BULLETIN NO. 93

The Status of the Harbour Seal in British Columbia, with Particular Reference to the Skeena River

BY

H. D. FISHER

Pacific Biological Station

PUBLISHED BY THE FISHERIES RESEARCH BOARD OF CANADA UNDER THE CONTROL OF THE HON. THE MINISTER OF FISHERIES

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ABSTRACT

HARBOUR SEALS are generally distributed in salt water and in the larger rivers and coastal lakes of British Columbia. About 450 individuals lived near the mouth of Skeena River during the summers of 1945 and 1946, and others occurred upriver for at least 200 miles. Mating occurs in September and October, and pups are born in late May or June. Pups weigh about 23 lb. and double their weight in 5 or 6 weeks. Adults examined weighed 128–300 lb., the latter figure being exceptional. Parasites found in or on seals in British Columbia include two ascarid worms, one acanthocephalan worm, a mite which lives in the nose, and a louse in the fur.

Food found in harbour seals taken from salt water consisted principally of fish of little value, and octopuses. In estuaries of the larger rivers, salmon are frequently taken, and damage done to nets is considerable. The present bounty on seals is not very effective or efficient because it does not sufficiently encourage hunting in areas where serious damage is being done, and many rewards are paid for seals taken where damage is negligible. Much better results might be obtained, at no greater cost, by employing a few professional hunters to operate where damage is greatest, notably in estuaries and up the larger rivers.

INTRODUCTION

THE HARBOUR SEAL, *Phoca vitulina*, ranges in the Western Hemisphere from southern California, and perhaps farther south, to the Bering Sea and south to China. The Pacific harbour seal, *Phoca vitulina richardii*, is a common sight in the coastal waters and large estuaries from Oregon north to the Pribilof Islands and the Bering Sea.

The habit of this mammal in plundering the gill-nets of salmon fishermen has resulted in considerable persecution by fisheries interests, and the complaints of fishermen concerning its activities on gill-netting grounds are widely known.

Like many predatory animals, the harbour seal has aroused the inevitable conflict of interest between naturalists and those who are directly affected by its predatory activities. To the great majority of fishermen, the harbour seal serves no useful purpose, but robs them of a living in a wanton and destructive manner. To biologists who have studied this mammal, it is a chance predator, with no predilection for a specific food item other than what is most readily available, and whose activities render control necessary in certain localized areas. It is, moreover, an interesting part of the fauna of northern coasts, an intriguing mammal whose biology and adaptations, both physiological and anatomical, to its aquatic habitats render it worthy of careful study.

Statements have been published that "hair seals work havoc on the fishing grounds", that they are a menace to the fishing industry, destroying vast quantities of salmon, each seal eating or destroying "4000 salmon and cod annually", and mortally wounding as many as it actually eats (anon., 1941). Such statements come under the public eye far more often than do the results of scientific investigation, which do not deny predation by seals upon commercial fish and depredations upon the gill-net fishery, but point out that methods of dealing with the situation have been ineffective and based on erroneous concepts.

T. H. Scheffer long ago deplored the attitude toward seals adopted by commercial fishing interests, in the face of what he termed "the prodigal wastefulness of the fishing industry". He noted the lack of investigation concerning the harbour seal (1928a), and presented the results of an analysis of 35 seal stomachs from the coast of Washington State (1928b). Scheffer and Sperry (1931), continuing the investigation into food habits, give results of an analysis of 100 additional stomachs from the same area, and representative of all seasons over several years.

The major published study located by the writer on the biology of the Pacific harbour seal is that of Scheffer and Slipp (1944), and concerns harbour seals in Washington State. Imler and Sarber (1947) present the results of an intensive study of harbour seals in Alaska. Considerable taxonomic, historical and biological data for the entire order Pinnipedia are given in Allen's monograph (1880). An extensive taxonomic treatise of the family Phocidae was published by the same writer (1902). The most recent taxonomic work on the genus *Phoca* is that of Doutt (1942) and of Anderson (1942).

No comprehensive study of any kind has been made in the past of harbour seals in British Columbia. The present study was undertaken by the writer during the summers of 1945 and 1946 as part of the Skeena River Salmon Investigation of the Fisheries Research Board of Canada. The work was confined in 1945 to a preliminary survey of the Skeena fishing area during the period June 12 to July 15. The study was continued in 1946 from the middle of May to the end of August.

It was not expected that the results of the study would be exhaustive. The main objects were to obtain figures on the amount of damage being done to the gill-net fishermen by seal depredation at the mouth of the Skeena, to gain some idea of the food habits of the seals and the position of salmon in the food relationship, and to study the life-history of seals in the area, their distribution, numbers and movements.

During the preliminary survey in 1945, hauling-out sites of the seals were located and trips were made with individual fishermen to the fishing grounds, where the activities of seals were noted.

The assignment to the project in 1946 of a small gill-net boat with an engineer helped greatly in keeping a close check on the activity of seals and on the damage which they caused. Early in May, mimeographed forms were distributed to fishermen on which they could record, for each set made, the number of fish caught, the number of these which were seal-bitten, the percentage of body destroyed and the actual monetary loss suffered. Examination of the tally sheets of packers was considered, but this method of determining damage was dropped owing to the fact that many fishermen did not sell damaged fish. Co-operation from fishermen in filling out and returning the forms proved on the whole to be poor.

Collecting of adult specimens was done with a 30'06 rifle equipped with telescopic sights, using soft-nose bullets, and of pups with a 12-gauge shotgun using BB shot. To get a large number of stomachs was impossible in the time available. Many seals were shot and killed but most of them sank immediately in deep water. There were no bounty hunters in the district to whom appeals for co-operation could be made, and fishermen rarely manage to recover the seals which they shoot. Twenty-eight specimens were recovered from the Skeena River, of which four were adults, four were yearlings and 20 were pups. Each specimen was measured and weighed and the stomach contents were noted. Eleven stomach samples were obtained from Fisheries Officers and Haida Indians on the east coast of the Queen Charlottes. Eleven stomachs which were obtained from fishermen of the Fraser River are considered for comparison with those from the Skeena.

During the fall and winter of 1946-47 an analysis was made of bounty claims in British Columbia turned in to the Dominion Department of Fisheries since 1942. An attempt has been made to evaluate the effect of the bounty system for control of harbour seals in the light of present knowledge concerning this mammal. Feasible alternative methods of control have been considered.

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The writer is particularly indebted to Dr. R. E. Foerster, then Director of the Pacific Biological Station, and to Dr. A. L. Pritchard, then in charge of the Skeena River Salmon Investigation, without whose help and encouragement this study would not have been possible.

CLASSIFICATION

The Pacific harbour seal is classified as follows:

Class	Mammalia
Order	Pinnipedia
Family	Phocidae
Genus	*Phoca*
Species	*vitulina*
Subspecies	*richardii* (Gray)

The order Pinnipedia contains three families, the Otariidae or eared seals, the Odoboenidae or walruses, and the Phocidae or true seals.

The Otariidae include the fur seals (*Callorhinus, Arctocephalus*), and the sea-lions (*Zalophus, Eumetopias, Otaria*). These, together with the walruses (*Odobaenus*), possess the ability to turn the hind limb forward for use in terrestrial locomotion, one of the characteristics which distinguishes them from the members of the family Phocidae, whose hind legs are incapable of being turned forward and are thus useless for terrestrial locomotion. The family Phocidae is sometimes referred to as comprising the "earless" seals, because of the smaller prominence of the external ear pinna than in the fur seals and sea-lions.

Members of the family Phocidae are broadly referred to as the Hair Seals. Five genera occur in Canada:

(1) *Erignathus*, containing one species (*E. barbatus*), the bearded seal or square-flipper of the Arctic.

(2) *Halichoerus*, containing one species (*H. grypus*), the gray seal or horse-head of the Atlantic.

(3) *Cystophora*, containing one species (*C. cristata*), the hooded, bladder-nose, or crested seal of the Arctic.

(4) *Mirounga*, containing one species (*M. angustirostris*), the northern elephant seal of the Pacific Coast.

(5) *Phoca*, containing four species:

(*a*) *P. fasciata*, the ribbon seal of the Bering Sea.

(*b*) *P. groenlandica*, the Greenland, harp, or saddleback seal of the North Atlantic.

(*c*) *P. hispida*, the ringed seals of the Eastern and Western Arctic, including three subspecies.

(*d*) *P. vitulina*, the harbour seals of the Atlantic and Pacific, including six subspecies.

Three subspecies of *Phoca vitulina* occur in Canada. *P. v. concolor*, the Atlantic harbour seal, ranges from the Carolina coast north to Hudson Bay, Baffin Bay and Southern Greenland. *P. v. mellonae*, the Ungava freshwater seal, is restricted to Upper and Lower Seal Lakes in Ungava Peninsula, east of Hudson Bay. *P. v. richardii*, the Pacific harbour seal, extends from Oregon north to the Pribilof Islands and Bering Sea, intergrading at the northern limit of its range with *P. v. largha* of the Asiatic area of the North Pacific, and at the southern limit of its range with *P. v. geronomensis* of lower California.

The taxonomic history of the family Phocidae is highly complex and contains an extensive synonymy, which is discussed in detail by Allen (1880). The original description of the Pacific harbour seal was made by Gray (1864) from two British Columbia specimens. The systematic history of this subspecies is dealt with fully by Scheffer and Slipp (1944). Doutt (1942) was the first to use the combination *Phoca vitulina richardii* for the Pacific harbour seal.

DESCRIPTION

Size and Body Proportions

The adult harbour seals obtained weighed between 128 and 300 pounds and measured from five to six feet in length. Data for length and weight of adults from British Columbia are available from only five specimens; these were measured and weighed by the author (Table I).

The males here average 41 per cent heavier than the females, but this difference is biased by the presence of the 300-pound male, a very old specimen judging from the extent of suture closure in the skull and extreme wear of the teeth, and heavier than males in any published record the writer has been

able to find. No females of a similar age were obtained. Scheffer and Slipp (1944) record a male from the coast of Washington weighing 256 pounds and measuring 1700 mm. The same authors give the geometric mean weights of 20 of their largest males and 20 of their largest females at 160 and 129 pounds respectively, indicating that the adult males appear to be about 24 per cent heavier than the adult females.

Table I. Lengths and weights of adult harbour seals taken in British Columbia

Males				Females			
Date	Place	Weight	Length	Date	Place	Weight	Length
		lb.	*mm.*			*lb.*	*mm.*
Aug. 14/46	Gibson Is.	128	1355	Aug. 8/46	Skeena R.	140	1550
Aug. 3/46	Skeena R.	200	1446	Jul. 12/46	Skeena R.	155	1440
Sept. 25/45	Fraser R.	300	1690				
Average		209	1479			148	1485

Table II gives detailed measurements for 14 males and 15 females of various ages from British Columbia, the features chosen for measurement being based on those used by Scheffer and Slipp (1944). The means of the measurements of the first-summer pups reveal very little difference in proportion and weight between the two sexes at this age.

Pelage

The extreme variability of the colour pattern of the pelage of the harbour seal was well described long ago by Allen (1880), who wrote that the variations are "almost endless, varying from almost uniform yellowish brown to almost uniform dark brown and even nearly black, with, between these extremes, almost every possible variation, from dark spotted on a light ground to light spotting on a dark ground. The markings vary in size from very small spots to large irregular patches and streaks" (Figure 1).

The British Columbia specimens obtained during this study showed variability from one extreme to the other (Figures 1, 2, 3, 10, 13). In many skins the lightest areas of the underparts in fresh specimens showed almost pure creamy white. In general the ventral surface is much paler than the dorsal, although two specimens were obtained from the Skeena in which the pelage was almost black all over (Figure 3).

In addition to the colours mentioned above, which are based on dry skins, a most attractive slate-bluish tint was usually noted on the back, in fresh wet specimens. This colour is apparent to the naked eye from some distance and is especially noticeable in river water, particularly on a sunny day, the slate blue

TABLE II. Detailed measurements of 14 male and 15 female harbour seals from British Columbia. Lengths are in millimetres, measured in a straight line. Weights are in pounds.

Field Number	Place	Date	Weight	Standard length—tip nose to tip tail	Length of tail	Length of foreflipper	Length of hindflipper	Expanded width of foreflipper	Expanded width of hindflipper	Circumference behind fore-flipper	Tip of nose to insertion of foreflipper	Centre of navel to tip of tail	Centre of anus to tip of tail
First-summer males													
103	Ecstall R.	VI. 8.46	21	805	70	160	190	115	240	430	245	270	85
105	Skeena R.	VI. 15.46	25	915	70	170	195	125	245	495	290	280	90
106	Skeena R.	VI. 20.46	15	865	65	195	195	123	240	390	285	270	80
110	Skeena R.	VI. 20.46	25	878	65	165	190	120	235	490	290	280	85
113	Skeena R.	VII. 5.46	39	833	65	165	195	120	240	656	285	255	75
114	Skeena R.	VII. 6.46	50	960	65	165	195	125	260	665	325	285	85
116	Skeena R.	VII. 17.46	47	896	60	170	198	125	266	695	290	265	80
117	Skeena R.	VII. 17.46	68	985	55	185	210	130	275	825	320	295	80
124	Gibson Is.	VIII. 14.46	30	943	67	178	207	118	265	633	305	291	85
Average			36	898	65	173	197	122	252	587	293	277	83
Second-summer males													
123	Gibson Is.	VIII. 13.46	70	1112	70	185	206	115	278	785	406	327	84
128	Skeena R.	IX. 6.46	90	1206	95	178	222	127	311	730	362	368	104
Average			80	1159	83	187	214	121	295	758	384	348	94
Adult males													
102	Fraser R.	IX. 26.45	300	1690	103	233	265	180	410	1160	650	540	115
120	Skeena R.	VIII. 3.46	200	1446	96	270	280	170	380	1070	480	470	120
126	Gibson Is.	VIII. 14.46	128	1355	87	215	255	140	328	900	395	422	105
Average			209	1497	95	239	267	163	373	1043	508	477	113
First-summer females													
104	Ecstall R.	VI. 9.46	28	805	70	160	195	115	250	500	245	280	85
107	Skeena R.	VI. 20.46	26	892	65	175	195	122	260	495	280	277	85
108	Skeena R.	VI. 20.46	32	870	55	167	185	125	250	595	280	280	80
109	Skeena R.	VI. 20.46	27	850	55	170	180	115	250	570	280	250	65
112	Skeena R.	VI. 23.46	26	840	60	170	195	120	250	520	280	265	80
100	Skeena R.	VII. 2.45	53	925	70	165	195	120	220	690	255	290	100
101	Ecstall R.	VII. 14.45	50	970	65	175	195	110	260	650	305	315	90
115	Skeena R.	VII. 16.46	46	864	50	166	198	125	254	705	290	260	80
118	Ecstall R.	VII. 19.46	55	980	65	166	205	117	248	785	250	307	85
125	Gibson Is.	VIII. 14.46	42	938	58	177	204	115	245	710	317	272	82
127	Gibson Is.	VIII. 14.46	52	966	58	180	206	122	270	613	316	300	90
Average			40	900	61	170	196	119	251	621	282	282	84
Second-summer females													
121	Ecstall R.	VIII. 5.46	52	1010	65	185	210	135	295	705	350	335	95
111	Skeena R.	VI. 21.46	100	1010	75	185	210	120	270	780	360	335	95
Average			76	1010	70	185	210	128	283	743	355	335	95
Adult females													
122	Skeena R.	VIII. 8.46	140	1530	96	230	280	166	370	935	520	495	120
119	Skeena R.	VII. 25.46	155	1440	100	220	270	145	255	1160	450	475	103
Average			148	1485	98	225	275	156	313	1048	485	485	112

Field Number	Centre of navel to centre of anus	Centre of naval to tip of lower jaw	Distance between mammae	From line between mammae to centre of navel	Centre of eye to centre of ear	Penis opening to centre of navel	Penis opening to centre of anus	Thickness of blubber on belly	Longest nasal vibrissa	Longest supranasal vibrissa	Longest brow vibrissa	Length of ovaries	Width of ovaries	Thickness of ovaries	Length of testes	Thickness of testes	Width of testes
First-summer males																	
103	200	515	x	x	40	—	—	28	76	20	50	x	x	x	24	—	10
105	215	595	x	x	40	115	110	28	—	—	—	x	x	x	27	7	15
106	200	580	x	x	39	98	105	7	88	18	50	x	x	x	29	9	11
110	200	585	x	x	45	110	100	30	90	18	60	x	x	x	—	—	—
113	200	575	x	x	40	112	95	36	77	18	43	x	x	x	25	—	—
114	220	670	x	x	42	125	100	42	100	20	43	x	x	x	22	—	—
116	215	618	x	x	42	137	95	42	85	17	50	x	x	x	25	11	10
117	255	650	x	x	40	155	100	46	100	15	50	x	x	x	25	11	10
124	238	646	x	x	40	130	111	28	105	17	42	x	x	x	28	11	—
Average	216	604	x	x	41	123	102	32	90	18	48	x	x	x	26	10	11
Second-summer males																	
123	256	776	x	x	50	145	122	35	83	13	47	x	x	x	28	14	—
128	279	813	x	x	54	146	139	41	70	13	40	x	x	x	25	13	—
Average	268	795	x	x	52	146	131	38	77	13	44	x	x	x	27	14	—
Adult males																	
102	450	1190	x	x	60	—	—	27	—	—	—	x	x	x	75	36	—
120	390	935	x	x	60	200	200	25	100	15	65	x	x	x	68	34	29
126	352	875	x	x	50	204	170	35	105	10	40	x	x	x	58	31	24
Average	397	1000	x	x	57	202	185	29	103	13	53	x	x	x	67	34	18
First-summer females																	
104	200	525	55	38	40	x	x	35	92	18	51	27	15	10	x	x	x
107	198	570	43	25	40	x	x	25	90	13	50	—	—	—	x	x	x
108	205	600	65	28	42	x	x	30	85	15	47	—	—	—	x	x	x
109	190	590	58	27	39	x	x	34	90	15	50	—	—	—	x	x	x
112	195	558	55	40	40	x	x	33	76	15	40	—	—	—	x	x	x
100	240	590	70	38	44	x	x	44	93	23	52	24	17	11	x	x	x
101	260	665	65	40	38	x	x	44	95	17	53	22	17	11	x	x	x
115	200	600	70	45	40	x	x	39	90	16	41	20	10	13	x	x	x
118	250	665	60	54	40	x	x	50	99	12	50	20	9	10	x	x	x
125	222	652	62	35	45	x	x	35	104	14	55	21	10	12	x	x	x
127	241	671	55	50	45	x	x	30	97	15	58	20	9	11	x	x	x
Average	218	608	60	38	41	x	x	36	92	16	50	14	12	11	x	x	x
Second-summer females																	
121	255	745	65	40	45	x	x	35	80	9	25	23	9	13	x	x	x
111	265	735	72	43	55	x	x	40	100	—	45	25	13	6	x	x	x
Average	260	740	69	41	50	x	x	38	90	9	35	24	11	10	x	x	x
Adult females																	
122	400	975	78	80	62	x	x	29	91	13	36	30	11	18	x	x	x
119	400	953	98	80	60	x	x	38	90	—	55	—	—	—	x	x	x
Average	400	964	88	80	61	x	x	34	91	13	46	30	11	18	x	x	x

contrasting most effectively with the muddy clayish colour of the water. This tint is lost when the pelage dries.

It was noted while observing harbour seals hauling out in the Skeena area during summer months, that the majority of individuals upon emerging from the water appeared quite dark, many almost black. When the pelage became

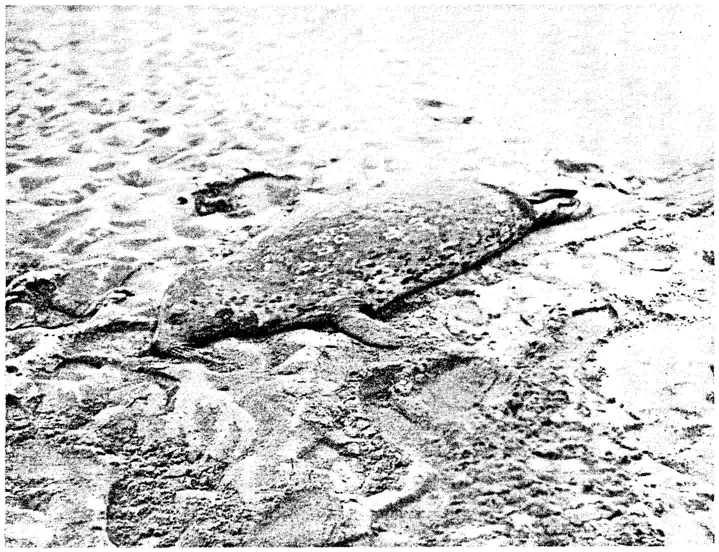


FIGURE 1. Yearling female taken in the Skeena River, June 20, 1946 (No. 111). Weight 100 lbs., length 1010 mm. Pelage pattern of this specimen is that most typical of harbour seals seen on the B.C. coast.

dry, however, the appearance of such individuals was different, ranging from light brown through yellowish tan to a silvery tan, accentuated by sunlight. The difference in appearance between the wet and the dry pelage is the result of the curling upwards and forwards of the non-pigmented tips of the drying overhairs, which allows the light to reflect from their flat shiny surfaces; this curling tends to mask the dark underlying colour, which is apparent when the pelage is wet and flattened out (Doutt, 1942).

The pelage of harbour seals consists of a fairly thick coat of coarse overhairs, with a sparse substratum of shorter, finer underhairs. The overhairs are shaped somewhat like blades of grass, being flat in cross section and tapering to a fine point. In the light-coloured areas of the pelage the overhairs are transparent and appear to be devoid of pigment. In the dark regions they are light or dark brown with the exception of the tips, which are unpigmented over the entire pelage. The underhairs, much fewer in number, are distinguished by their shorter length and finer texture.

The tanned hides of three specimens of first-summer pups taken in the Skeena River possess a thick coat of overhairs averaging 11 mm. in length and

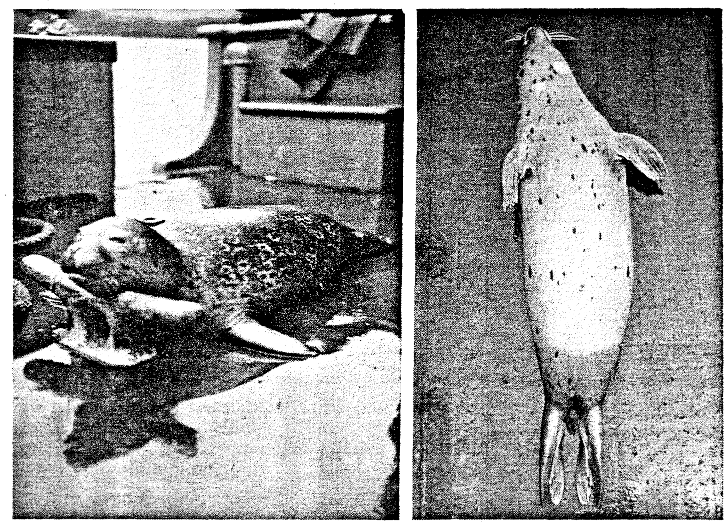


FIGURE 2. Two views of female pup five to six weeks old, taken in the Ecstall River, July 14, 1945 (No. 101). Weight 50 lbs., length 970 mm. Note dorsal location of nostrils, small but noticeable ear pinna.

a stratum of underhairs thicker than that of adult specimens and half the length of the overhairs. One of these specimens was taken a few minutes after birth. It possessed at that time a uniform yellowish coat of thin silky hairs which was being rapidly shed, revealing the normal pelage underneath (see Figure 12). The hairs of this foetal coat were about 23 mm. in length. The lengths of the overhairs, underhairs, and foetal hairs agree closely with those given by Scheffer and Slipp in their descriptions of the pelage of pups of Washington harbour seals.

The tanned hides of first-summer pups are soft, durable and attractive. In pelts of adult specimens the overhairs are much coarser to the touch than in those of pups, and are shorter. In old individuals the pelage is frequently worn down to the skin in the region of the armpits.

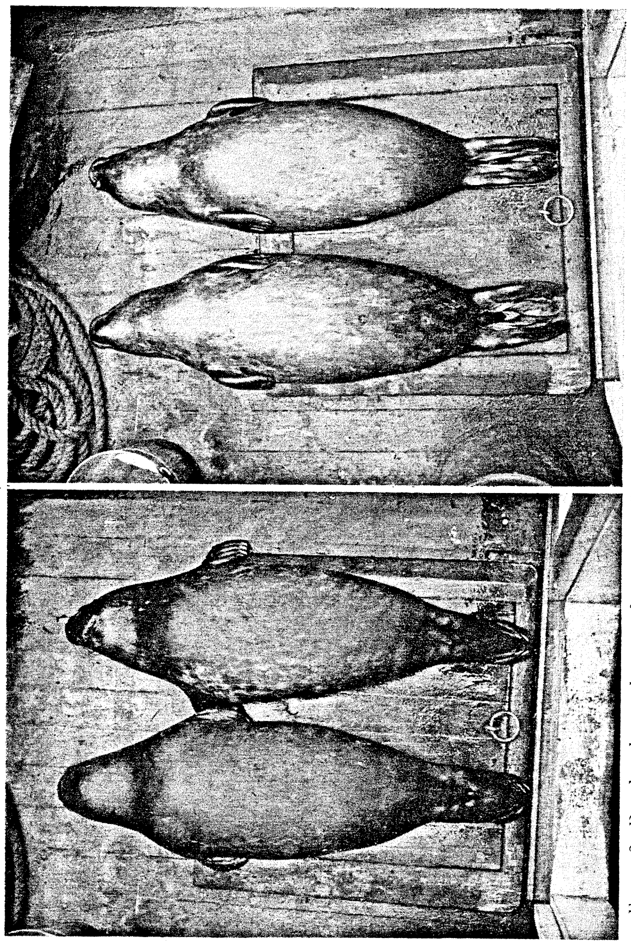


FIGURE 3. Dorsal and ventral views of two unusually dark pups about six weeks old, taken in the Skeena River, July 16-17, 1946. *Left*—male, weight 47 lbs., length 896 mm. (No. 116). *Right*—female, weight 46 lbs., length 864 mm. (No. 115). Note penis opening in male, the only means of determining sex from external characteristics.

An early stage of moulting was observed in one adult female specimen taken in the Skeena River on August 8, 1946. The outer pelage could be easily removed with thumb and forefinger, leaving 1.5 mm. of new hair underneath, pure silvery in appearance. This would suggest that moulting begins early in August. Scheffer and Slipp (1944) mention the moulting of a harbour seal kept in an aquarium. The moult began to show on the hind parts at the end of August and was nearly completed by September 25. The same authors state that various stages of moulting were observed in a herd of seals on the coast of Washington on October 7, 1942.

DISTRIBUTION AND HABITAT

Occurrence in British Columbia

Harbour seals are widely distributed along the coast of British Columbia, occurring around most of the coastal islands and in practically all of the enclosed marine waters, including those of the Queen Charlotte Islands and of Vancouver Island. They are seldom seen more than 10 miles from land, being typically littoral in their salt water distribution. They are numerous at the estuaries of large rivers and from spring to fall are distributed for some distance up these rivers.

Observations on the Skeena River and the examination of bounty claims reveal that the distribution of harbour seals in the rivers and lakes of British Columbia which drain into the sea is perhaps more extensive than is generally realized.

It has long been known that hair seals habitually enter fresh water. According to Allen (1880) the Atlantic harbour seal has ascended the St. Lawrence River to the Great Lakes and has been taken in Lakes Ontario and Champlain. Soper (1944) records statements of Eskimos that the Atlantic harbour seal occurs in Tessikjuak and Ungmaluktuk Lakes which are connected by Moukjunil River with a common drainage by Kommanik River to Foxe Basin. They were also recorded from Aukbauya River, south of Bowman Bay. Doutt (1942) describes a fresh water race of harbour seal which is landlocked in Upper and Lower Seal Lakes, in the Ungava Peninsula. On the Pacific Coast, according to Allen (1880), harbour seals have been reported from the Columbia River near the Dalles "above the Cascades and about 200 miles from the sea". Brown (1868) states that the Dog River, a tributary of the Columbia, takes its name from a dog-like animal, probably a seal, being seen in the lake whence the stream rises. Walker (1915) reporting on harbour seals in south-eastern Alaska, states that they are common in the Stikine River far above the boundary line between the United States and Canada, and that they at times "ascend the streams and rivers in greater or lesser numbers, sometimes becoming quite abundant far up the larger streams and also occasionally entering freshwater lakes near tidewater". Imler and Sarber (1947) record the presence of harbour seals in Copper River, Alaska, five to ten miles above its mouth, and at the mouth of the Stikine River. Bonham (1942) reports the occurrence of two seals in Lake Union, Seattle, Washington. Scheffer and Slipp (1944) state that harbour seals do not, to their knowledge, habitually enter any of the Washington lakes but mention their occurrence in Harrison Lake, B.C., and in its tributary. The latter record is the only published information found on the occurrence of seals in fresh water in British Columbia.

During the present study, fresh water records of harbour seals in British Columbia were accumulated from 20 rivers and six lakes. Many of the rivers are quite small and most of the lakes are near tidewater. Many more freshwater occurrences would undoubtedly be revealed by further investigation. The most important rivers from the standpoint of numbers of records of occurrence are the Naas, the Skeena, and the Fraser.

The exact upriver distribution in the Naas River is unknown but probably extends for several miles above Aiyansh.

In the Skeena River there are no obstacles to upriver distribution for many miles, and harbour seals are distributed in the summer and fall along the entire length of the river up to and possibly above Hazelton, about 200 miles from salt water, occurring also in Lakelse Lake. Groups of appreciable size haul out in the area around the mouth of the river, in upriver areas within tidewater influence, and in other areas up to Terrace and above the influence of tidewater.

Seals are numerous in the sloughs and channels of the Fraser River delta and occur in Harrison Lake the year round and in its tributary, Silver Creek. Bounty records have been filed from Hatzic Lake, which is above tidewater influence, and from Pitt Lake. It is probable that when salmon are running in the spring, summer and autumn, harbour seals range upriver as far as the first major rapids near Alexandria.

Bounty kills have been made in other lakes and in many other smaller rivers. Records of such kills, listed from south to north, are available from the following rivers: Serpentine, Nikomekl, Indian, Capilano, Little Qualicum, Cypre, Squamish, Adams, Salmon, Keogh, Kitlope, Kitimat, Khutzemateen, Oona, Mamin, Yakoun and Tlell; and from Kennedy, Nitinat and Nimpkish Lakes.

Three distinct types of habitat are involved in the distribution of harbour seals as outlined above, the purely marine habitat, tidal sand bars at estuaries, and fresh water, each with a different environment.

The purely marine habitat embraces the saltwater reefs, rocky islands, spits, bays and inlets mentioned above. Hauling-out sites consist of low reefs or ledges where there is ready access to deep water. They may consist of sand spits such as Rose Spit on the northern tip of Graham Island.

The estuaries of rivers such as the Skeena and the Fraser, where the water is a mixture of salt and fresh, are characterized by the presence of numerous mud flats and sand bars which become exposed at low tide. On those bars

which slope quickly into water deep enough to provide good escape facilities, harbour seals will haul out, sometimes in groups of several hundred. The daily movements of seals in this type of habitat are governed to a great extent by the tide.

The fresh-water habitat may be further subdivided into three types, namely: upriver areas still within tidewater influence, upriver areas above tidewater influence, and lakes.

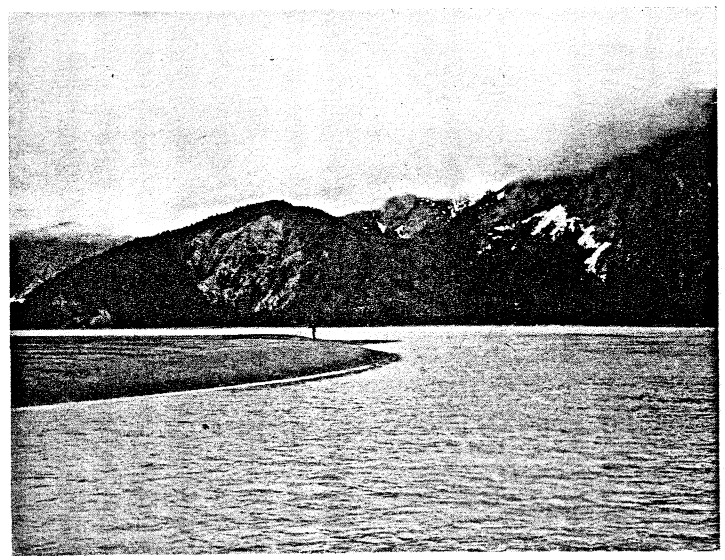


FIGURE 4. Hauling-out bar in the Ecstall River at low tide. This bar, situated about 14 miles from the mouth of the river, is under 10 to 15 feet of water at high tide.

In upriver areas within tidewater influence, the water is practically entirely fresh, the flood tide merely backing up water from the mouth of the river. The hauling-out sites consist usually of sand bars in the middle of the river, either isolated or extending from small islands. They are covered at high tide and bared on the ebb. No hauling-out sites were found which can be utilized during flood tide periods in this portion of the freshwater habitat. Seals therefore can only haul out on selected bars on the ebb tide to rest and digest their food, or, during the birth season, to bear their young.

Only sand bars sloping quickly on one side into deep waters are utilized (Figure 4). Many other bars are present in the same areas in both the Skeena and the Ecstall, but the slope at the edges is too gradual to allow immediate escape facilities. On those which are used, seals will bed down in the sand making characteristic depressions (Figure 5).

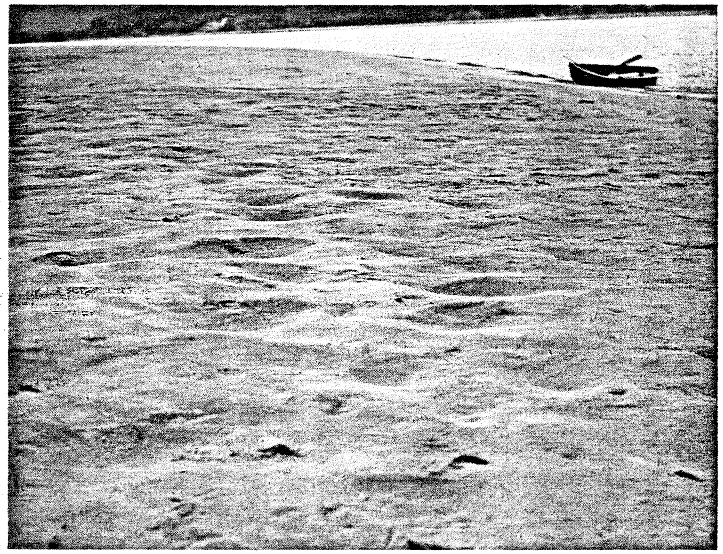


FIGURE 5. Main hauling-out bar in the Skeena River at low tide, showing "beds" made by harbour seals when hauled out. When the water level goes below the water mark visible in front of the boat, the seals leave the bar and go upstream to deeper water.

In the Ecstall, there is no road or trail on either side of the river, the banks being steep and mountainous. The only source of danger from man therefore is by boat, and the bar commands an excellent view of the river for at least a mile on either side, its strategic position rendering it impossible to approach a hauled-out group to within effective gunshot range. Both of the hauling-out bars in the Skeena River are out of effective gunshot range from either shore.

Hauling-out sites above tidewater consist of exposed rocks, sand or gravel bars, or in isolated spots may be on the actual banks of the river. An area considered typical for this type of habitat is located at the mouth of the Lakelse River, which empties into the Skeena about 12 miles below Terrace. The banks of one island directly opposite the mouth of the Lakelse are of coarse rounded

gravel and slope down into deep swift-running water affording an ideal hauling-out site for the seals. Here, as in marine areas, seals can feed and haul out whenever they feel the urge and are not confined by tidal movement to definite periods for hauling out.

Practically nothing is known of the habits of harbour seals in lakes. A man who had logged at Nimpkish Lake, Vancouver Island, informed the writer that seals haul out on the log booms in the lake, chiefly at night. J. C. Williams of Pitt Lake, B.C. (personal communication) states that seals are common in Pitt Lake, being numerous during the salmon run in the fall. A few are present during the winter. The seals frequent the rocky cliffs and the islands.

ENVIRONMENTAL RELATIONSHIPS

The differences in the environmental conditions of the habitat types described illustrate the adaptibility of the harbour seal to a variety of surroundings.

Contrast for example the conditions under which seals live in the marine, the estuary and the upriver habitats. In the purely marine habitat there is no access to fresh water. It has been demonstrated by Irving *et al.* (1935) that the seal kidney has no unique ability to excrete salt, the urine containing an insignificant amount of chloride, as well as the faeces. Seals apparently cannot drink salt water, but sufficient water for urine formation and excretion is gained from the food. The necessary conservation of water is accomplished by a delicately adjusted water balance which has been demonstrated by Irving *et al.* (1935) and Hiatt and Hiatt (1942).

In fresh water areas, however, the necessity for a water balance for conservation of water from food would appear to be obviated. While the concentration of salt in estuarial waters may at times be too great to allow seals to drink it, it is possible that they drink freshwater in areas farther upriver, though they were never actually observed to do so by the writer. Irving *et al.* (1935) state that a group of harbour seals shipped overland in an express car greedily drank fresh water after the journey.

A seal in fresh water therefore would be able to go without food for a much longer time than one in a marine habitat where it is dependent upon food for its water. This could explain why seals appear in upriver areas at dates in the early spring when there is apparently little or no available food supply.

It was established during the study that suckling of first-summer pups extended into August in upriver areas within tidewater influence. At that time there was no evidence of milk in the stomachs taken from pups in the marine habitat of the Gibson Islands; and from the stomach contents and presence of ascarid parasites in these pups and of one from the Queen Charlottes taken in July, it was inferred that they had been weaned for some time. The possible fact that suckling occurs over a greater period of time in upriver areas may well be correlated with the availability of fresh water. Lactation must demand a considerable supply of water, and in marine areas would be a definite strain on the water-balance mechanism of the mother seal who depends upon her food for fresh water.

In marine areas hauling-out sites are usually available at any stage of the tide, which would therefore have a minimum effect on the movements of harbour seals. Since they can, under such conditions, haul out at any stage of the tide, they can feed whenever they feel the urge, though little or nothing is known of the comparative activity of hair seals at night and during the day in marine areas.

In the region of tidal mud flats and bars typical of an estuary, however, the tide assumes a greater role in controlling the daily movements of seals. Areas upon which to haul out and rest are available only at low tide. In the estuary of the Skeena River a certain number of seals are active at low tide periods, but the majority, if left undisturbed, haul out at low tide regardless of whether this occurs during the day or at night, and remain there until the bar is covered by the flood tide.

In upriver areas within tidewater influence, daily movements are governed entirely by tidal conditions. If seals were undisturbed while under observation in upriver areas, none were ever noted to be active at low tide except a number playing in the water in front of the bars. It is not implied that the animals are compelled to haul out by low-tide periods, but since harbour seals do not habitually sleep afloat in the water after the manner of fur seals, they must come onto land or shallow water in order to do so, and the only times when suitable areas are available upon which to haul out are during low tides when the sand bars are uncovered.

In upriver areas above tidewater influence, seals can, as in most marine areas, haul out at any time of the day or night.

Harbour seals are probably exposed to greater natural hazards in the marine habitat than in any other. Heavy storms may take a toll. Wilke (1943) describes a serious injury to a young harbour seal on the Pribilof Islands, apparently the result of being dashed against boulders during a gale. Killer whales (*Grampus*) occur in the marine habitat and almost certainly constitute the most important natural predator of seals. Hamilton (1939) cites an instance where the stomach of one killer whale contained 24 seals, while another had eaten 13 porpoises and 14 seals. Scheffer and Slipp (1944) cite an experience of the lightkeeper at Port Simpson, British Columbia, who, with another witness, watched a harbour seal chased from the water by a group of killer whales. C. J. Guiguet (personal communication) watched a group of killer whales at the very head of Dean Channel in July, 1939, cause a number of harbour seals to come right up to the edge of the shore, despite the presence there of human onlookers. Other instances of predation on seals by killer whales are numerous.

Large sharks, according to Scheffer and Slipp, are also known to devour seals.

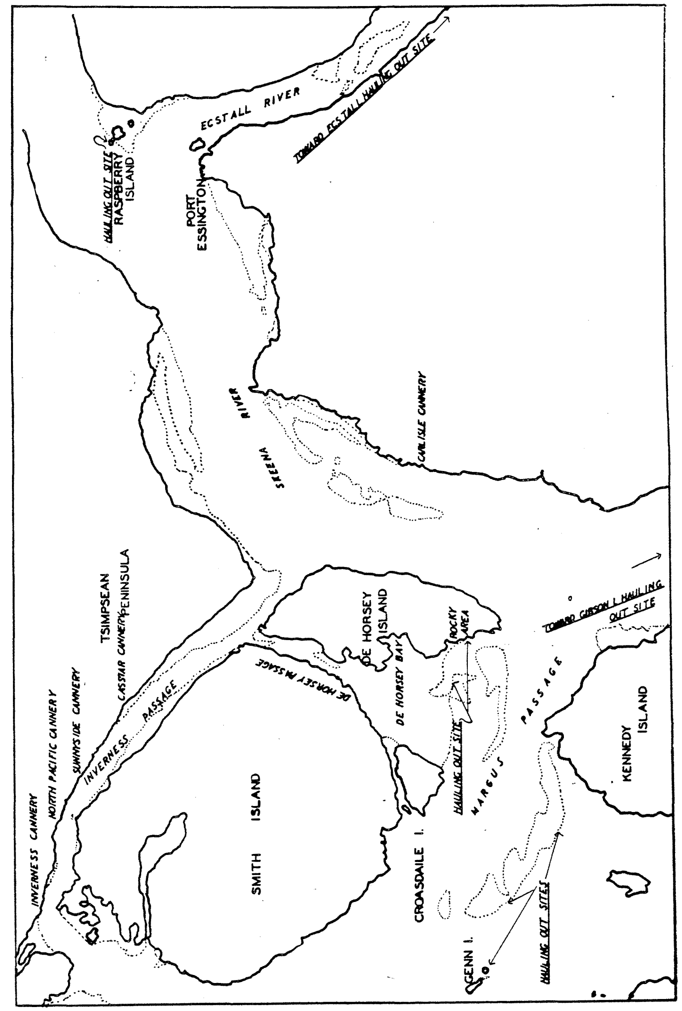


FIGURE 6. Mouth of the Skeena River, showing hauling-out sites of the harbour seal.

In estuarial and upriver areas such natural hazards are greatly reduced.

The close relationship with man in estuaries and other gill-net fishery areas places an economic importance upon harbour seals, since they become active in raiding the fishermen's nets. In upriver areas where the salmon are running to their spawning grounds the predation by seals upon salmon may present in certain localities a sizeable problem in general predation on salmon. The economic status of the harbour seal is discussed in a later section of this bulletin.

Distribution in the Skeena River

Since the present study was centred on the Skeena River area, more data on harbour seal distribution are available for this area than for any other.

Table III. List of hauling-out bars used by harbour seals in the lower Skeena River and off its mouth.

Location	Number of seals	Remarks
Sand bar—NW corner of Kennedy Island	Few	Small numbers of seals in summer, apparently augmented by upriver population in winter.
Genn Island, South Rocks	12 to 24	Seals haul out usually when salmon are not running.
Bar between Croasdaile and De Horsey Islands.	40 to 60	
Rocky area—SE coast of De Horsey Island	Variable	Utilized during half-tide periods. At low tide seals must go to the bar described just above.
Raspberry Island—mouth of Ecstall River	25	Utilized in spring and late autumn, when fishing boats are scarce.
Sand bar—2 miles below Big Falls Creek, Ecstall River	20 to 50	Only hauling-out area in Ecstall except rocks opposite Big Falls Creek, where 2 to 6 seals appear.
Sand bars 4 miles above Kwinitsa, Skeena River.		At extreme low tide seals go to a grassy island up river.
(a) Bar in middle of river	150 to 200; usually 60 to 100	
(b) Bar 1 mile downstream	25	Scattered groups of seals.
Mouth of Lakelse River	45	Seals haul out on the gravel bank of the island directly opposite the river mouth.
Maze of sand bars and islands to Terrace and above	?	

Because the mouth of the Skeena River is the site of an important gill-net fishery, and because the seals assume considerable economic importance with regard to the fishery, the distribution is outlined below in some detail.

Figure 6 shows the location of the hauling-out sites of harbour seals in the area of fishing activity. Lamb Island, of the Gibson Islands group at the head of Grenville Channel, is not shown, being a few miles to the south, but should be mentioned since a group of at least 30 harbour seals continually frequents the rocks of the island, apparently breeding and bearing young there. Local seine fishermen report that at times the rocks are "completely covered" with seals. The group may provide a source of influx to the population in the area of the gill-net grounds a few miles further north. (See also Figure 17.)

Table III gives a list of the sites on which harbour seals haul out in the lower Skeena and at its mouth, together with pertinent comments and estimates of numbers thereon. With respect to the "miscellaneous" sites, military personnel stationed in the Skeena area stated that they had observed seals hauled out at several points in the Skeena above tidewater influence, and up to Terrace.

Harbour seals are widely distributed from Hazelton down, and it is likely that there are many areas in the river where individual animals will haul out. They have been reported from Lakelse Lake; and Walter Wright, Chief of the Kitselas Indians, informed the writer that harbour seals occur some miles up the Kispiox River, which empties into Babine River north of Hazelton.

Seals will journey up any stream entering the Skeena, that is deep enough for them to be assured of quick escape. The Lakelse River in places is barely deep enough, yet seals occur in Lakelse Lake. In the upper area of tidewater influence, individuals were observed by the writer several miles up both the Khtada and Khyex Rivers. Two pups were observed one-half mile up a narrow winding creek tributary to the Ecstall River.

Whether any seals occur upriver during the winter, making use of breathing holes in the ice, is unknown.

Abundance in the Skeena River

An estimate of the population of any area was difficult to make, but sufficient field work was conducted along the lower reaches of the Skeena River to make possible a fairly reliable estimate of the seals in that region.

It was found impossible to visit all of the hauling-out sites in the area at the mouth of the Skeena during one low-tide period when the majority of seals were hauled out. In almost every instance where seals were observed hauled out, a certain number were still in the water, usually close to the bar, but continually submerging and reappearing in different places, rendering impossible an attempt to count them from the distance at which it was necessary to keep oneself if they were not to be alarmed.

Judging from estimates made at hauling-out sites at various times during the summers of 1945 and 1946, 450 harbour seals, not including pups, is a conservative figure for the population of the area at the mouth of the Skeena River, from Kwinitsa down, including the Ecstall River and Lamb Island, at the head of Grenville Channel. The figure represents an estimate for the summer months only. There must be at this time several hundred more distributed along the Skeena River up to and possibly above Hazelton.

Harbour seals are much less numerous in the Skeena area than in the delta of Copper River, Alaska, which contains a far greater area of sand bars and mud flats. Imler and Sarber (1947) estimated that no fewer than 6,000 harbour seals live in the Copper River delta.

MOVEMENTS

Seasonal Upriver Movement

Phoca vitulina richardii, like the other races of the species, is more or less sedentary in its habits and is resident throughout the year in all areas of its extended marine habitat.

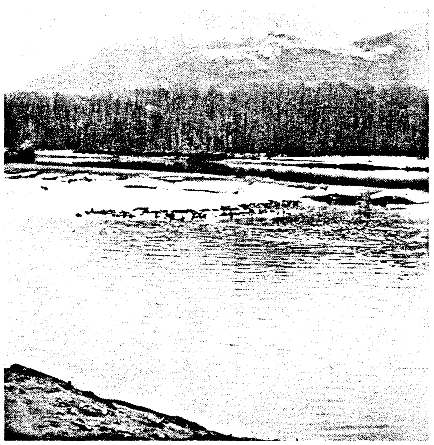


Figure 7. Group of seals hauled out on an ice- and snow-covered sand bar above Kwinitsa, on the Skeena River, March, 1939. Photo by R. Suriol, reprinted and enlarged from an old print.

During the Skeena River study, however, a definite seasonal upriver movement became apparent, coinciding in general with the salmon run. This is not mass migration, but appears to take place gradually, the numbers upriver steadily increasing as the number of salmon rises. Seals are reported to appear in upriver areas as soon as the ice breaks in late February or March (Figure 7).

J. R. Brett (personal communication) reported seeing a harbour seal in Lakelse Lake on April 14, 1944. From April on, seals begin to appear in increasing numbers along the Skeena River up to and possibly above Hazelton. The movement appears to be at a maximum in September when seals are a common sight in the river from railroad and highway, especially in that part of the Skeena up to Terrace. On September 8, 1945, the writer counted 13 seals in the river from a train en route from Terrace to Prince Rupert, within 45 minutes after the train had left Terrace. Two Fisheries Research Board biologists, while driving to Prince Rupert from Terrace on August 30, 1946, counted 32 seals in an area comprising about one-eighth of that part of the river below Terrace.

A Port Essington fisherman told the writer that seals first become numerous in upriver areas with the onset of the run of eulachons (*Thaleichthys pacificus*), which begins in March. The latter part of this run overlaps with the onset of the spring salmon (*Oncorhynchus tshawytscha*) run, which is at its peak in late May and in June. It is during the spring salmon run that the seals begin to range upriver beyond tidewater influence.

The extent of upriver distribution appears to be dependent upon the available salmon supply. Residents of Terrace stated that during a heavy run of salmon numerous seals appeared at Terrace and above this point, and that a poor run of salmon resulted in very few seals reaching Terrace. In the summer of 1945, during which an exceptionally heavy run of pink salmon (*Oncorhynchus gorbuscha*) ascended the river, reports stated that harbour seals were numerous in the fall around Terrace and up to the entrance of the Babine into the Skeena, near Hazelton. In 1946 by early September very few pink salmon had appeared in the river at Terrace and very few seals had been noted at this locality. Pinks were running into the Lakelse River on September 6, 1946, however, at which time a group of over 45 seals was observed at the mouth of this river.

A trapper who lives in a cabin on the banks of the Ecstall, some 30 miles upriver, stated that seals occurred at that point only when salmon were numerous in the river.

The early phase of the upriver movement coincides with the onset of the pupping season. From May 18 to 20, 1946, very few seals were noted by the writer in the hauling-out area of the Skeena River, just below Kwinitsa. On June 11, 1946, an estimated 200 were seen, many small pups were present and there were signs that the bars had been very recently occupied for bearing young. Whether the majority of the 200 had come down from upriver or had ascended from areas nearer the mouth is unknown. No first-summer pups were seen in a group of seals in the Skeena at the mouth of the Lakelse River, when this area was visited on September 6, 1946.

An interesting note on upriver distribution was obtained from W. Wright, Chief of the Kitselas Indians of the Skeena. According to him, it is only within the last 40 to 50 years that seals have become numerous in the Skeena above the mouth of the Lakelse. Before this time tribes of Indians lived along the

Lakelse River, and in various other localities in the Skeena area, including the Kispiox River. The harbour seal at that time was an important factor in the welfare of the Indians. The Lakelse tribes made considerable use of the seals which congregated upriver and which therefore were subjected to harassment from hunting effort, a fact which kept upriver distribution at a minimum. It was very seldom that seals were seen as far inland as the Kispiox River, and they never entered Lakelse Lake, since Indian tribes were encamped along the shallow stream which drains it. It is only since the tribes disbanded that seals began to appear in the lake and in anywhere near the numbers which are now seen during the summer in a survey of the Skeena River from the highway.

The cessation of hunting effort in upriver areas, therefore, coupled with the considerable and comparatively recent increase of hunting pressure exerted on the coast as a result of the development of the fishing industry and the installation of the bounty system of control, may be a cause of the present upriver distribution of harbour seals. This distribution appears to be slowly increasing in extent.

Daily Local Movement

In the area of tidewater influence of the Skeena, the tide appears to be the chief factor in determining the daily movements of harbour seals. While the animals can be termed as loosely gregarious when hauled out, they are solitary in their foraging habits. Very seldom were adult seals observed in close company in the water, unless they were playing at the edge of a sand bar during a hauling-out period. Dispersal for feeding activities is exceedingly rapid and a group of seals will, on a flood tide, become widely scattered in the locality of their hauling grounds.

Daily or seasonal ranges of individuals are unknown. From observations in the area of the Skeena gill-net grounds, the writer would estimate daily movements from a hauling-out site to vary from a few hundred yards to several miles.

For example, of the group of seals hauling out on a sand bar near De Horsey Island (Figure 6), from 12 to 25 individuals were seen, when the group was under observation, to move with the flood tide into the general area between De Horsey and Croasdaile Islands, and would remain in the area until the next low tide. A favourite site of exploration was the bay of De Horsey Island, which, dry at low tide, is under 10 to 18 feet of water at high tide.

At least seven or eight seals invariably could be seen scattered at various points in the bay, coming right into the edge of the shore at the head of the bay. A few always appeared with the flood tide in the slough between De Horsey and Smith Islands and one was seen on one occasion to make its way slowly into Inverness Passage and return toward the De Horsey sand-bar area with the ebb tide.

Many seals from the above-mentioned sand bar distribute themselves at high tide along the southwest shore of De Horsey Island, frequenting especially

the rocky area shown in Figure 6. Here, seals frequently haul out on the rocks during the last part of the flood tide and the early part of the ebb. Other individuals frequent the gill-net drifting areas along Marcus Passage and the east shore of De Horsey Island. During the salmon fishing season, from spring to late fall, gill-nets are set, usually at low-water slack, and allowed to drift up the river mouth with the flood tide. Seals will at times frequent the nets and eat salmon caught in the meshes. With the increase in numbers of boats when sock-eye fishing begins at the end of June, activities of seals around the nets are reduced and feeding activities appear to be carried on in the shallows adjacent to the sand bars.

A few seals in the Skeena estuary were frequently seen in the fishing areas at low-tide periods when the majority were hauled out. Feeding activities, therefore, are not entirely confined to high-tide periods.

In upriver areas still within tidewater influence, the tide still appears to be a stronger factor in controlling daily movements. In the Skeena for some 20 miles from the mouth, and in the Ecstall for about 30 miles of its length, the direction of flow, at least on the surface, is reversed by the flood tide, which pushes water back from the mouth. The current on both the flood and the ebb tide may attain a speed of from three to four knots in the Skeena and of from five to six knots in the Ecstall, the speed varying according to the size of the tide.

Observations of the groups of seals hauling out on the sand bars below Kwinitsa and in the Ecstall River indicate that many allow themselves to be carried upriver for some miles by the flood tide, apparently feeding as they go, and then drifting back with the ebb tide, arriving at the hauling-out bars as these are uncovered. This drifting with the flood and with the ebb of the tide was most pronounced in the Ecstall River, seals being carried on the flood up to ten miles beyond the hauling-out bar. During low-tide periods very few seals were seen more than two miles above the bar, on which many would be hauled out.

In the Skeena River some seals extend with the flood tide to both sides of the river, staying near shore. Some are frequently seen in the Khyex River. Others drift upriver towards Kwinitsa.

Feeding activity was occasionally noticed during flood-tide periods. Seals were twice seen devouring salmon at the mouth of the Khyex river. During a swift flood tide, one seal was noted just above the Ecstall bar eating a salmon, drifting upstream with the flood tide for nearly half a mile before finishing its meal.

LIFE HISTORY

Mating

It was not possible to gain first-hand data on mating activities during this study. Local fishermen reported that in the Skeena River breeding takes place mainly during September and October, with mating activity greatest in September. The latter information agrees with that obtained by Scheffer and Slipp for

Washington State. The examination of the testes of four adult seals by these authors in the summer months reveals that spermatogenesis starts in that area in early July.

The testes of a 300-pound male taken in the Fraser River on September 25, 1945, were found to be sexually active. They measured 75 x 36 mm., and a smear from the epididymis showed many sperms.

Though no signs of sexual activity were noticed after a 15-minute observation of a group of seals hauled out on Lamb Island on August 14, 1946, it appeared to be developing on the hauling-out bar in the Skeena River just below Kwinitsa, on August 8, 1946. Here, although no actual mating acts were observed, the amount of restlessness and of squalling, grunting, barking and fighting had noticeably increased from earlier periods in the summer and was taken to indicate the onset of sexual activity.

According to Allen (1880) Newfoundlanders state that the Atlantic harbour seal also mates in September.

TABLE IV. Size of bacula from seals of different ages.

Field Number	Age	Standard length of body	Body weight	Testes length & depth	Baculum length	Baculum weight
		mm.	*lb.*	*mm.*	*mm.*	*gm.*
106	Newly born	805	21	24 × 10	40	0.191
124	First-summer pup	985	55	25 × 11	43	0.200
128	Second summer	1206	90	25 × 13	41	0.230
126	Young adult	1355	128	58 × 31	108	8.0
120	Adult	1446	200	68 × 34	139	19.5
102	Old adult	1690	300	75 × 36	133[a]	22.5[a]

[a]Baculum chipped off at one end.

No positive data have been gained as to the age at which the male harbour seal matures sexually. Very little development in the testes and baculum (penis bone) takes place during the first year as evidenced from the size of these organs in a second-summer pup (Table IV). Asdell (1946), citing B. Havinga, states that the young of the harbour seal of Holland is believed to reach puberty at the end of its third year, at which time a sudden growth of the baculum occurs. There is some evidence, from comparison between baculum size and body size, that a similar situation exists for the Pacific harbour seal.

Data for the body weight and length, testes measurements and baculum size of three male adult seals from British Columbia are given in Table IV. The bacula are photographed in Figure 8.

The average dimensions of the testes of nine first-summer pups was 25 × 11 × 9 mm., the average length and weight of the bacula of two of these

being 41.5 mm. and 0.196 gms. The baculum size of first-summer pups is somewhat larger than values obtained by Scheffer and Slipp. For three first-summer

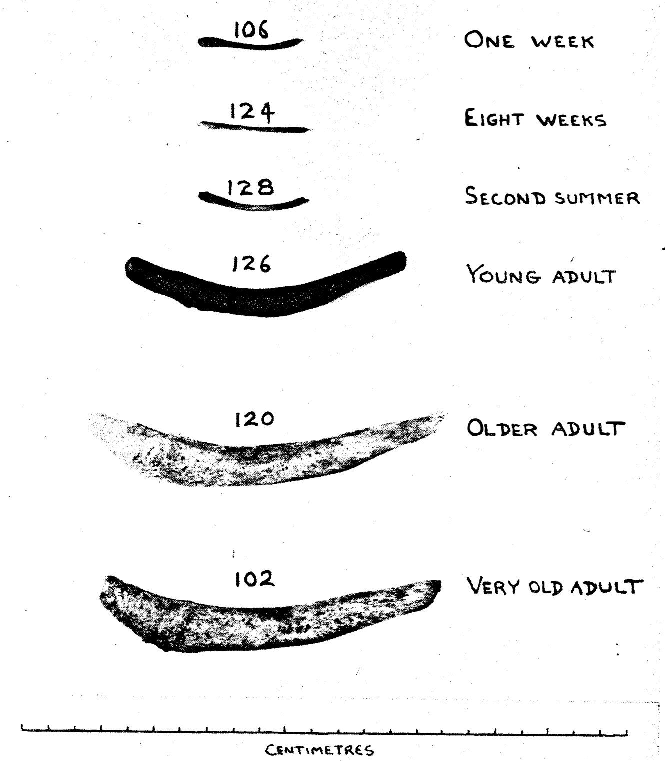


FIGURE 8. Photograph of the bacula of six harbour seals from British Columbia, of varying ages. See Table IV for lengths and weights. Numbers are author's field catalogue numbers (Table II).

pups from Washington State these authors obtained an average baculum length of 33.9 mm. and an average baculum weight of 0.140 gm. (Figure 8).

Very little difference is seen in testis and baculum size of a yearling as compared with those of first-summer pups.

It would seem that the testis and baculum sizes for the old adult given in Table IV approach the limit of development.

Scheffer and Slipp present evidence that the female does not mate in her second autumn and must attain an age of at least two years before so doing, and an age of at least three years before bearing her first young. Data on the body length and weight, and ovary dimensions of 11 first-summer females, two second-summer females and one adult female are given in Table V. The above named authors give ovary dimensions of a 51-pound second-summer female as 19 × 11 × 4 mm., and of a 94-pound third-summer female as 27 × 17 × 8 mm.

Of 28 seals taken in the Skeena area, 13 were males and 15 were females.

TABLE V. Size of ovaries in female seals.

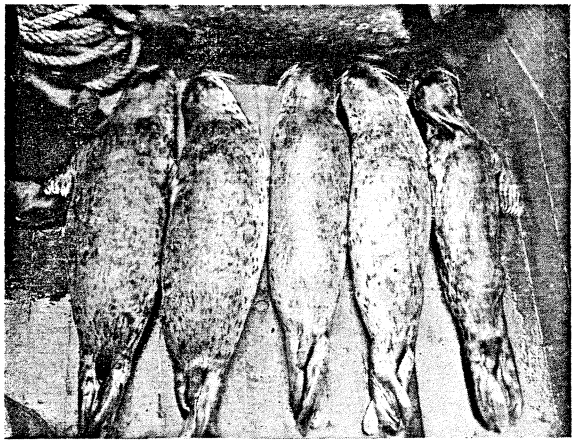
Field Number	Age	Standard length	Body weight	Dimensions of ovaries
		mm.	*lb.*	*mm.*
(Average of 11 specimens)	First-summer	900	40	23 × 12 × 10
111	Second-summer	1010	100	25 × 13 × 6
121	Second-summer	1010	52	23 × 9 × 13
122	Adult	1530	140	30 × 11 × 18

BIRTH AND INFANCY

Allen (1880) gives the gestation period of the Atlantic harbour seal as approximately nine months. This would appear to be so for the Pacific harbour seal as well. It was established definitely that the birth season in the Skeena area begins during the last part of May at the earliest, and terminates during the latter half of June. This was concluded from the following observations.

On May 18, 1946, the area about De Horsey Island was investigated. In a herd of seals hauled out on the sand bar, no pups were present. On May 19, a trip was made to the area of the hauling-out bars in the Skeena below Kwinitsa. Only three adults and no pups were seen. On May 20, the hauling-out bars themselves were thoroughly investigated at low tide. Only two seals were seen in the water near the bar, but there were no signs of any seals hauled out or having been hauled out recently. A few more adults were noticed half a mile below the bar.

The De Horsey area was revisited on May 21, at which time an estimated 60 seals were hauled out at low tide. No pups could be seen. The area was again visited from June 1 to June 4, during which no pups were present. It was concluded that birth had not begun by June 4 in the De Horsey Island area.



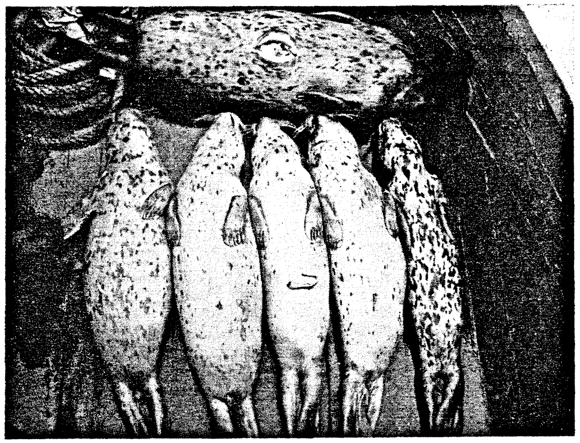


FIGURE 9. Dorsal and ventral views of five pups taken in the Skeena River, June 20, 1946 (*left to right*, Nos. 109, 108, 110, 107, 106). See Table II for weights and measurements. Note emaciated condition of No. 106, thought to have lost its mother and starved. Note also swelling on right side of neck of No. 107, being an infection of the lymphatics. Umbilical stubs present on Nos. 110, 107, 106.

On June 8, the hauling-out bar in the Ecstall River was visited. Upon approaching the bar by boat, about 12 adult seals were flushed into the water, each accompanied by a small pup. A newly born pup, still attached to the placental afterbirth, was found on the bar. From the state of other afterbirths seen in this locality, it was evident that births had begun late in May.

On June 11, the Skeena River bar below Kwinitsa was revisited at low tide. Twenty-eight seals, about 12 of which were pups, were hauled out in scattered groups below the main hauling out bar. On the latter, an estimated 150 to 200 were present, many of them pups. No more specimens were

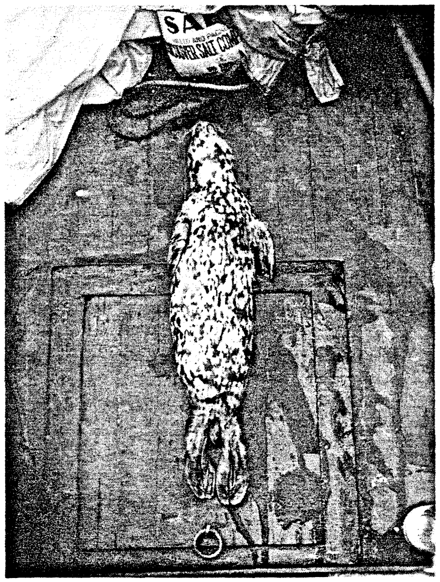


FIGURE 10. Ventral view of female pup taken at Osland, Smith Island, mouth of Skeena River, June 23, 1946 (No. 112). Unusual ventral coloration of black splotches on pure white background. Two or three days old, note umbilical stub. Weight 26 lbs., length 840 mm.

obtained, but about a dozen afterbirths were noted, none of which appeared to have been deposited more recently than several days beforehand. A few fresh afterbirths were found on June 20, when five pups were taken. Three of the latter had umbilical stubs and were judged to be not more than a week old (Figure 9).

On June 23, a 26-pound pup was taken by hand while it was swimming in De Horsey Passage. It bore an umbilical stub about three inches long (Figure 10).

It was concluded, therefore, that the birth of pups begins during the last of May at the very earliest, and extends into the latter half of June, being at its peak in early June. This conclusion is in accord with that reached in the Stikine River area by Imler and Sarber (1947). The young are born on sand bars regularly used throughout the year as hauling-out sites.

Pups were always scarce in the De Horsey area, as compared with their number upriver. It appears that the majority of births in the Skeena area take place upriver on the Skeena and Ecstall sand bars.

A somewhat earlier birth date is indicated in the observation by C. J. Guiguet of a small pup at the south end of Langara Island, Q.C.I., on May 22, 1946.

Scheffer and Slipp established that the pupping season in Washington State begins in May in the coastal bays and perhaps along the ocean shore itself, and present evidence that the season is from one to two months later in Puget Sound and adjacent waters.

The writer was unable to obtain evidence that a female harbour seal may bear more than one pup. Scheffer and Slipp, however, state that a female will, on rare occasions, bear two pups and cite bounty hunters' reports that in odd instances two foetuses may be found in a female.

The weight of the newly born male pup from the Ecstall (No. 103) taken on June 8, 1946, was 21 pounds and its length 805 mm. The female pup taken on June 9, 1946 (No. 104) weighed 28 pounds and measured 805 mm. (Figure 11). Detailed measurements of these and of subsequent specimens are given in Table II.

It is of interest to record the appearance and behaviour of the newly born male pup found on the Ecstall hauling-out bar on June 8, 1946. Its birth was estimated to have taken place not more than 15 or 20 minutes previous to its capture. The pup bore a coat of yellowish foetal hair which was almost dry (Figure 12) and the umbilical cord was still attached to the placental afterbirth. The pup was lying on its back about 20 feet from the water and was very still, seemingly asleep. So well did the colour of the foetal coat blend with the colour of the dried sand, that it was at first not recognized as a seal pup. It was discovered when the mother, which had been reluctant to leave the sand bar on the approach of the boat, came onto the sand bar for the pup after the writer had passed and was some 50 yards distant. She was noticed before reaching her pup and quickly entered the water when the writer turned to investigate. When the pup was touched, it immediately opened its eyes, rolled over and attacked the writer, hissing and biting. Within two minutes it began a steady, plaintive, sheep-like bleating. The hairs of the foetal coat, which were about 23 mm. in length, came out at the least touch and as the pup squirmed around on the sand, much of the coat came away in large patches,

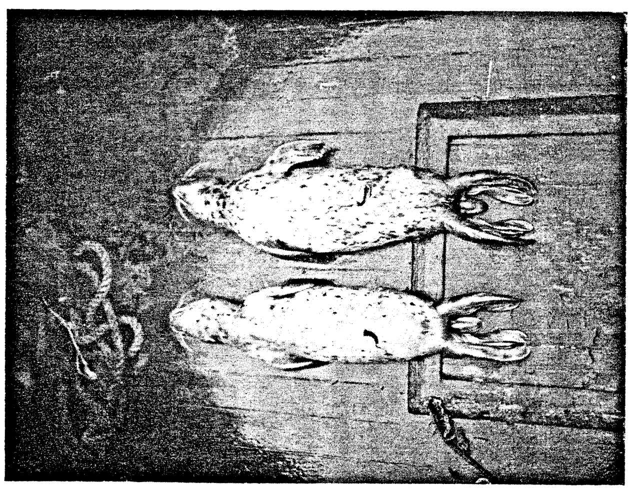


FIGURE 11. *Left*—newly born male pup, Ecstall River, June 8, 1946 (No. 103). Weight 21 lbs., length 805 mm. *Right*—recently born female pup, Ecstall River, June 9, 1946 (No. 104). Weight 28 lbs., length 805 mm.

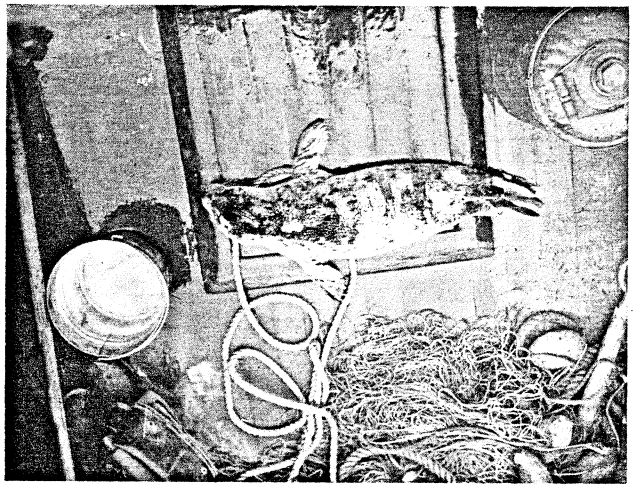


FIGURE 12. Harbour seal (No. 103—see Figure 11), about one half hour after birth. Whitish material is foetal hair with which pup was covered at birth. This hair came away easily, revealing the normal spotted coat underneath.

forming a mat. After about one half hour, during which the pup was handled frequently, practically all of the foetal coat had been divested, revealing the normal shorter spotted coat underneath. The pup became quite tame in a few minutes and attempted to follow the writer, issuing its plaintive cry. The mother seal in the water, meanwhile, viewed the proceedings from a safe distance. The pup was kept alive on the boat for several hours, during which time it became extremely tame, wailing loudly until it was picked up. One interesting fact noted was the remarkably prehensile property of the fore-flipper. The pup was able to flex the phalanges of the foreflipper to almost the same degree as a human, and could grasp one's finger or clothing with a grip surprising in its tenacity. If the writer refused to pick up the pup as it lay crying on the deck of the boat, it would vigorously flap first one foreflipper and then the other on the deck, and then pull itself part way up the writer's trouser leg.

There has been some conjecture whether the foetal coat is shed before birth and if it is not, about the length of time which it persists after birth. According to Scheffer and Slipp, the foetal coat may, in some parts of North America, probably in the colder waters, persist for a few days after birth. They conclude, however, from their own studies and from information supplied by seal hunters, that the harbour seal in Washington is normally born with the short, spotted coat.

Very young pups seem to be possessed initially of little or no sense of danger. The second pup obtained from the Ecstall bar was estimated, from the condition of its umbilical stub, to be not over two days old. It was observed on the bar with its mother, about 20 feet from the water, for some minutes before being approached. The mother seemed to be having difficulty in coaxing it into the water and showed some agitation upon the approach of the investigators, humping hurriedly back and forth between the edge of the water and the pup.

A shot was fired at the female in an attempt to collect it. It missed and the female swam off under water until out of rifle range. The pup showed no concern when the shot was fired, nor did it take heed of the approach of the writer until it was touched, whereupon it snarled and attempted to bite for a few minutes, then tried to escape into the water. It seemed very active and healthy and soon became quite tame, behaving much as did the pup captured on June 9.

The recently born pups which were flushed with their mothers from the Ecstall bar on June 8, 1946, seemed to experience no difficulty in swimming and submerging, except that they appeared to be unable to stay submerged for more than about a minute. The newly born pup captured on the bar immediately submerged and swam under water when the writer tied a cord around one hindflipper and put it into the river. The interval between the time of birth of seals in this area and the time at which they first enter the water is not more than a few hours.

For the first week or so the mother seal remains very close to the pup, ensuring that it keeps out of danger from human observers. Frequently a pup separated from its mother and approached the boat to within 20 feet, gazing intently at the boat and its occupants. On such occasions, the mother seal would frequently surface suddenly beside it and in a flash grasp it by the back of the neck with her teeth and pull it under in the middle of its typical cry, in which case a distinct gargling sound ensued. Pups often became separated from their mothers for some time, especially when the investigators had been harassing a group in the water in an attempt to secure specimens. At such times a pup would keep up a steady bleat until, on many occasions, the gargling sound indicated that its mother had located it.

On two occasions a pup was seen resting on its mother's back in the water, holding firmly to her sides with its foreflippers.

The intense curiosity exhibited by pups at the presence of humans either in a boat or on shore persisted well into August, by which time very little association with the mother seal, while in the water, was noticed. Adult seals, while also possessed of a curious nature, are very quick to sense danger and are more careful to keep at a safe distance than are the pups. While hunting the latter with shotguns, it was noticed that they soon learn to keep out of gunshot range during the immediate hunting period but the following day are as guileless as ever.

In the course of observations made in upriver areas during the pupping season, there was evidence suggesting that parturition is adjusted to the tidal exposure of the pupping sites. Hauling-out bars in upriver areas within tidal influence are uncovered during the ebb tide and are covered by the flood tide some three to five hours later. The banks of the Ecstall River are very steep—in fact perpendicular for much of its length—and no hauling-out sites were discovered that could be used during flood tides. In spite of careful observation, no evidence was found that the young are born in the water. Afterbirths were found nowhere but on the regular hauling-out bars. The onset of parturition, therefore, appears to be adjusted to the tidal exposure of the bars, though it is difficult to imagine the mechanism of adjustment.

Growth of the Young

Of the 22 first-summer pups collected, nine were obtained in June, eight in July, and five in August. In addition, four yearlings (second-summer) and five adults were secured.

Detailed measurements of all specimens were made (Table II), the data were grouped chronologically and means were determined. It is felt that the resultant indications on general development and rate of growth are of some significance. It must be borne in mind that the measurements of the 20 first-

summer pups probably do not represent a perfect series in sequence of time. Some of the later specimens may have been born earlier or later in the birth season than were the first pups obtained, so that the rate of growth shown for the first summer may be either greater or less than it actually is.

Table VI. Averages of measurements given in Table II of first-summer, second-summer and adult harbour seals, to show extent of increase or decrease in body proportions with age. Numbers in brackets in each column refer to number of animals measured. Weights are in pounds, measurements in millimetres.

	First-summer pups, sexes combined				Second-summer			Adult		
	June	July	Aug.	Aver.	♂	♀	Av.	♂	♀	Av.
	(9)	(8)	(3)	(20)	(2)	(2)	(4)	(3)	(2)	(5)
Weight	26	51	41	39	80	76	78	209	148	185
Standard length	858	927	949	899	1159	1010	1085	1497	1485	1492
Length, tail	64	62	61	63	83	70	76	95	98	96
Length, foreflipper	167	170	179	170	182	185	183	239	225	234
Length, hindflipper	191	199	206	196	214	210	212	267	275	270
Expanded width, foreflipper	120	122	119	120	121	126	124	163	156	160
Expanded width, hindflipper	247	253	260	251	295	283	289	373	313	349
Circumference behind fore-flippers	512	709	652	617	758	745	750	1043	1048	1045
Tip of nose to insertion of foreflipper	275	290	313	286	384	355	365	508	485	499
Centre navel to tip tail	272	286	288	280	348	335	341	477	485	480
Centre anus to tip tail	82	85	86	84	94	95	95	113	112	113
Centre navel to centre anus	200	230	234	217	268	260	264	397	400	398
Centre navel to tip lower jaw	569	629	657	606	794	740	767	1000	964	986
Distance between mammae	55	66	64	61	x	64	64	x	88	88
From line between mammae to centre navel	32	44	43	38	x	42	42	x	80	80
Centre eye to centre ear	41	42	43	42	52	50	51	57	61	58
Penis opening to centre navel	108	132	130	123	146	x	146	202	x	202
Penis opening to centre anus	105	98	111	102	131	x	131	185	x	185
Thickness of blubber on belly	30	42	31	35	38	38	38	29	34	31
Longest nasal vibrissa	86	93	102	91	77	86	84	103	91	97
Longest supranasal vibrissa	17	18	16	17	13	10	12	13	12	12
Longest brow vibrissa	50	47	52	49	44	31	39	53	43	48
Ovary dimensions—length	27	22	21	23	x	27	27	x	30	30
thickness	15	12	10	12	x	10	10	x	18	18
depth	10	11	12	10	x	16	16	x	11	11
Testes dimensions—length	27	24	24	25	26	x	26	67	x	67
thickness	12	10	11	11	x	x	x	34	x	34
depth	8	11	x	9	14	x	14	27	x	27

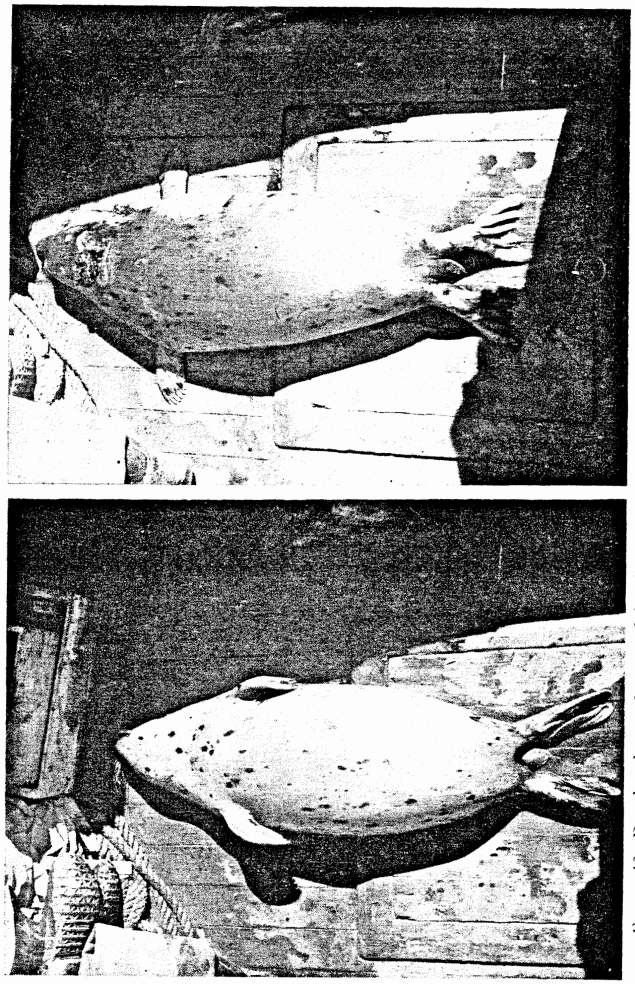


FIGURE 13. Dorsal and ventral views of female pup, six to seven weeks old, taken in the Ecstall River, July 19, 1946 (No. 118). Weight 55 lbs., length 980 mm. Exceedingly fat, blubber layer 50 mm. thick.

The rapid gain in weight while suckling is the most remarkable factor in the early growth of the pups. As seen from Table VI, the body weight is doubled in the first six or seven weeks of life, during which the young seal is nourished by milk. The chief factor contributing to this weight increase is the production of blubber, the average thickness of the blubber of three pups taken in the first half of June being 30 mm., as against an average of 42 mm. for eight specimens in July. The increase in thickness of blubber is at a maximum by July, when the pups are round and tight-skinned in appearance (Figures 13 and 14).

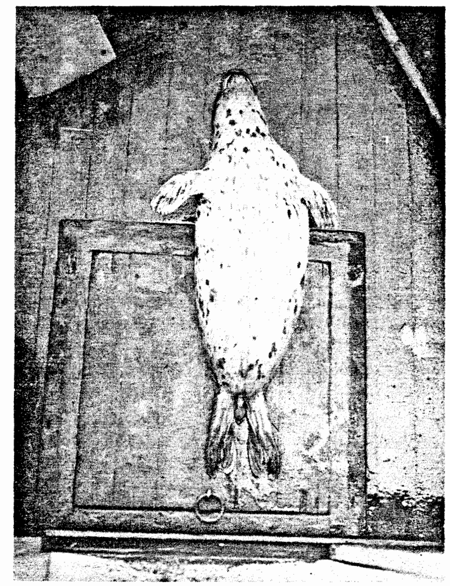


FIGURE 14. Ventral view of male pup about four weeks old, taken in the Skeena River, July 5, 1946 (No. 113). Weight 39 lbs., length 833 mm. Note rounded, fattened appearance in comparison with younger specimens shown in Figure 11.

Scheffer (1945) found a similar weight increase in sea-lion pups (*Eumetopias jubata*), the body weight doubling within the first seven weeks of life.

Bertram (1940) writing of the Weddell seal (*Leptonychotes weddelli*) of the Antarctic, states that the weight of the pup, which is 60 pounds at birth, may double itself after a fortnight on the nourishment of milk, and that the pup may gain weight at the rate of seven pounds per day while suckling. The milk in this species, according to Bertram, begins to fail in about six weeks, when a marked decrease in the weight of the pup occurs until it learns to catch fish and squid.

A comparison of the growth rates of male pups of the Pacific harbour seal with female pups shows no significant difference between sexes in the first summer.

July specimens of first-summer pups show an increase of 8 per cent in body length, 96 per cent in weight and 38 per cent in circumference over June specimens.

August specimens increased 2 per cent in body length over July specimens, and showed a decrease of 20 per cent in body weight and of 5 per cent in circumference, due apparently to the decrease in blubber accompanying the weaning process.

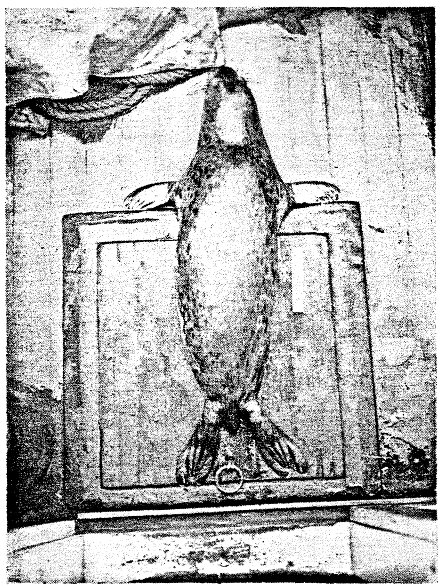


FIGURE 15. Male first-summer pup taken at the Gibson Islands at the head of Grenville Channel, August 14, 1946 (No. 124). Weight 30 lbs., length 943 mm. This pup, and others with it, were noticeably lighter than Skeena River pups taken a month earlier. Blubber 28 mm. thick, much less than in river pups. Feeding on shrimps and lampreys.

The four yearling specimens show an increase of 14 per cent in body length over the August first-summer series, accompanied by a 90 per cent weight increase and a 15 per cent increase in circumference.

The adult series shows an increase of 38 per cent in body length and of 137 per cent in body weight, with a 39 per cent increase in circumference, over the yearling series.

From birth to the adult size in the series under consideration, an increase of 74 per cent in body length takes place, and of 104 per cent in circumference, with the body weight increasing seven times.

Of the 74 per cent increase in body length about 49 per cent is in the region anterior to the navel and 25 per cent is posterior to this region.

Data for the change with age in other body parts are given in Table VI.

The three first-summer pups taken in August, 1946, were from the Gibson Islands at the head of Grenville Channel, an area considered as being in the marine habitat. These pups, as well as a number seen in this area, were noticeably smaller than specimens taken and seen in July and early August in the Skeena area (Figure 15). The most conspicuous difference was a smaller circumference due to a thinner blubber layer. As stated previously, there is evidence that the pups from the Gibson Islands are weaned earlier than those in the Skeena area. The stomachs of the marine pups contained large nematodes, along with contents such as octupus beaks, numerous shrimp and small rockfish. Milk was totally absent. The stomachs of Skeena and Ecstall pups obtained were entirely free of parasites and all contained appreciable quantities of milk. On August 5, 1946, the stomach of a yearling, taken at high tide near the Ecstall bar, contained, besides nematodes, only the back-bones of two small fish, indicating that food supply in the river, aside from salmon, is scarce. It is safe to conjecture that upriver pups are still suckling in August. The stomachs of three obtained in the Fraser River on September 1, 1945, contained only milk.

PARASITES AND DISEASE

According to Scheffer and Slipp (1944), less than 48 species of internal and external parasites have been recorded from harbour seals. Ascarids are of common occurrence, and were present in every stomach examined by the writer except those of first-summer pups. They varied in number in each stomach from a few to several hundred, being most numerous in the pylorus, but none being found beyond the pyloric valve. Specimens sent to the Institute of Parasitology, Macdonald College, Quebec, were identified as *Porrocaecum decipiens* and *Contracaecum osculatum.*

Several hundred acanthocephalans identified by the above-named Institute as *Corynosoma semerme* were found in the ileum of an adult male seal (No. 102) from the Fraser River. None of these were found in the Skeena River specimens examined. Scheffer and Slipp record *Corynosoma strumosum* from seals in Washington. These authors also record the mite *Halarachne*. Several dozen mites of this genus were collected from the naso-pharynx of an adult male (No. 120) and a yearling male (No. 123) seal from the Gibson Islands at the head of Grenville Channel.

About two dozen sucking lice (Anoplura) of the family Echinophthiriidae were collected from seals of the Skeena area. Roundish in shape and about 3 mm. in length, they were most common on the dorsal and ventral surface of the web of the hind flippers, though they were found also on the sides of the body and on the belly. They were taken from two pups about one month old (Nos. 113, 114) from the Skeena River, from a pup about six weeks old (No. 118) from the Ecstall River and from a yearling (No. 123) from the Gibson Islands.

In no instance was a parasite infestation heavy enough to cause apparent detriment to the health of a seal.

Harbour seals appear to be remarkably free of disease. One pup (No. 107), however, judged to be less than a week old, was afflicted with a considerable swelling of the lymphatics on the right side of the neck (Figure 9). The swelling was hard to the touch, and a clear liquid discharge issued from an opening in the skin. The pup was more lethargic than others, and was captured by hand on the Skeena hauling bar. The blubber on the belly was 25 mm. in thickness, compared to an average of 33 mm. for three other pups captured at the same time. Brown (1868) describes an identical condition occurring in pups of the harp seal (*Phoca groenlandica*) in the Spitzbergen and Greenland seas and states that the disease is analagous to, if not indeed, true scrofula.

Another pup obtained at the same time (No. 106) was exceedingly emaciated, being almost without blubber except for a trace on the belly (Figure 9). It was found on a sand bar and barely had strength to hold up its head. It was inferred that the condition was the result of starvation rather than of disease.

FOOD HABITS

One thing essential to reaching a decision on the effect of seal predation on the run of salmon in a given area is to collect a series of stomachs from the area representative of all seasons of the year and in this way to gain a definite idea of the importance of salmon in the diet of the seal and of the seasonal variation in the food relationship. Scheffer and Sperry (1931) assembled a collection of 100 stomachs from Puget Sound and in the semi-enclosed and coastal waters of Washington State from December 1927 to August 1930. Fishes were found to comprise 93.6 per cent of the volume of the food, molluscs 5.8 per cent, and crustaceans 0.6 per cent. The chief species of fish were tom-cod, flounders, Pacific herring, hake, sculpins, cod, blue-cod, pollack and shiners. Salmon were found in only two stomachs. Squids were eaten in winter and

octopi in summer. Shrimps were occasionally taken in quantity. Smaller forms of crustaceans were present probably occurring as food of other fishes eaten.

Scheffer (1928) records the contents of 35 harbour seal stomachs taken at all seasons of the year from Puget Sound, chiefly at Nisqually Flats. Thirteen, being pups, contained milk. Of the others, two contained salmon, while the remainder held food items of little commercial value, such as herring, tom-cod, shiners, sculpins, shrimps, crabs, squid, octopus, skate, starfish and flounders.

Imler and Sarber (1947) record the contents of 67 harbour seal stomachs from the Copper River delta, and of 99 from southeastern Alaska. Seals collected from the Copper River, being taken in late May and June during the eulachon season, were feeding almost entirely on this fish. Seals collected in southeastern Alaska were feeding extensively on gadids. Herring ranked second in impor-

TABLE VII. Frequency of items in stomachs of twenty adult harbour seals from the Fraser River, Queen Charlotte Islands and the Skeena River, August 5, 1945, to September 1, 1945, and July 4, 1946, to November 6, 1946, and percentage of total volume occupied by each item.

Item	Number of stomachs in which item occurred	Approximate percentage of total volume
Rockfish (*Sebastodes*)	7	19.0
Octopi or their beaks	7	5.2
Salmon	5	28.5
Herring (*Clupea pallasii*)	2	20.0
Shrimp (*Caridea*)	2	2.5
Small crabs	2	2.5
Lamprey (*Entosphenus tridentatus*)	1	0.04
Snail opercula (*Thais*)	1	trace
Unidentified fish (not salmon)	6	16.6
Unidentifiable material	12	6.0

tance, and flounders third. Shrimps appeared to be a choice food during July and August in certain localities. A number of other species occured in small numbers, including salmon.

Fifty harbour seal stomachs were obtained from British Columbia during the present study, from September 1945 to November 1946. The great majority of these were obtained during summer months. Of the 50 stomachs, 10 were empty, 20 contained milk only, and 20 contained food. The frequencies of the individual items found in the 20 stomachs containing food, with the percentage of total volume of each item, is given in Table VII.

Identifiable items occurring most frequently are rockfish (*Sebastodes*) and octupus, or the beaks of octupus, each being present in seven stomachs. Much or all of the meat had been digested from both items, leaving the bones of the rockfish or the beaks of the octopus. One stomach contained 19 rockfish otoliths.

Salmon occupied the highest percentage of the total volume but much more meat was present than in the case of the other fishes which were more thoroughly digested.

Many of the small crabs are believed to have been present because they had been eaten by rockfish.

The unidentifiable material occurring in 12 stomachs, forming six per cent of the total volume, is believed to have been mainly well-digested fish.

Of the 50 stomachs obtained, 18 were from the Skeena River. Of these, 13 were of first-summer pups, 12 containing milk and one being empty. Of five adult or subadult stomachs, three were empty. One obtained at De Horsey Island on August 3, 1946, contained parts of two salmon. Another from the mouth of the Lakelse River, September 6, 1946, contained almost an entire coho salmon in several chunks, weighing about six pounds.

Five stomachs were obtained from the Ecstall River in the summer of 1946. Of these, four were pups, three containing milk and one being empty. One stomach of a yearling contained the backbones of two very small fish, believed to be flounders because of their abundance in the area.

Five stomachs were obtained from the Gibson Islands, August 13-14, 1946. One, that of an adult, was empty, save for many ascarids. In the remaining four stomachs, which were of pups, shrimp (*Caridea*) was the most prominent item, one stomach containing 51. Small rockfishes, octopus beaks and lampreys were also present.

Of 11 stomachs from the east coast of the Queen Charlottes, eight were taken from July 4 to July 10, 1946, and three were taken on November 6, 1946. Of the former series, rockfish (*Sebastodes*) occurred in five stomachs, being the chief item of diet in each case. Octopi, or the beaks of octopi, occurred in seven stomachs. Also present in lesser quantities were small crabs, probably occurring secondarily as rockfish food, opercula of the marine snail *Thais,* believed to occur as secondary food of octopi, and small unidentified fish. Of the three stomachs secured in November, one was empty save for many ascarids. Two from Sedgewick Bay, Lyell Island, each contained parts of one five- or six-pound chum salmon.

Eleven stomachs were obtained from the mouth of the Fraser River from August 16 to September 25, 1945. Of these, six were of pups, five containing milk and one being empty. Of the remaining five, two were filled with herring, one contained an entire humpback salmon (*Oncorhynchus gorbuscha*) of about six pounds in two pieces, and two were empty.

In addition to the stomach analyses, the testimonies of three men contacted by the writer are felt to be reliable. According to William Leask, seine fisherman, harbour seals feed heavily on spawning herring off Metlakatla, near Prince Rupert, each year in April.

Helmar Stain, gill-net fisherman who has resided for years near Port Essington at the mouth of the Skeena, states that in March eulachon are running into

the river mouth, and with their appearance harbour seals occur in numbers off Point Lambert and follow the eulachons up the Ecstall River.

The eulachon run apparently marks the beginning of the seasonal upriver movement of seals. By the end of the eulachon run in April, spring salmon are ascending both the Skeena and Ecstall, and form part of the diet of seals.

J. C. Williams of Pitt Lake, B.C., who has shot several seals in the lake, states that he has observed seals chasing trout under the surface of the water.

The feeding habits of the harbour seal are in contrast with those of the ringed seal (*Phoca hispida*) of the Canadian Eastern Arctic, which has been shown (Dunbar, 1941) to concentrate its attention on planktonic amphipods and schizopods to such an extent that fluctuations in the abundance of the plankton food species result in corresponding fluctuations in the abundance of the seals.

From these observations it is concluded that the harbour seal eats a wide variety of foods, mostly fishes. It appears to have no specific predilection for any one item other than what happens to be most readily obtainable at a given time.

Local fluctuations in numbers of harbour seals on the Pacific Coast appear at times to be based to a great extent on fluctuations in the abundance of any of one or more species of the wide variety of organisms upon which they have been shown to feed. For example, numbers of seals are reported to occur off Metlakatla, British Columbia, during the herring spawning season, and off Point Lambert in the mouth of the Skeena River during the eulachon run, and in upriver areas during the salmon run.

In the majority of areas, however, fluctuations in abundance of food organisms appear to result merely in changes of food habits. For example, harbour seals are present all year at the De Horsey Island mud flats at the mouth of the Skeena. At the height of the salmon run, seals possibly prey chiefly upon the salmon. In winter, however, they must concentrate on other food organisms. There appears to be a seasonal occurrence of squid and octopus in the food of seals, squid occurring in winter months and octopi in summer months (Scheffer, 1945). Octopi were common in stomachs of harbour seals taken in the present study during the summer of 1946 from the Gibson Islands area and from the east coast of the Queen Charlottes, but no squid were found.

Furthermore, all indications resulting from food-habit studies of *Phoca vitulina richardii* point to the fact that in marine areas this seal preys upon relatively unimportant items such as rockfish, tom-cod, flounders, herring, sculpins, squid, octopus and the like, even during the salmon fishing season. In Canoe Pass in the estuary of the Fraser River on August 16, 1945, when salmon were running, the stomachs of two adult seals obtained were filled with herring.

Great care must be exercised in forming any definite conclusions on the effect of harbour seal predation in reducing the salmon runs of British Columbia, especially in view of the small number of stomachs obtained. Though it may have been possible to assess with a fair degree of accuracy the extent of predation on salmon in certain other areas of the Pacific Coast, it must not be inferred that conditions determined for a given area are similar to those on any other area. Errington (1946), after a comprehensive study of predation and vertebrate populations, concludes that the only quantitative data bearing upon predation pressures in vertebrate populations which are likely to repay close study are, as a rule, that small proportion which is obtained from investigations continued year after year on the same areas. Having obtained such data, their validity must be "appraised according to variables introduced by the size of the area and the mobility of the resident species, emergency crises, and other factors which if not considered, may distort analyses". Considering the wide distribution of the harbour seal of the Pacific Coast, its mobility and its adaptability to various environments, conditions in any local area should be thoroughly investigated before definite conclusions are drawn and policies adjusted accordingly.

In spite of the limited amount of data on hand concerning predation pressure on the Skeena River salmon run, analysis of existing data coupled with observations in the field suggests that the most serious depredations in numbers of salmon by seals take place in *upriver areas above the river mouths.*

In such areas they undoubtedly feed on salmon, since they were observed on occasions during the study up both the Skeena and Ecstall Rivers struggling with salmon at the surface of the river. The stomach of a yearling collected from a group of over 45 seals at the mouth of the Lakelse River on September 6, 1946, contained several large pieces of a salmon. At the time, salmon, mostly pinks with a few cohoe, were rising to the surface of the Skeena and ascending the Lakelse River in a slow, steady stream. The seals were undoubtedly feeding on them.

Scheffer and Slipp (1944) record daily amounts of fish eaten by harbour seals in captivity. A pet two-year-old male hair seal consumed about eight pounds of smelt a day. Each of four adult harbour seals in the National Zoological Park, Washington, D.C., was eating about 15 pounds of fresh fish daily in the summer of 1942.

If one assumed that each adult seal in the Skeena River destroyed 10 pounds of salmon daily, a fairly serious problem in salmon predation would present itself. For example, if there were 1,000 seals in the entire river system, and they ate 10 pounds of salmon per day for six months, over 1,800,000 pounds, or about 30,000 cases, would be eaten. Nothing is known, however, of the extent to which the seals feed on other fresh water fish which may be present in the river. A beach-seine haul, made on June 28, 1945, just below the hauling-out grounds near Kwinitsa, netted several dozen Dolly Varden trout six to eight inches long and many starry flounders two to six inches long. Steelhead trout were also seen to be present in shallow depressions on sand bars. These constitute available seal food.

Further investigation is necessary in both estuarial waters and upriver areas, before a definite statement can be made on the extent of predation by harbour seals on salmon in the Skeena area or in British Columbia as a whole.

ECONOMIC STATUS OF THE SKEENA SEALS

In the Skeena River, salmon are caught exclusively by means of gill-nets. Damage to the nets from seal action was found to be small. On odd occasions a seal may become entangled in a net and cause wide tears, but in the over-all picture this is not serious. The usual extent of damage amounts to a few strands of the net broken where a seal attacks a salmon caught in the mesh.

The damage to salmon caught in gill-nets observed by the writer usually consisted of a few mouthfuls of meat torn from the throat region. In numerous cases the entire head was eaten away, and in the process strips of skin may have been torn from the body, rendering the fish worthless. In some instances the entire body of the salmon was missing, only the head being left hanging in the net. Sometimes the lower jaw was torn away (Figure 16).

Seal activity in the fishing area is invariably indicated by the presence of a skiff towed behind each gill-net boat. Normally fishermen prefer not to take a skiff with them, as its presence is a nuisance while setting and picking up a net. The majority of sets are made at low water slack. The net is then allowed to drift with the flood tide for up to an hour, after which it is "picked up" and the salmon are removed. In many cases the net is immediately re-set and allowed to drift again. The net is usually left untended in the water, but when seals are active it becomes necessary for each fisherman to "skiff" the net, that is, to maintain a ceaseless patrol of the entire 300-fathom length of the net in his skiff, carefully watching the corkline for signs of salmon striking a portion of the net, then rowing immediately to the spot to pull up that portion and to remove the salmon. If this is not done, many salmon may be mutilated by seals before the net is picked up. The seals are reported to become quite bold at night and to snatch at a salmon in the net while it is being reeled onto the net drum of the boat. No protective action other than patrolling the net seems feasible. The use of firearms is dangerous because of the presence of other boats in the vicinity.

In the majority of instances when seal damage occurred while the writer was present, the seal or seals had never been seen near the net, and had apparently carried out the whole attack while submerged.

Actual figures of amounts of damage done by harbour seals are recorded in Table VIII. These data were gathered by the writer on various boats and concern spring-salmon fishing only.

The few forms which were turned in by fishermen recording the damage in actual figures may be considered as fairly representative of the loss during the spring salmon (*Oncorhynchus tschawytscha*) season, since by the middle of May, 1946, only 28 boats were fishing on the Skeena.

Five records made by reliable men are reduced for convenience to the form shown in Table IX.

The majority of springs caught were of the red-meated variety. For these the fishermen received 20 cents per pound undressed, in 1946. The price granted

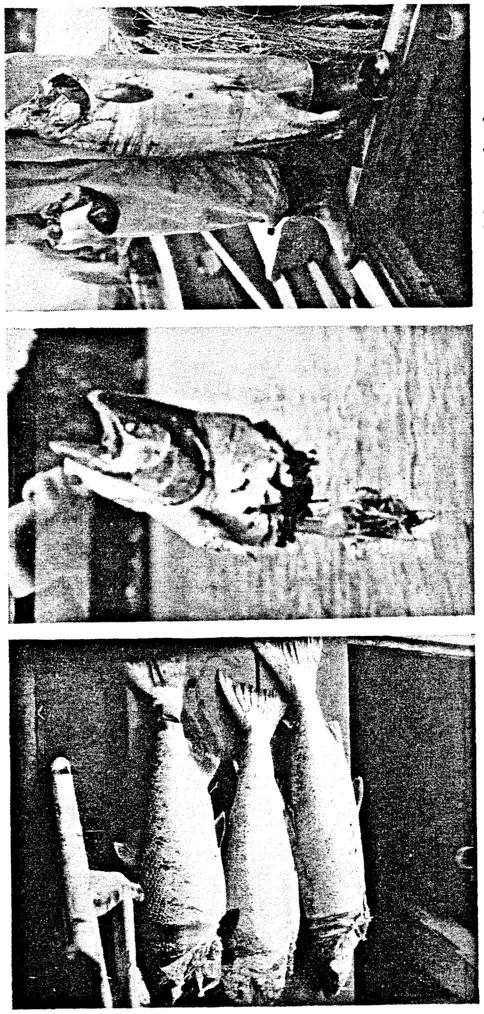


FIGURE 16. Seal damage to spring salmon caught in gill-nets, Skeena River. *Left*—most typical damage, heads eaten away. *Centre*—body eaten away. *Right*—lower jaw torn off, and all that was salvaged of another salmon. Note marks of gill-net behind pectoral fins.

TABLE VIII. Observable damage done by seals to six net sets for spring salmon in May, 1946. The sets were randomly selected by virtue of the author's presence on the boat.

Date	State of tide when set	No. of fish caught	No. of fish bitten	Percentage of body destroyed	Colour	Original weight	Weight of remains	Salvage credit per lb.	Loss
				%		*lb.*	*lb.*	*cents*	$
May 7	?	24	2	(1) 90	red	20	2	0	4.00
				(2) 90		15	2	0	3.00
9	low slack	18	3	(1) 20	red	15	12	6	2.28
				(2) 60	red	35	18	6	5.92
				(3) 80	red	20	9	6	3.46
13	low	12	1	20	red	20	16	6	3.04
20	?	21	1	2	red	18	16	6	2.64
27	?	15	2	(1) 24	white	25	19	0	2.00
				(2) 13	red	15	13	6	2.22
29	?	14	1	10	red	20	18	6	2.92

TABLE IX. Data from seal damage records Nos. 2 to 6 to show monetary loss in percentage of money made in the period May 20 to July 31, 1946, by five gill-net fishermen of the Skeena area.

Record number	Period fished	Number caught	Number bitten	Total money made	Loss	
				$	$	%
2	May 20 - 31	58	11	172.12	19.81	12
	June	50	0	148.40	0	0
	July	473	5	1,729.28	21.84	1
3	May 30 - June 8	187	12	555.04	43.19	7
	July 1 - 12	199	3	590.68	7.84	1
4	June 3 - 17	72	13	213.72	52.00	24
5	June	166	24	492.64	79.88	16
6	June	189	23	567.00	87.27	15
2 - 6 incl.	May 20 - 31	65	12	193.76	22.95	12
	June	657	71	1,935.16	259.20	13
	July	672	8	1,994.52	29.68	1.5
Total	May 20 - July 31	1,394	91	4,468.88	311.83	7

for white-meated springs was eight cents per pound. For individual salmon partly damaged, for example with a mouthful of meat torn from the belly, the price dropped to six cents per pound whether the meat was red or white. If mutilation was excessive, the fish was rendered entirely worthless.

It should be borne in mind that seals frequently remove salmon completely from the nets. Such cases were not recorded, since it was impossible to tell how many were removed. The loss as shown, therefore, is probably below that which actually occurred.

Of the 1,713,300 pounds of spring salmon recorded at the Head Office of the Dominion Department of Fisheries as being landed from the Skeena area in 1946, 968,700 (57 per cent) were red-meated and 744,600 (43 per cent) were white-meated. Neither the proportions of red and white, nor the individual weights, of the salmon recorded on the forms, are available. Therefore, the proportion of 57 per cent red springs and of 43 per cent white springs, with an arbitrarily set value of 20 pounds for each salmon, is used in estimating the loss in percentage of money made.

During the period June 3 to July 26, 1946, the number of boats increased, especially as of June 30, the opening date for the sockeye season, and the number of bitten fish decreased.

Although no damage is recorded in Record No. 2 for June, the fisherman stated that he tended his net continually, since a few seals were in the vicinity.

Record No. 4 is from a fisherman who operated in June, farther upriver and nearer to the fishing boundary than did any of the others who turned in forms. Seals were more numerous here than in any other part of the fishing area, hence the comparatively large loss in percentage of money made.

Although the figures obtained might suggest that seal depredation in May and June is about equal, many reliable reports from spring salmon fishermen indicate that the damage is at its worst in April and May, when few boats are on the river. With the great increase in numbers of boats accompanying the sockeye season, the activity of seals on the fishing grounds decreases considerably. This decrease in damage may be due to the increase in numbers of running salmon which creates a more available food supply for seals and makes it unnecessary for them to resort to net-raiding, or it may be due to the large number of boats (about 600) scaring the seals away, or spreading the damage over a greater number of boats.

Examples of seal-bitten sockeye were few, though the writer visited many boats fishing this species. The little damage occurring in July was centred on spring salmon. No records of damage to sockeye salmon were turned in by fishermen.

Walker (1915), recording damage from seal depredation in the period May 12 to 19, 1915, at the mouth of the Stikine River, Alaska, found that of a total of 1,462 springs taken in the nets visited, 348, or 23.8 per cent were seal bitten. The amount of damage later in the season or on other species of salmon was not ascertained.

Imler and Sarber (1947), investigating damage at the mouths of the Copper and Stikine Rivers, Alaska, inspected 10,863 salmon netted in the period May 28 to June 26, 1946, and the total loss observed was estimated as equivalent to 92 fish, or 0.85 per cent of the catch. This figure was considered as less than the actual loss. In this same publication, Imler is stated as believing that $15,000 would be a conservative estimate of the value of the total number of red (sockeye) salmon destroyed by harbour seal predation on the Copper River delta in 1945.

CONTROL

The Bounty System

A bounty system for the control of harbour seals is at present in effect in British Columbia. This system has been in force for 21 of the years in the period 1914-1947. The present amount of the bounty is $5.00. Claimants are required to present the nose of each harbour seal for which claim is made, with data about the date and locality of the kill.

In view of the fact that complaints in the gill-netting areas of British Columbia concerning harbour seal depredation on salmon are as frequent as they ever were, the bounty system has been examined with a view to evaluating the effects of the system in controlling the numbers of harbour seals on the British Columbia coast.

Kartchner (1941), Gerstell (1941), and Jacobsen (1945) present some of the recent trends of thought with regard to the bounty system for predator control. According to the modern viewpoint, a bounty system should include the following factors:

(1) It must be applied over a wide area practically covering the range of the species, otherwise the animals will increase in regions where it is not applied.

(2) The rates should be uniform in all localities and should be high enough to provide inducement for carrying out the system's provisions, yet not so great that the cost will exceed the losses which it seeks to avert.

(3) The responsibility for its operation should be vested in a qualified conservation agency, not an elective law-making body.

(4) The operating organization alone should possess power to place any species on the predator list or to remove it, to set rates of payment, to declare areas for and periods of effectiveness, and should possess power with a specific obligation to pass upon the validity of the claims presented.

(5) The system should guard against fraud and there should be adequate legal provision to allow for prosecution of any attempt at fraud.

A factor which is considered by Gerstell (1941) as advantageous, and which is pertinent to the present study, is that a bounty system of control could be made a source of supply of material for research on subjects such as distribution, reproduction and food habits.

The disadvantages of the bounty system, which in almost every instance have outweighted the advantages, are presented as follows:

(1) It is impossible to differentiate between those animals killed specifically for the bounty and those killed otherwise. Many predators are killed whether or not a bounty is placed on them. Claims paid for such individuals represent wasted money.

(2) Unless the system is extremely well devised, it encourages attempts at fraud, such as the presentation of counterfeit scalps, or the submission of claims for kills made in areas where the bounty rate is less or where there is no bounty.

(3) The expense is frequently out of all proportion to the benefit gained.

(4) Usually it has been found impossible to maintain equal rates of payment in all areas within the range of the species under control.

(5) It is seldom that overall control is justified or feasible and a bounty system cannot be made specific as to locality.

Effectiveness of Bounties in British Columbia

With the above points in mind, the results of the bounty system for harbour seal control on the coast of British Columbia will be considered for the period 1914 to December 1945.

From Table X it is seen that in the 21 years since 1914 in which the bounty system has been in effect, bounty was paid on 55,703 seals up to December 1946 with a cost of $145,901.50. The number of seals on which bounty was paid probably represents about 60 per cent of the actual kill, in view of the difficulties connected with recovery. Possibly not all of these were harbour seals, as fraudulent submission of sea-lion noses is known to have taken place. However, assuming that the claims *were* from harbour seal kills, a possible total of nearly 93,000 seals were killed. This does not take into consideration the years in which no bounty was placed upon seals, but in which a number undoubtedly were shot by fishermen.

For each bounty claim submitted, the date and locality of the kill is recorded only for the period 1942 to December 1947. The individual claims for this period were sorted by fishing districts, dates, and locality of kill.

One of the chief sources of error likely to distort the figures for harbour seal bounty claims is the possibility that sea-lion noses were at times passed off as harbour seal noses. Attempts to substitute sea-lion noses for those of harbour seals are common and are known to have succeeded. In one attempt which the writer witnessed 81 sea-lion noses had been dried thoroughly in salt, pounded flat with a mallet, had the longest nasal vibrissae pulled out, and had been altered in appearance with a knife to make them resemble harbour seal noses.

A further possible source of error is the fact that harbour seal noses may

Table X. Bounties paid for harbour seals, British Columbia, 1914-47.

Year	Rate	Number of claims	Amount paid
	$		$
1914–15	3.50	2237	7,829.50
1915–16	1.00	749	749.00
1916–17	1.00	785	785.00
1917–18	1.00	748	748.00
1918–27	No bounty		
1927–28	3.50	567	1,984.50
1928–29	3.50	3209	11,231.50
1929–30	2.50	5944	14,860.00
1930–31	2.50	6308	15,770.00
1931–32	2.50	6084	15,210.00
1932–33	2.00	4300	8,600.00
1933–34	1.50	400	600.00
1934–35	No bounty		
1935–36	No bounty		
1936–37	1.50	1933	2,899.50
1937–38	2.50	4295	10,737.50
1938–39	2.50	4569	11,422.50
1939–40	2.50	3546	8,865.00
1940–41	No bounty		
1941–42	2.50	3282	5,699.50
1942–43	2.50	1168	2,920.00
1943–44	2.50	1001	2,502.50
1944–45	2.50	961	2,402.50
1945–46	5.00	1978	9,890.00
1946–47[a]	5.00	1639	8,195.00
Total		55703	143,901.50

[a]Up to December, 1946.

have been imported from United States areas of the Pacific Coast at times when the Canadian bounty exceeded the American.

Table XI shows the annual kill by districts, for each locality which was found to provide consistently ten or more kills per year, or which showed an appreciable increase from a number lower than ten, and the percentage composition of the total kill, of the kills from each locality. The numbers of kills listed by "Remainder of District" were widely distributed throughout each fishing district of British Columbia. Table XII shows for the period 1939 to and including November 1946, the total *monthly kill* for each district. (See Figure 17 for locations of areas.)

While the data were being assembled in the above fashion, it was found that the exact localities of some bounty kills were uncertain. Such claims were omitted from consideration. The yearly totals for the three districts therefore

TABLE XI. Harbour seal bounties paid in areas within each district, 1942 to December 1946.

Area	1942-43	1943-44	1944-45	1945-46	1946-47	Totals	Percentage of total kill
District No. 1							
Fraser River	45	42	61	85	62	295	4.5
Remainder of district	20	33	36	46	36	171	2.6
District totals	65	75	97	131	98	466	7.1
District No. 2							
Naas River	37	44	60	70	46	257	3.9
Skeena River	36	40	21	93	160	350	5.3
Banks Island	32	39	10	21	21	123	1.9
Kitkatlah area	53	8	8	43	26	138	2.1
Kitimat area	18	46	13	33	11	121	1.9
Dean Channel area	44	22	56	64	14	200	3.0
Dundas Island area	31	71	26	41	39	208	3.1
Queen Charlottes	83	58	45	269	250	705	10.6
Totals	334	328	239	634	567	2102	
Remainder of district	230	130	110	250	247	971	14.7
District totals	564	462	349	884	814	3073	46.5
District No. 3							
Kingcome Inlet	18	17	14	17	7	73	1.1
Knight Inlet	13	7	16	45	13	94	1.4
Pender Island	54	49	23	44	24	194	2.9
Barkley Sound	25	5	1	14	37	82	1.2
Sechelt area	16	51	40	46	13	166	2.5
Blunden Harbour	26	31	32	31	44	164	2.5
Seymour Inlet area	37	14	18	26	25	120	1.8
Smith Inlet	17	20	18	17	33	105	1.6
Nitinat Lake	15	20	2	28	18	83	1.2
Bute & Toba Inlets	20	15	22	56	73	186	2.7
Quatsino Sound	19	23	20	44	16	122	1.8
Seal, Hornby & Denman Is.	42	15	14	36	27	134	2.0
Totals	302	267	219	404	330	1523	
Remainder of district	234	194	235	502	397	1562	23.6
District totals	536	461	455	906	727	3085	46.4
Grand totals	1165	998	901	1921	1748	6624	

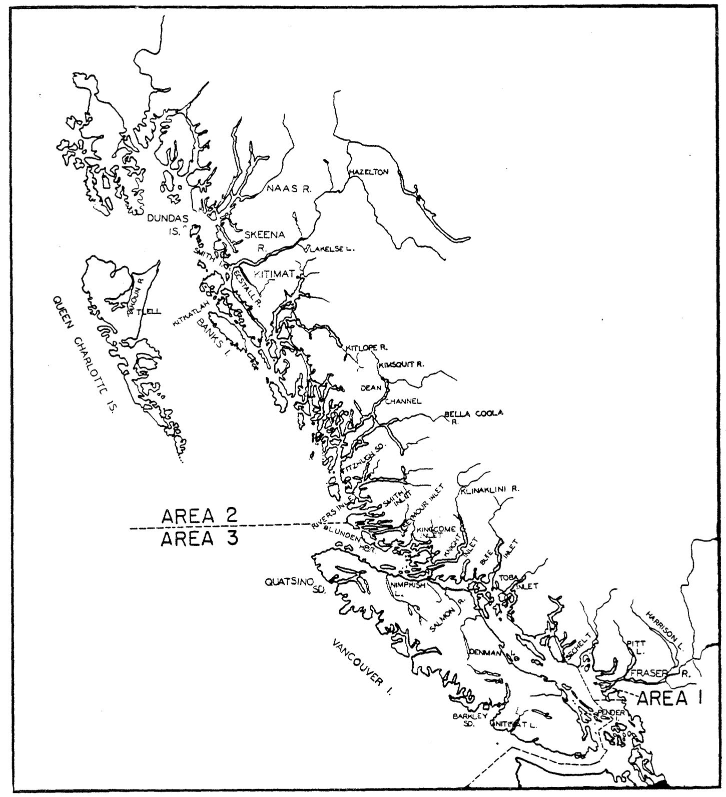


FIGURE 17. Coastline of British Columbia, showing the division into areas for purpose of fishery regulations.

may not exactly equal those recorded from the Annual Reports of the Dominion Department of Fisheries, but the difference in each case is insignificant.

From Table XI it is seen that of a total of 6,624 bounty claims examined from the three districts for the period 1942 to November 1947, 7.1 per cent of the kills occurred in District 1, 46.5 per cent in District 2, and 46.4 per cent in District 3.

In District 1, well over half the kill in the period under consideration came from the Fraser River in the area between the lightship off Sandheads to Harrison River. Of the total kill for the three districts, 4.5 per cent came from the Fraser, the third highest percentage for a specific area.

TABLE XII. Total harbour seals paid bountie in British Columbia from January 1939 to November 1948 tabulated by months. (December 1946 through March 1947 is omitted.)

	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total
District No. 1	24	46	39	78	155	165	123	39	22	14	15	25	745
District No. 2	349	584	1073	810	801	564	560	210	213	217	300	628	6309
District No. 3	202	374	705	484	727	656	535	426	261	273	272	359	5274
Totals for all districts	575	1004	1817	1372	1683	1385	1218	675	496	504	587	1012	12328
Yearly average	82	143	260	196	241	199	174	98	78	84	98	161	1814

In District 2, the kills on the east coast of the Queen Charlotte Islands form 10.6 per cent of the total kill, the highest percentage for any one area. The Skeena River, with 5.3 per cent of the total kill, is the locality with the second highest percentage for any one area. The Fraser River, with 4.5 per cent of the total kill, provided the third highest number of bounty kills, followed by the Naas River with 3.9 per cent and the Dundas Islands with 3.1 per cent of the total kill.

In District 3, the locality with the highest number of bounty kills was Pender Island, with 2.9 per cent of the total kill, followed by Bute and Toba Inlets with 2.8 per cent of the total kill, and the Sechelt area and Blunden Harbour each with 2.5 per cent of the total kill.

Aside from the above-mentioned localities in the three districts, and the localities in addition to those listed in Table XI, the remainder of the total kill showed no concentration in any area, but was widely scattered along the entire British Columbia coastline.

An examination of the total bounty kill by months for the period 1939 to and including November 1946 (Table XII), shows for Districts 2 and 3 a decided increase from April to June. In May the kill for the seven-year period is nearly double that of April, and in June the kill is nearly doubled again and is maintained at a fairly high level through the summer and fall, generally decreasing with the onset of winter. The rapid increase in the spring is correlated with the pupping season, which occurs at the same time, and the majority of noses submitted with the claims from May to August or September are of first-summer pups. The number of claims for District 1 shows no appreciable increase until August and September, reaching a peak in the latter month. The increase in this case appears to be correlated more with the sockeye salmon

fishing season and the majority of claims come from fishermen who shoot the seals while gill-netting in and off the mouth of the Fraser River.

It is not felt that the annual numbers of claims submitted represent to any significant degree an index to the abundance of harbour seals during the period under consideration. There is evidence that at the lower bounty rates many seals were shot for which claims were not submitted.

Association with many fishermen of the Skeena area during the summers of 1945 and 1946, provided strong evidence that the majority of men, making good money at fishing, did not consider it worth their while to make special efforts to hunt seals for the $5.00 bounty or to recover seals shot in the ordinary course of events. This has apparently been the case right from the advent of war and more prosperous times in the fishing industry, and offers a more likely explanation of the decrease in annual number of claims from 1938 to 1945, than does a decrease in the harbour seal population.

The increase of the bounty rate from $2.50 to $5.00 in 1945-46 does not appear to have offered greater inducement for the submission of bounty claims. Most fishermen contacted during this study stated that they always shoot a harbour seal when the opportunity arises, but that they make no great effort to recover them for the noses, even at the $5.00 rate.

It has been suggested, on the basis of indications considered in the previous section of this report, that the most serious depredations in numbers of salmon by harbour seals take place at the deltas of rivers, and in upriver areas above the commercial fishing boundaries. Control measures, therefore, should be centred in such areas, and in the areas of gill-net fisheries. The major localities in British Columbia representative of such areas would appear to be the Fraser River, the Skeena River, and the Naas River. From Table XI it is seen that while the Skeena, Fraser and Naas rivers are localities providing the second, third and fourth highest percentages of the total kill, these percentages are actually small, totalling only 13.7 per cent of the entire kill.

There are many smaller rivers, located along the entire length of the British Columbia coastline, into which salmon run. Some of these, for example, are the Kitimat River at the head of Douglas Channel, the Kitlope River at the head of Gardner Canal, the Bella Coola River at the head of North Bentinck Arm, the Klinaklini River at the head of Knight Inlet, the Yakoun and Tlell rivers on the Queen Charlottes, and, on Vancouver Island, the Nimpkish, Salmon and Nitinat Rivers. Harbour seals have been reported from all of these localities, but the number of bounty kills occurring in any of them is insignificant.

Complaints of harbour seal depredations are numerous from the gill-net areas of Fitzhugh Sound and Rivers Inlet, reports indicating that the problem was especially serious in the summer of 1946. Bounty kills, however, are insignificant in number in these areas also.

The 10.9 per cent of the total kill from the Queen Charlottes occurred mainly along the small offshore islands and reefs of the east coast, in the marine habitat. Many other localities providing bounty kills of ten or more per year are in the marine habitat where seals do not feed to a significant extent on salmon, for example, Banks Island, Pender Island, Blunden Harbour, Quatsino Sound, and Seal, Denman and Hornby Islands. The majority of claims lumped under the heading of "Remainder of district", forming 40.9 per cent of the entire kill, was from widely scattered areas in the marine habitat.

The bounty system, therefore, has a serious drawback in that the kill which it supports is too widespread and does not concentrate on those areas where the presence of seals is inimical to salmon. Fifty per cent of the total bounty kill occurs in areas where control is not really of value. The remaining kill is spread to such an extent that it appears to be having little effect in accomplishing its purpose.

The disadvantages of the bounty system for the control of harbour seals in British Columbia may be summed up as follows:

(1) From all evidence, the concentration of bounty kills in areas where control is needed is not sufficient to reduce adequately the numbers of harbour seals in such areas.

(2) That portion of bounty money which is being paid for claims from salt water areas represents wasted money, in view of the fact that such areas are remote from the fishing grounds and from the schools of salmon passing through these grounds.

Moreover, a number of seals are killed by fishermen whether or not a bounty is set on the seals. Claims paid for these also represent wasted money.

(3) The system appears to be encouraging attempts at fraud, such as the presentation of counterfeit snouts, and there is no adequate legal provision for the prosecution of attempts at fraud. There is no way, moreover, of checking the importation of snouts from American waters of the Pacific Coast.

(4) Equal rates of payment are not maintained in all areas within the range of the animal under control. The American bounty has differed from the Canadian, or else harbour seals have been protected in American waters while being bountied in Canadian waters, offering inducement for the smuggling of snouts from one area to another.

(5) The bounty system, under its present arrangement, cannot be associated with an investigation which would ascertain more about the seals, including the places and times that they do most damage, and the best methods of controlling them. Furthermore, it cannot be relied upon to provide an index to the annual abundance of seals. In any system of control of an animal, it is desirable to have accurate indications of the effect of the control upon the numbers of the animal.

The argument may be brought up that the harbour seal is an animal with a wide range, and that individuals killed in outlying marine areas are at least prevented from entering rivers and gill-netting areas. Insufficient data are at

hand concerning the seasonal ranges of individual harbour seals, but the animals are breeding in rivers and estuaries close by the gill-netting grounds, and the kill in these areas still allows the seals to maintain themselves at numbers which constitute a nuisance to the fishery.

Even if the bounty system did possess the five desirable features outlined at the beginning of this section, there is no indication that it could exert adequate control where this is required.

Alternative Methods of Control

During the writer's study on the Skeena River, methods of control other than by bounties were considered. While hunting seals near the sand bars in the Skeena, it was found possible to secure pups fairly easily by using a shotgun from a skiff. The young are very vulnerable just after birth since they are exceedingly curious and have to come to the surface more often than do older specimens. A 30′06 rifle fitted with a telescopic sight worked well on adults at long ranges though the majority sank in deep water before they could be reached.

In most areas under study it was found possible to approach carefully a group, hauled out, to within rifle range (about 300 yards). It appeared here that machine guns such as Brens might be effective, but no opportunity for a test was available. Soft pointed or other mushrooming ammunition should be used, as military ammunition frequently does not kill.

Dynamiting of a hauling-out bar has been tried in the Fraser River. McHugh (1918) describes an experiment involving a hauling-out site "located approximately half way between Point Grey and the north light on the Fraser River, about two miles south of the Vancouver Cannery". It was found impossible to approach closer than half a mile to a herd of "between two and three hundred" seals which at that time utilized the bar at low tide periods, and therefore control by ordinary hunting was not possible. No entire seal bodies were recovered after the explosion, though many apparently were blown to pieces. McHugh gave no estimate of the number of seals killed, but was confident that "every seal within the radius of the explosion, both in and out of the water was killed". The total cost of this experiment was $150, the major portion being for leading and connecting wires which would have served for use in further work.

Further experimentation along such lines should be carried out, preferably modified so that entire bodies could be obtained for biological study. All the sand bars located in the Skeena and Ecstall rivers are admirably suited to dynamiting, and there are undoubtedly bars in other areas of British Columbia where control may be needed.

Employment of one or more conscientious crews of trained hunters with suitable firearms and other equipment, and a good river boat and skiff, should accomplish far better results in harbour seal control than does the bounty system. Advantages of employing this method would be as follows:

(1) Control methods could be concentrated at will on spots where they are most needed, for example, in the Fraser, Skeena and Naas Rivers, and in gill-netting areas where the seal problem is acute.

(2) The system should provide much-needed knowledge on numbers, distribution, food-habits and reproduction, through co-operation with biological studies.

(3) The possibility of fraud would be eliminated.

(4) All seals killed would be additional to those which are normally killed whether or not a bounty is offered.

SUMMARY

Adult Pacific harbour seals obtained weighed between 128 and 300 pounds, the males averaging heavier than the females.

Distribution in British Columbia is extensive and includes at least 20 rivers and six lakes. Harbour seals are numerous at the estuaries of the Naas, Skeena, and Fraser rivers. An estimated 450 individuals utilize eight hauling-out sites in the area about the mouth of the Skeena River in summer months, while in the same season seals are widely distributed in the river up to and possibly above Hazelton, at least 200 miles inland.

A seasonal upriver movement in the Skeena River begins with the onset of the eulachon (*Thaleichthys pacificus*) run in March, developing to a maximum in the fall; its extent is apparently dependent upon the available salmon supply.

Daily movements of seals vary from a few hundred yards to several miles. They are controlled to a large extent by the tides in the estuary of the Skeena, and are completely governed by the tides in upriver areas within tidal influence.

Harbour seal habitats are divisible into three distinct types: purely marine, estuarial, and fresh water. The latter is subdivided into fresh water within tidal influence, above tidal influence, and lakes.

The adaptability of the harbour seal is illustrated in the varied conditions of environment in the three types of habitat. The need for the water balance mechanism existing in salt water areas is obviated in fresh water areas.

Mating in the Skeena area is reported to take place in September and October. The birth season in this area begins in the last part of May and ends in the last part of June. Parturition in upriver areas appears to be adjusted to the tidal exposure of the pupping sites. Newly born pups weighed from 21 to 26 pounds, and measured between 805 and 915 mm. (31.6 and 36.0 inches). The seal at birth bears a coat of soft yellowish foetal hair, loosely attached and rapidly shed. Newly born pups show no difficulty in swimming and submerging.

Evidence that pups born in salt water areas are weaned earlier than those born in upriver areas suggests that the longer suckling period in fresh water areas is made possible by the availability of fresh water.

The weight of the pup is doubled in the first five or six weeks of life, during which it is nourished by milk, and a weight decrease of about 20 per cent occurs during the weaning period in the fall.

Little evidence of disease was found, and few parasites other than ascarids were noted. Known parasites are the ascarids (*Porrocaecum decipiens* and *Contracaecum osculatum*) from the stomach, an acanthocephalan *Corynosoma semerme* from the ileum, a nasal mite of the genus *Halarachne,* and a sucking louse (Anoplura) of the family Echinophthiriidae.

Damage to gill-nets from seal action in the Skeena estuary was found to be negligible. The monetary loss suffered by fishermen from seal depredation upon salmon caught in nets is at its worst in the early part of the spring salmon (*Oncorhynchus tschawytscha*) fishing season in April or May, when it may amount to 12 per cent or more of the value of the catch.

The contents of 20 adult seal stomachs from British Columbia are recorded. Rockfish and octopus, unidentifiable fish (not salmon), salmon, herring, and shrimp occurred in that order of frequency.

The localities where seal depredation upon salmon is felt to approach significant proportions are in upriver areas, and this is where control should be centred.

After a review of the bounty system of control and its effect in British Columbia, this system is concluded to be ineffective, the chief reason being that the kill is too widespread, the majority of kills taking place in marine areas where control is of little value.

The employment of one or more crews of trained hunters equipped with proper facilities should result in far better control than does the bounty system.

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