring (October) (Fig. 2B).

Leopard and elephant seals were recorded in callouts along the Kaikoura coast, but in very low numbers. Three elephant seals and 12 leopard seals were reported during the entire study period, i.e. 2.4% of all callouts (15/630) were of non-fur seal species. Of these 15 callouts, 5 were recorded as two incidents (e.g. once as a non-fur seal incident and once as a 'seal on road' incident), meaning

TABLE 2. GEOGRAPHIC LOCATION OF ALL SEAL-RELATED INCIDENTS IN THE KAIKOURA REGION BETWEEN JULY 1995 AND OCTOBER 2004, BROKEN DOWN BY INCIDENT TYPE.

INCIDENT TYPE	LOCATION				TOTAL	%
	NORTH COAST	NORTH PENINSULA	SOUTH COAST	SOUTH PENINSULA		
Unexplained death	49	166	68	45	328	40.9%
Entanglement	67	52	42	11	172	21.5%
Illness/injury	24	92	23	7	146	18.2%
Vehicle strike	26	0	12	0	38	4.7%
Train strike	2	0	2	0	4	0.5%
Boat strike	0	1	0	0	1	0.1%
Seal on road	14	10	36	2	62	7.8%
Wandering	6	6	1	1	14	1.8%
Public harassment	2	11	3	0	16	2.0%
Dog attack	1	2	1	1	5	0.6%
Non-fur seal*	2	9	3	1	15	1.9%
Total	193	349	191	68	801	
%	24.1%	43.6%	23.8%	8.5%		

* Five non-fur seal incidents were additionally recorded as specific incident types: 'illness/injury' ($n = 3$) and 'seal on road' ($n = 2$).

TABLE 3. ANNUAL RESPONSES BY THE DEPARTMENT OF CONSERVATION TO ALL SEAL-RELATED INCIDENTS IN THE KAIKOURA REGION BETWEEN JULY 1995 AND OCTOBER 2004.

RESPONSE	1995*	1996	1997	1998	1999	2000	2001	2002	2003	2004†	TOTAL	%
No action	0	3	10	7	8	8	17	13	11	14	91	11.4%
Check only	7	60	78	87	47	44	54	89	44	18	528	65.9%
Mediate	0	4	4	2	0	3	5	4	6	5	33	4.1%
Unsuccessful intervention	2	3	6	6	1	1	1	5	1	2	28	3.5%
Successful intervention	3	11	30	9	7	12	11	18	9	11	121	15.1%
Total	12	81	128	111	63	68	88	129	71	50	801	
% 'no action'	0.0%	3.7%	7.8%	6.2%	12.7%	11.8%	19.3%	10.1%	15.5%	28.0%		

* 1995 is a partial year only (July–December).

† 2004 is a partial year only (January–October).

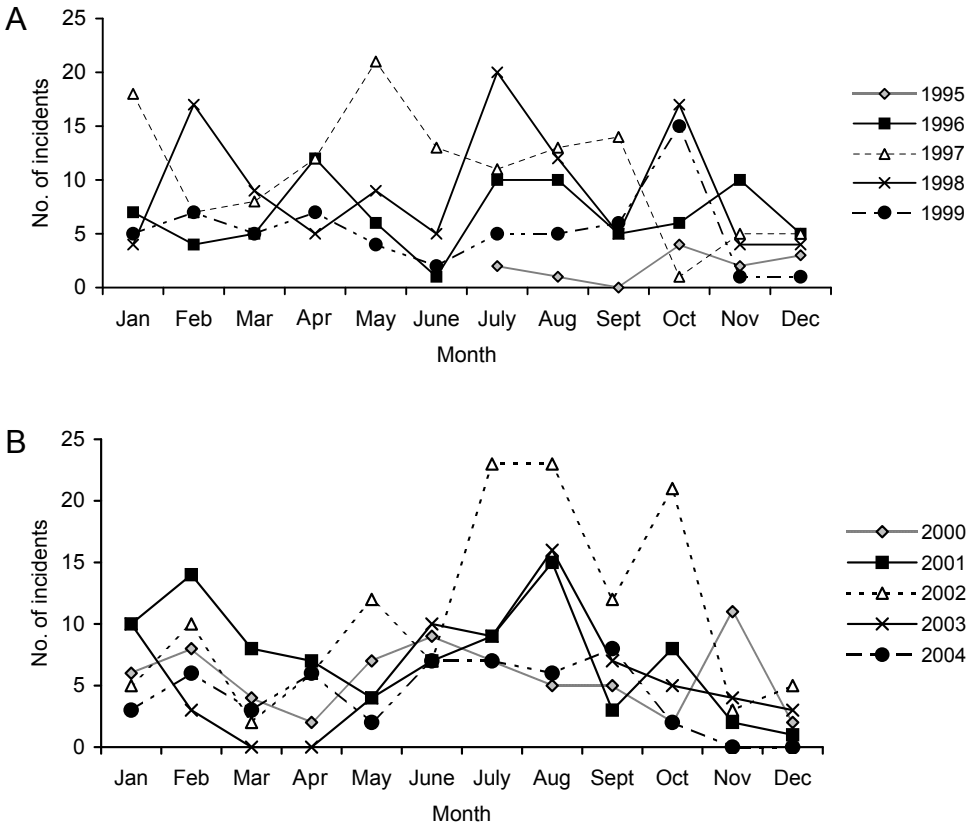

Figure 2. Monthly breakdowns of the number of all seal-related incidents recorded on Department of Conservation callout forms in the Kaikoura region for the calendar years A. 1996–2000, and B. 2001–2004.

that in total 20 of the 801 incidents actually related to non-fur seals, although only 15 were specifically categorised as such. The majority ($n = 8$) of the leopard seal sightings occurred between October and February.

Two road-related incidents involved species other than New Zealand fur seals: one leopard seal and one elephant seal. The elephant seal was a young female that came ashore onto a road in the township to moult and had to be moved onto the beach. The seal was in good condition and after completing its moult left the area. There was also one elephant seal and one leopard seal reported as possibly ill or injured, one of which (in 1999) underwent a successful surgery to have a fish spike removed from its lower jaw.

3.2 INCIDENT TYPE AND SEASONALITY OF FUR SEAL INCIDENTS

The five most common incident types affecting fur seals (unexplained death, entanglement, illness/injury, seal on road and vehicle strike) accounted for 94.9% of all incidents. Unexplained death was the most common incident (42% of all incidents), with peaks in late winter to spring (August to October) and a small peak in summer (February) (Fig. 3A; Table 4). Entanglement was the next most frequent incident (22.0%) and occurred at a relatively constant level, except for a slight peak in July–August followed by a decrease in spring (October). Illness/injury (18.3%) showed a small peak in February and a larger peak from mid-

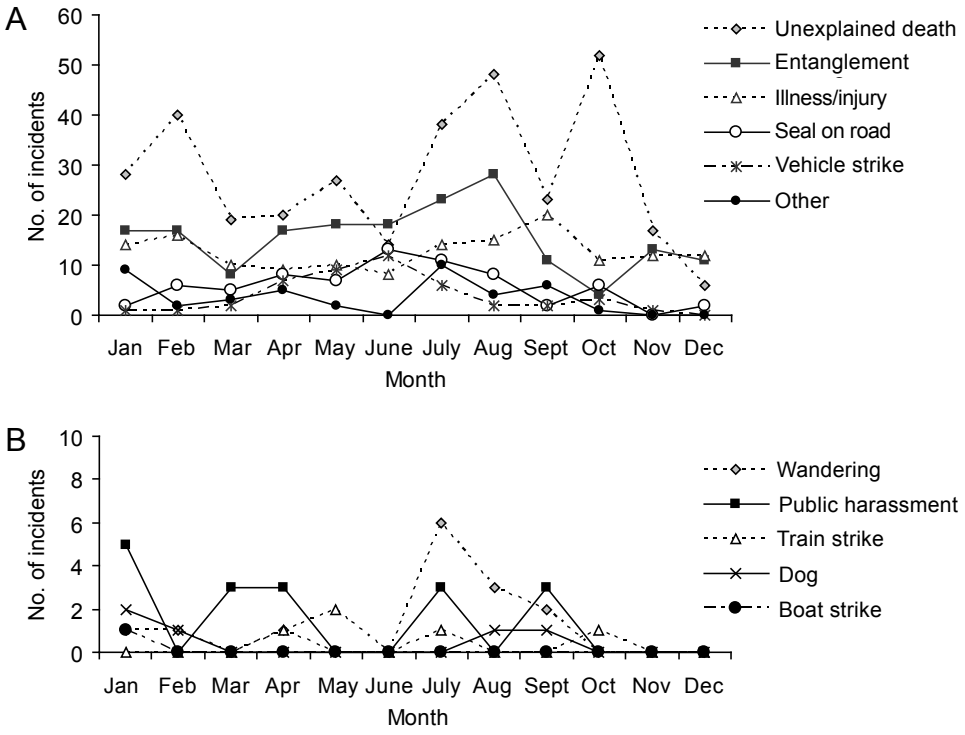

Figure 3. Monthly breakdowns of the total number of A. most commonly reported and B. less frequently reported types of fur seal (*Arctocephalus forsteri*)-related incidents reported on Department of Conservation callout forms in the Kaikoura region between July 1995 and October 2004. (Note different scales on the *y*-axes.)

winter to spring (July–October). Both the number of seals on the road (7.8%) and the number of vehicle strikes (4.9%) were highest in winter, peaking in July. Of the remaining categories, wandering (1.8%) peaked in July (Fig 3B) and public harassment (2.0%) occurred year round, but peaked slightly in January, when tourism was highest. Further details of some of these incident types are given below.

TABLE 4. RANGE OF INCIDENT TYPES FOR ALL FUR SEAL (*Arctocephalus forsteri*)-RELATED INCIDENTS RECORDED ON DEPARTMENT OF CONSERVATION CALLOUT FORMS IN THE KAIKOURA REGION BETWEEN JULY 1995 AND OCTOBER 2004, BROKEN DOWN BY CALENDAR YEAR.

INCIDENT TYPE	1995*	1996	1997	1998	1999	2000	2001	2002	2003	2004†	TOTAL	%
Unexplained death	3	24	43	61	27	21	43	69	25	12	328	42.0%
Entanglement	4	11	30	22	16	19	19	19	19	13	172	22.0%
Illness/injury	5	28	26	15	7	12	10	20	8	12	143	18.3%
Vehicle strike	0	3	0	3	1	6	10	7	7	1	38	4.9%
Train strike	0	1	0	0	0	0	0	3	0	0	4	0.5%
Boat strike	0	0	0	0	0	0	0	1	0	0	1	0.1%
Seal on road	0	7	16	3	9	6	4	6	5	4	60	7.8%
Wandering	0	1	2	2	0	2	1	0	3	3	14	1.8%
Public harassment	0	2	6	1	1	0	0	1	3	2	16	2.0%
Dog attack	0	0	1	0	0	0	1	0	1	2	5	0.6%
Total	12	77	124	107	61	66	88	126	71	49	781	
%	1.5%	9.9%	15.9%	13.7%	7.8%	8.5%	11.3%	16.1%	9.1%	6.2%		

* 1995 is a partial year only (July–December).

† 2004 is a partial year only (January–October).

3.2.1 Entanglements

Entanglements were the second most common incident type. They require a more extensive response by DOC staff than the other incident types. Between July 1995 and October 2004, there were 172 reported fur seal entanglements. DOC staff responded to 89.5% of all incidents pertaining to entangled seals (Table 5). While the response rate was lower in 2000 and 2003, in the remaining years over 87.5% of entanglement-related calls were acted upon. All age classes were affected, although age class and gender were not always recorded. The highest proportion of entanglements (39.0%) were recorded from North Coast, followed by North Peninsula (30.2%) and then from near Barney's Rock on the South Coast (24.4%) (Table 2).

TABLE 5. TOTAL NUMBER OF FUR SEAL (*Arctocephalus forsteri*) ENTANGLEMENT-RELATED INCIDENTS IN THE KAIKOURA REGION BETWEEN JULY 1995 AND OCTOBER 2004, AND THE RESPONSE OF DEPARTMENT OF CONSERVATION STAFF.

YEAR	TOTAL	RESPONSE				% WITH
		'CHECK ONLY'	INTERVENTION*		'NO ACTION'	ACTION TAKEN
			SUCC.	UNSUCC.		
1995†‡	4	1	0	3	0	100%
1996	11	6	2	2	1	90.9%
1997	30	13	4	13	0	100%
1998	22	11	3	7	1	95.5%
1999	16	8	1	5	2	87.5%
2000	19	6	1	8	4	78.9%
2001	19	9	1	7	2	89.5%
2002	19	3	5	10	1	94.7%
2003	19	6	1	6	6	68.4%
2004‡	13	4	1	7	1	92.3%
Total	172	67	19	68	18	89.5%

* 'Successful intervention' (succ.) and 'unsuccessful intervention' (unsucc.).

† 1995 is a partial year only (July–December).

‡ 2004 is a partial year only (January–October).

Table 6 shows the recorded outcomes of entanglement incidents. While 'unknown' was the most common outcome for a fur seal (56.5%), DOC staff successfully intervened and released fur seals in 39.5% of incidents. A few reports of entanglement (2.3%) actually proved to involve a 'normal' animal, i.e. a fur seal with an old wound or that had managed to free itself.

TABLE 6. RECORDED OUTCOMES OF FUR SEAL (*Arctocephalus forsteri*) ENTANGLEMENT INCIDENTS IN THE KAIKOURA REGION BETWEEN JULY 1995 AND OCTOBER 2004.

See section 2.2 for detailed descriptions of outcomes.

OUTCOME	NUMBER	%
Normal	4	2.3%
Poor	0	0.0%
Successful intervention	68	39.5%
Death	3	1.7%
Unknown	97	56.5%
Total	172	

3.2.2 Illness and injury

Eighteen percent of incidents involved ill or injured fur seals ($n = 143$ from July 1995 to October 2004; Table 4). This represented a mean of 17.4 ± 3.1% of the total fur seal incidents reported during complete calendar years (1996–2003). The potential outcome of these incidents ranged from 'normal' (false alarms) to 'death' (Table 7). 'Unknown' and 'normal' were the most common outcomes, accounting for 39.2% and 38.4% of the illness/injury incidents, respectively. One example of 'normal' occurred when a tourist thought a seal was dying, reported it to DOC staff, and covered it in seaweed. When DOC staff arrived to check on the seal, they found it in good health, resting, and buried in seaweed. Several outcomes were unknown because the seal had gone before staff arrived. In a few cases, intervention and release was attempted and successful, including relocating a pup to a nearby colony and on a couple of occasions performing surgery to remove a fish spike from a fur seal's mouth. In some situations, the seal was in poor health and needed to be left alone, and in two cases, the local vet administered worming medication or antibiotics. The majority of incidents involving sick or injured seals were reported from North Peninsula (63%; Table 2).

TABLE 7. RECORDED OUTCOMES OF ILLNESS AND INJURY INCIDENTS FOR FUR SEALS (*Arctocephalus forsteri*) IN THE KAIKOURA REGION BETWEEN JULY 1995 AND OCTOBER 2004.

See section 2.2 for detailed descriptions of outcomes.

OUTCOME	NUMBER	%
Normal	55	38.4%
Successful intervention	6	4.2%
Poor	17	11.9%
Death	9	6.3%
Unknown	56	39.2%
Total	143	

3.2.3 Road-related

Road-related incidents either involved a fur seal being on the road or vehicle strike. Both scenarios increased in frequency over the winter months, when seas would have been rougher (Fig. 2A). Although in many cases seals on roads moved off on their own or were moved on by DOC staff, several were killed by vehicle strikes each year. A total of 60 fur seals were recorded on the roads with non-fatal results ('seal on road' incident type). However, an additional 38 seals were recorded as vehicle strike incidents, with all but one of these being fatal. Therefore, a total of 98 fur seals were on the road at some time, with 37 of these incidents (37.8%) being fatal (Table 8). The proportion of fatal road-related incidents was highest in 2001, when 71% of all road-related incidents were fatal (Table 9).

TABLE 8. OUTCOME OF ROAD-RELATED INCIDENTS FOR FUR SEALS (*Arctocephalus forsteri*) IN THE KAIKOURA REGION BETWEEN JULY 1995 AND OCTOBER 2004.

See section 2.2 for detailed descriptions of outcomes.

OUTCOME	SEALS ON ROAD	VEHICLE STRIKES
Normal	43	0
Successful intervention	2	0
Poor	0	0
Death	0	37
Unknown	15	1
Total	60	38

TABLE 9. PROPORTION OF ALL FUR SEAL (*Arctocephalus forsteri*) ROAD-RELATED INCIDENTS THAT WERE FATAL EACH YEAR.

INCIDENT TYPE	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	TOTAL
Vehicle strike*	0	3	0	3	1	6	10	7	7*	1	38*
Seal on road	0	7	16	3	9	6	4	6	5	4	60
Total	0	10	16	6	10	12	14	13	12	5	98
%*	0%	30%	0%	50%	10%	50%	71%	54%	50%	20%	38%

* One vehicle strike (in 2003) was not fatal; the remaining 37 had fatal outcomes.

3.2.4 Public harassment

A total of 16 public harassment incidents were recorded between July 1995 and October 2004 (Table 4). At least five of these incidents resulted in the death of the fur seal, one of which was euthanised as it had been shot and was found still alive. Two others had also been shot, although the outcome for one of these incidents was unknown. One individual was found being skinned. Another was alive when it was reported that children were throwing rocks at it, but was later found dead, although it was thought unlikely the rocks alone were the cause of death. The fifth fatal incident involved an individual found dead with an eye hanging out, but the history of the incident prior to DOC staff arriving is unknown. The majority of public harassment incidents (10/16) were related to tourists (e.g. approaching too close, surrounding or chasing seals), or jet skiers approaching the breeding colony.

3.2.5 Dog attack

Between July 1995 and October 2004 there were only five incidents involving fur seals being harassed by dogs (Table 4). One case was not investigated, one required a check only, and in the remaining three situations DOC staff separated the animals, spoke to the owners, or mediated the situation in some way. In one of these three cases (non-fatal), the dog's owner was fined. In two of the five incidents, the seal was killed: one of these seals required euthanasia and the other was killed outright by the dog.

3.2.6 Other incidents

One boat strike and four train strikes were recorded from July 1995 to October 2004. The outcomes of the boat strike and two of the train strikes were unknown as the seals were not found. The other two train strikes were confirmed by DOC staff as being fatal.

3.3 MORTALITY DATA FROM CALLOUT FORM ANALYSIS

There was a mean of 39 ± 7 deaths per calendar year between 01 January 1996 and 31 December 2003, based on analysis of fur seal incident reports. A peak of 61 deaths was recorded in the calendar year 1998 and another of 69 deaths in 2002. DOC staff were not always able to confirm death, e.g. find the seal and know that it really was dead. As earlier noted, in some instances seals reported as 'dead' were found to be merely sleeping. When the analysis was restricted to confirmed deaths, the annual mean (for the calendar years January 1996 – December 2004) was 37 ± 7 deaths/year, with peaks of 60 in 1998 and 67 in 2002. The majority of unexplained deaths were reported from North Peninsula (166/328).

Post-mortems are not carried out by DOC staff, and in many cases the carcasses are not fresh enough for post-mortems. This is why the cause of death was not always known ('unexplained deaths'). Similarly, sex and age class were not always reported or available (depending on state of decomposition). For the 56 carcasses where age class was recorded, 72% were adults. For the 28 carcasses where sex was recorded, 77% were males.

Mortalities were also associated with other incident types, where the cause of death is known from the incident type. However, 'unexplained death' was the most common incident type and accounted for the vast majority of fatalities (84.2%; Table 10). Of the remaining causes of mortality, 'vehicle strike' was the highest (10.1% of all deaths), followed by 'illness/injury' (2.4%) and 'public harassment' (1.5%).

TABLE 10. MORTALITY OF FUR SEALS (*Arctocephalus forsteri*) IN THE KAIKOURA REGION BETWEEN JULY 1995 AND OCTOBER 2004, BASED ON INCIDENT TYPE.

INCIDENT TYPE	TOTAL	MORTALITIES IN CATEGORY		% OF TOTAL	
		n	%	MORTALITIES (*n* = 368)	FUR SEAL INCIDENTS (*n* = 781)
Unexplained death	328	310	94.5%	84.2%	39.7%
Entanglement	172	3	1.7%	0.8%	0.4%
Illness/injury	143	9	6.3%	2.4%	1.2%
Vehicle strike	38	37	97.4%	10.1%	4.7%
Train strike	4	2	50.0%	0.5%	0.3%
Public harassment	16	5	31.3%	1.5%	0.6%
Dog attack	5	2	40.0%	0.5%	0.3%
Total	706	368	52.1%	100%	47.1%

4. Discussion

Over the c. 10 years of this study (01 July 1995 – 31 October 2004), DOC staff in the Kaikoura region have spent at least 530 hours[2] dealing with 630 seal-related callouts. Although three species of pinnipeds were involved in callouts, the majority (97.6%) involved fur seals. As outlined in section 1, increasing numbers of fur seals combined with increasing ecotourism and public interest in the region could maintain or even exacerbate the frequency of callouts. This has implications both for DOC's time and financial budgets in the Kaikoura region, and for the health and welfare of the fur seals.

There were no obvious seasonal trends in overall numbers of incidents, except between 2001 and 2004 when a bimodal pattern of a small peak in late summer and a larger one in winter was detected (Fig. 2B). However, when broken down by incident type (Fig. 3), public harassment was found to peak in summer when more tourists were around, while entanglement, wandering seals on the road and vehicle strikes all peaked in winter, when weather was more severe and the most affected cohort (pups) was more mobile. Illness, injury and death were bimodal, having a peak when weather conditions were more severe or around pup weaning time (July–October), and again in February. The latter peak was probably related to a seasonal increase in tourist numbers and public harassment, but see below (section 4.1) for a discussion of possible sources of bias.

Tourists and the general public were responsible for reporting most incidents (34%), probably because they often visited Kaikoura to look for the marine wildlife and so found more incidents. As a result, most reported incidents (44%) were from a restricted area on the north side of the peninsula, which tourists visit more than the other locations. Potential caveats to interpreting reports are discussed below (section 4.1). Most incidents involved no more than DOC staff checking on the situation (66%; Table 3). However, in the case of entanglements, DOC responded to 89% of incidents, since if a net or band is left on a seal it can cause death.

4.1 CAVEATS TO DATA

Visibility of ill, injured or dead seals is a key factor in the accuracy of reported/recorded data. Since the public report the majority of incidents to DOC, there is a bias in reporting towards what is visible to the public. Most tourist activity in Kaikoura is centred around the northern side of the Kaikoura Peninsula (Fig. 1), which is near a non-breeding haul-out of (mostly male) fur seals. As a result, many of the reports of dead seals were for this region and involved, and possibly over-represented, sub-adult or adult males (77% of carcasses).

Sick or injured animals are likely to be overestimated in tourist reports, especially if multiple reports are made for one injured individual. The reporting could

[2] This is a minimum estimate, based on travel time to each incident and allowing 10 min at the final location; where a rescue/release was carried out, more time would be spent at the location.

also be expected to peak in spring and summer at the height of tourist activity (Boren 2001). Seal researchers in the area spend most of their time at Ohau Point colony and less time on the peninsula. Researchers, unlike tourists, will often only report if the situation requires human intervention or is of particular interest (e.g. road-related mortality).

Seals struck by vehicles on roads will be more visible than seals washing up on inaccessible parts of the coast, so there is likely to be a bias towards reporting these types of incidents. However, there are some potential reasons why the number of seals on the road and vehicle strikes will be underestimated. Sightings of seals on the road(side) are becoming more common in the Kaikoura region, and although the risk of fatality is high, such incidents are not always reported (pers. obs. 1999–2006). People may also attempt to move seals themselves, without calling DOC, which may mean that the bodies of some mortally injured animals cannot be located.

North and south of Kaikoura township, much of the coastline is not readily accessible to the main road, and at Ohau Point, public viewing is limited to the northern- and southern-most points of the colony. While researchers have multiple vantage points above the Ohau Point seal colony, the terrain includes very large boulders and several caves, which can obscure carcasses from view, also resulting in an underestimate of the number of dead individuals in the colony.

Overall, mortality is more likely to have been underestimated than overestimated, since areas suitable for seals to haul-out or breed along the Kaikoura coastline extend for > 100 km and, as discussed above, cannot all be surveyed. Information gathered by focusing observations on a few areas and by utilising reports from the public will, inevitably, lead to underestimation of the true mortality for the region. Surveys undertaken by the author in a separate study along the peninsula during two austral summer seasons (2001/02 and 2002/03) resulted in numbers similar to those reported to DOC for the entire calendar year (Boren 2005). This suggests that average mortality is underestimated by DOC records. Despite this, a baseline of information based on consistent reporting over a long time scale can still show when periods of increased mortality occur, such as those observed in 1998 and 2002.

4.2 ENTANGLEMENT INCIDENTS

Reported entanglement rates for a population are typically minimum estimates, as not all entangled animals will be sighted and many may be unable to swim back to shore, instead dying at sea (Henderson 1984). Fur seal entanglement incidents predominantly had unknown outcomes or resulted in successful release of the animal (Table 6). Boren, Morrissey et al. (2006) reported that 42% of entangled seals were successfully released. However, without tagging and follow-up information on seal behaviour, it is difficult to monitor the recovery of animals that have been released, especially in cases of non-breeding individuals that might be in a more transient life stage. The high proportion of entanglements reported from North Peninsula (Table 2) may have been due to the large number of transient seals that move into and out of the area on a regular basis, as well

as the fact that more tourists will have been present in this area and thus will have had more chance of seeing entangled seals here (see section 4.1). At the other area with a high proportion of entanglements, Barney's Rock on the South Coast, successful capture and release from an entanglement was rare. We suggest this was due to the flighty nature of fur seals and because the breeding colony lies on an island that does not have much space above high tide, often making it difficult to access the colony by boat and land before the entangled seal went into the water.

Boren, Morrissey et al. (2006) reported two estimated annual entanglement rates for the Kaikoura region: one based on a population estimate for the region as a whole using aerial survey counts, and one based on mark-recapture estimates of pup numbers carried out at Ohau Point, the largest breeding colony in the region (accounts for over 75% of the fur seals in the region). The mean estimated entanglement rates for the Kaikoura region were 0.60 ± 0.14% for the whole region and 2.84 ± 0.68% for the Ohau Point colony. The maximum entanglement rate calculated was for 1997 at 1.55% (whole region). These estimates for the region are some of the highest reported in the published literature. The highest entanglement rate estimate reported to date was for a population of Californian sea lions (*Zalophus californianus*) near a small fishing village in Los Islotes, Baja California (3.9%–7.9%: Harcourt et al. 1994). Other reported annual population entanglement rates are 0.1%–0.6% for South African fur seals (*A. pusillus*; Shaughnessy 1980); 0.1%–0.4% for Antarctic fur seals (*A. gazella;* Croxall et al. 1990); 0.18%–0.85% for Hawaiian monk seals (*Monachus schauinslandi*; Donohue et al. 2001); 0.4% for sub-adult male northern fur seals (*Callorhinus ursinus*; Fowler 1987); 1.3% for Australian sea lions (*Neophoca cinerea*; Page et al. 2004); and 0.9% for New Zealand fur seals in Australia (Page et al. 2004).

The debris in which seals become entangled is typically representative of fisheries material near the species' foraging grounds (Page et al. 2004). Fur seals in Kaikoura most commonly became entangled in trawl nets and packing tape or plastic strapping (Boren, Morrissey et al. 2006). Sometimes the debris will break, the seal will free itself, or the seal is caught and disentangled (Henderson 1984). However, a reasonable proportion of entanglements cause injury and leave deep wounds (i.e. in 30% of *A. gazella*; Croxall et al. 1990) that may be life threatening (e.g. in 48% of entangled Australian pinnipeds; Page et al. 2004). While 1.7% of entangled seals were known to have died in this study (July 1995 to October 2004) (Table 6), Boren, Morrissey et al. (2006) reported a slightly higher proportion of seals (2.2%) to have died from entanglement over their study period July 1995 to July 2005.

4.3 ROAD-RELATED INCIDENTS

The proximity of a major highway and railroad track to seal colonies and haul-outs along the Kaikoura coast result in a high proportion of fatal vehicle and train strike incidents for fur seals (Tables 8 & 9; section 3.1.3). This aspect of mortality has previously only been reported for northern elephant seals in California (Hatfield & Rathbun 1999). The stretch of road adjacent to the Ohau Point seal colony is particularly dangerous. While crash barriers and fences have

been erected to keep seals off the road, these did not extend the full length of the colony during this study. In one week in May 2005, five seals were confirmed as killed on roads around Kaikoura. Four of these were near Ohau Point, three of which were 6-month-old pups killed on the same night. The same evening, a car lost control and ended up in the south end of Ohau Point seal colony (pers. obs. 2005). The increase in mortality associated with road-related incidents during severe storms in 2002 was probably associated with seals trying to get away from rough seas by sleeping on the road or train tracks (Boren 2005).

Despite efforts in recent years to keep fur seals off the road and to warn drivers of the potential hazard, they still find their way onto the road. Work by Jaeger & Fahrig (2004), modelling the effect of fencing by roads on population status of various animal species, found that if the species in question exhibited low road avoidance and there was a moderate to high chance of road mortality, then fencing significantly aided the persistence of the population. However, the fencing needs to be effective in preventing the animal from getting onto the road in the first place. Although the Ohau Point colony has now had the original metal vehicle crash barrier extended to cover the full length of the colony, this is at a height of 60 cm and does little to prevent fur seals getting onto the road. Increasing numbers of pups are involved in vehicle strikes each year and represent on average 2.4% of the pups born (Boren et al. 2008). These accidents accounted for 28% of pup mortalities from carcasses found between December 2003 and February 2005 (Boren et al. 2008).

4.4 HUMAN-RELATED INCIDENTS

Human-related interactions include public harassment, dog attack and shooting of animals. Harassment as a result of increased tourism encounters has been documented for a variety of marine mammal species (Gales et al. 2003), and investigated in detail for New Zealand fur seals at Kaikoura (Barton et al. 1998; Boren et al. 2002). While only a few incidents may directly result in death, consistent interactions may lead to increased stress among seals, which in turn may lead to reduced fitness, loss of muscle mass, and suppression of the immune system and even of reproductive behaviour (Creel 2001).

Dogs have been associated with at least two seal deaths in Kaikoura in the past decade (see section 3.1.5), and people have been sighted taking dogs off-lead into the Ohau Point seal colony (pers. obs. 2005). While no seals were injured on these occasions, there is a potential risk to young pups when a dog is in the breeding colony. The potential for zoonotic transfer of disease between dogs or other land mammals and seals (Cooke et al. 1999)—as may be occurring in Namibia where jackals and wild dogs often come into contact with Cape fur seals (*A. pusillus*) (Gowtage-Sequeira et al. 2004)—means that there should be continued monitoring of diseases and interactions between the species at Kaikoura.

Shooting of several pinniped species has been reported in North America (Carretta et al. 2001). Although reports of shooting have been quite low for Kaikoura (three incidents in 10 years; section 3.1.4), increasing fur seal populations around the country are raising concerns with fishermen, because of perceived conflict between seals and fisheries.

4.5 INCIDENT AND MORTALITY PATTERNS

The total number of seal-related incidents varied between years, peaking in the calendar years 1997 and 2002, with high levels in 1998 as well (Table 1, Fig. 2). These periods coincided with El Niño events and severe weather (Boren 2005; NIWA 2005). Unexplained deaths were the most common incident overall (40.9%), with a mean of 39 dead seals/year reported for January 1996 to December 2003, and with two major increases in reported deaths in 1998 and 2002 (Table 4, Fig. 2), both of which again corresponded with a strong negative Southern Oscillation Index (SOI), indicative of an El Niño event (Boren 2005; NIWA 2005).

These data suggest that some peaks in incidents, specifically mortality, might be partially predictable. For a variety of pinniped species worldwide, reduced pup production and growth, and increased mortality have been repeatedly linked to the reduced food availability brought about during an El Niño event (Ono et al. 1987; Trillmich et al. 1991). Reduced pup production and increased mortality was also observed at 20 other colonies around New Zealand in 1998 (Bradshaw et al. 2000) and for New Zealand fur seal pups at Kangaroo Island, South Australia, in 2002 (T. Haase, La Trobe University, pers. comm. January 2005). Reduced pup condition and growth was observed at Ohau Point, Te Oka Bay and Horseshoe Bay fur seal colonies during El Niño events in 2002, and again in 2004–2005 (Boren, Muller et al. 2006). During these years, mass mortalities were also reported in New Zealand sea lions, *Phocarctos hookeri* (Wilkinson et al. 2006).

4.6 MORTALITY AND POTENTIAL FOR DISEASE TRANSFER

While the effect of an El Niño event may partially explain the increase in the numbers of dead seals found in the Kaikoura region during 1998 and 2002, it is a concern that the majority of these deaths remain unexplained. Although Boren (2005) found no evidence that diseases were prevalent among seals in the Kaikoura region during a study from 2001 to 2005, zoonotic transfer of disease between humans and fur seals, fur seals and dogs, and fur seals and livestock remains a possible risk (see section 4.4).

It is also possible that disease can be introduced into an otherwise healthy wild seal population through proximity with humans. Although such transfer has not been confirmed, it was hypothesised as a possible cause of the *Klebsiella pneumoniae* outbreak in New Zealand sea lion pups in the 2001–02 and 2002–03 breeding seasons, because the same strain of *K. pneumoniae* found in the pup clonal epidemic was also found in an adult sea lion on the Otago Peninsula in 2004 (Castinel et al. 2007). As tourism grows in the Kaikoura region in parallel with an increasing fur seal population, it might be advisable to begin to monitor the mortality of fur seals more closely. It would be beneficial to be able to better determine causes of death as well as trends in the sex and age classes affected.

5. Conclusions

Analyses of DOC callout reports in Kaikoura between June 1995 and October 2004 have provided useful information on the frequency and location of different types of fur seal callouts, the outcomes of responses to certain incident types, and some of the causes of fur seal mortality in the region. While public reports may be biased towards over- or under-reporting the frequency of some incident types, they still provide valuable baseline data to understand and monitor trends in incident type and frequency.

The relatively high frequencies of, and mortalities associated with, incidents involving humans, such as entanglements and road-related incidents, indicate the need for continued analysis and monitoring of fur seal callout and mortality data. This is particularly important as both the fur seal and human populations in the region continue to grow. The high proportion of incidents where cause of death is unknown suggests that improved understanding of the causes of fur seal mortality in the region would be beneficial when managing human and fur seal interactions.

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