EASTERN CANADIAN GREY SEAL: 1978 RESEARCH REPORT AND STOCK ASSESSMENT

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INTRODUCTION

This document reviews the research on grey seals conducted in 1978 and presents a new assessment of the eastern Canadian population. The revised assessment is based on the results of two years of complete cohort tagging on Sable Island (see Figure 1) and a revised natural mortality rate as developed in Harwood and Prime (1978). The latter rate is about two-thirds of the value used in the 1977 assessment (Gray 1977) and the subsequent virtual population analyses seem to better reflect what is known about the population. Though the analyses give reasonable estimates of the order of magnitude of the population, there are still wide ranges for the estimated numbers. Research in the next few years will be aimed at narrowing these ranges.

REVIEW OF RESEARCH

This year the research on grey seals included continuation of the work to improve population estimates and an attempt to estimate the costs to fishermen of damage by grey seals along the Eastern Shore of Nova Scotia.

In January-February 1978 virtually all of the pups born on Sable Island were again tagged (see Appendix 1). The pup counts made during the tagging operation indicated that the pup production was 2687, an increase of 23% over that of last year. This increase may be partly due to a disturbance of the Camp Island herd that caused most of it to pup elsewhere. In the last two or three days of the Sable trip few pups were born and so it is unlikely that more than a few pups were missed in the count. Approximately 14% of the pups were found dead from desertion and subsequent starvation by the end of the tagging trip. However by that time most survivors had weaned and so it is unlikely that mortality rates of this magnitude continued much longer.

The prime use of the tags applied on Sable Island is to divide Sable Island pups from other pups in the bounty kill. It was suggested that any substantial tag loss would bias our results because the number of killed pups from the Sable Island production would appear to be lower than was actually the case. Therefore, this year, as well as tagging all pups, 1025 were branded with the letter 'S' on the lower back. An initial analysis of the returns is found in Beck (1978) which is attached as Appendix 2. To determine rates of tag loss it is important to consider only animals which were checked for both tags and brands. Many tags are returned without brands from branded seals because either it is thought the reward for brands is not worth the effort required to remove and prepare the branded patch or the seal is not checked for the brand. Given this situation, some tagged and branded seals which had lost the tag would not be identified. Hence in analysing tag loss we considered only those seals from which brands were returned. To date (2 Jan 79) 29 brands have been returned with 28 accompanying tags. In the one case in which only a brand was sent in, the seal was checked carefully for a tag. This gives a tag loss rate of 3.5%. Of course, because of the small number of returns, this number is just a rough approximation, but it does indicate that tag loss should not seriously bias our calculations.

Since the total number of pups produced on Sable Island is known and they are all marked, then we can use the Petersen method to estimate total pup production if the pups from all segments of the population are found, well mixed, in one area. Most grey seal pups are born in the southern Gulf of St. Lawrence-Northumberland Strait area, on islands along the Eastern Shore or on Sable Island. Seals from all these areas are found the rest of the year in the area from Halifax to Scatari (see Mansfield and Beck, 1977). Since 1967 most of the seals born on the Eastern Shore islands and some born in the Gulf have been culled. In this analysis we assume that the majority of Sable and Gulf produced pups are found along the shore from Halifax to Scatari and that the proportion of tagged pups in the bounty returns from this area is representative of the proportion of Sable pups in the entire population. Using the Petersen method, the returns for 1977 and the 115 tags returned by November 1978 yield total pup production estimates of 10,565 (95% confidence limits 6828 - 17,158) and 12,992 (9038 - 19,988) respectively.

There are three problems remaining with the use of these estimated productions. First, the small sample size means that each proportion has wide confidence limits. However, each year we are making an independent measurement of the proportion, and so, if it changes little from year to year, the confidence limits around an overall estimate will decrease with each new estimate. Second, we do not know that the same proportion of the Sable and Gulf pups spend the summer along the Nova Scotia coast. Our present methods assume this distribution and any deviation from this assumption will bias the estimates. To try and determine how these proportions compare, pups born in the Gulf and those born on Sable will be tagged in 1979. Third, there is some indication that a group of grey seals produce pups in the northern Gulf. Some of these pups will show up in the bounty kill but they may not be considered by this method of assessing pup production. However, close touch is maintained with the fishermen in various locations around the Maritimes and any evidence of newly discovered pupping areas is checked thoroughly.

This summer a damage survey was conducted along the Eastern Shore and in Cape Breton (the main areas of grey seal damage) to try and estimate the cost to fishermen of this damage. This survey was conducted by Ms. Deborah Lawrence of the Program Planning and Co-ordination Branch. The results will be made available as a separate CAFSAC document.

NEW DATA

Once again in 1978, the department carried out a controlled cull of seals in breeding areas in the Gulf of St. Lawrence and along the Eastern Shore. Table 1 gives the breakdown of the numbers culled in the last 12 years.

We now have aged all returns from the 1977 bounty kill and a large proportion of the returns from the 1978 bounty kill. Table 2 shows these bounty kills by age along with past random samples. Figure 2 shows the same data in a more visual form. The 1977 bounty kill shows a lower number of 1 - 5 year olds relative to older seals than would be expected if all age groups are equally exploited or from comparison with the previous samples. It does not appear that this indicates a decline in the size of recent year classes since some of the same year classes were better represented in the 1976 bounty kill. Not enough of the jaws from the 1978 bounty kill have been aged for valid comparisons to be made.

The data presented in Table 2 were used to estimate average total mortalities experienced by the seal population. If the equation $N_t = N_o \exp(-At)$ is fit to aged catch data for a stable population, A will estimate Z = M + F, the average total mortality experienced by the population during several years up to the date to which the data refer. However, if the population is increasing at a constant rate R then A will estimate R + Z = R + M + F. Hence, unless there are other pieces of information that can be used to estimate some of the parameters, we cannot obtain independent values for R, M and F. Regressions were run for all the sets of data shown and various combinations of them. Runs were made for ages 1 - 29, ages 1 - 20 and ages 6 - 25. Resulting A's ranged from .1 to .2 with most values between .14 and .17. The lower values were found when the younger ages were included. F on juveniles will be lower because they are not in the breeding areas and therefore not affected by the controlled cull and because, as noted above for 1977, they may not be fully available to the bounty hunt.

No new data were available on age-specific reproductive rates or age distributions on the breeding grounds. If the population has been increasing it would be interesting to determine if there had been a density-dependent shift in the reproductive rates. Due to the size of the bounty kills, samples must be collected for several years to get reasonable estimates of rates. It is proposed that we begin collecting pregnancy data this year to obtain rates that can be compared with those in Mansfield and Beck (1977).

In Harwood and Prime (1978) survival rates are estimated using catch curves for a population on which F is zero and R is known. They estimate an annual survival rate of at least 0.935 which corresponds to an instantaneous natural mortality rate of 0.067. In our 1977 assessment, we used estimates of M of at least 0.1 since the data we have are not sufficiently detailed to allow a reasonable estimate to be made and 0.1 is as low as we had found in the recent literature on seals.

CATCH-AT-AGE

The catch-at-age data for 1977 was calculated as outlined in Gray (1977). However, in that assessment, the reproductive rates in Mansfield and Beck (1977) were misinterpreted. In their data, the rates were associated with the age at conception. Since ages are determined and assigned from the start of the pupping season rather than at conception which is about 12 months earlier, the age at pupping is one higher than assumed in the 1977 assessment. Hence their data imply that 16% of the 4 year olds, 71% of the 5 year olds, etc. will pup not 16% of the 3 year olds, 71% of the 4 year olds, etc. as used in the 1977 assessment. Catch-at-age figures for all years were recalculated with this change and are presented in Table 3.

COHORT ANALYSES

Cohort analyses were run for ages 1 to 20 and keyed to estimated pupping rates and pup productions as outlined below. Two final runs were accepted and both of these show the population to be increasing.

In last year's assessment (Gray 1977) we assumed M was at least 0.1. Most of the cohort analyses run indicated that the population was stable or was becoming stable. However, this is at variance with the obvious increase in the part of the population pupping on Sable Island. Table 4 and Figure 3 show the pup production on Sable Island for the past 17 years. These data indicate that this part of the population is increasing at a rate of about 12% per year. The sharp increases in the last few years may be indicative of general population increases or due to disturbances in the breeding colonies close to the mainland. Such detailed statistics on the rest of the herd are not available but the cull data may give some indication of the general situation. If we ignore the first two years in which the cull was very low due to lack of knowledge of conditions and exact pupping dates, there is no significant trend in the number of pups or adults killed. The data is very variable due to problems with ice conditions and weather, but more or less the same number are killed each year. Almost all pups and, a fair proportion of adults in the cull area are killed each year, and since the results of culling do not indicate a declining population, some seals must be immigrating into these areas in order to keep the numbers approximately stable. This immigration appears to be about the same each year, thus it can be assumed that the Gulf part of the herd is remaining relatively constant. The actual increase in herd size in the past few years, therefore, depends on the relative sizes of the Sable and Gulf breeding components and the rate of increase of the Sable Island herd.

As the earlier discussion of catch curves indicated, there is a trade-off between estimates of R, M and F. It seems that the R that could be derived from the cohort analyses run in 1977 is too low. Therefore this year the cohort analyses were run with the estimate of M = 0.067 with the result that for a given F we would expect to obtain higher estimates of R.

The hunting mortalities (F's) to be put into the analyses will depend upon population size and partial recruitment. We developed estimates of starting F's by an iterative procedure using two scenarios. For the first scenario the Peterson estimates from our taggings were assumed to be correct and the production in 1977 was set at about 10,600. In the second scenario the estimate in Mansfield and Beck (1977) that production in 1976 was 6,400 was assumed correct. In both cases cohort analyses were run until (1) the estimated population could produce the required production in the indicated year, (2) pup mortalities were approximately constant, (3) mature F's followed catch size adjusted for population size and (4) the overall value of R + M + F appeared reasonable. Note that condition (3) uses the fact that the catch and the fishing mortality are approximately linearly related if F is small and the population is relatively stable.

For both scenarios a resonable partial recruitment was found to be .175, .225, .25, .3, .7, 1, 1, 1, ... The low values for early ages are reasonable since 44% of the 1+ seals (ages 1 and older) killed in 1977 were shot in the pupping areas and young seals did not show up well in the bounty kill. If we assume the lack of young seals is due to small year classes and, therefore, use higher partial recruitments on ages 1 - 5 we get estimates of numbers at age that imply very high instantaneous pup mortality rates (0.9 - 1.0). These are about double both the rates found for earlier year classes and those found by Harwood and Prime (1978).

Results from the two cohort analyses are presented in Table 5. Both analyses fit the data quite well and provide reasonable estimates of the various parameters. Table 6 and 7 give the estimated numbers-at-age for scenarios 1 and 2 respectively. As is seen we now suggest that the population is still increasing.

The only major difference between the two analyses presented is the size of the population. The pup production of 6400 in 1976 (scenario 2) is probably a minimum estimate because the analysis in Mansfield and Beck (1977) tried to account for all pups from known pupping areas. Tagging returns and bounty kills indicate that the heaviest concentrations of seals in the summer are between Halifax and

Scatari. Tagging studies (Mansfield and Beck, 1977) suggest that most of the Gulf born pups come out into this area in the spring. In May 1978 during a harbour seal tagging experiment on Sable Island, more than 6000 grey seals were observed on the Island including more than 1000 pups. A rough count of tagged and untagged pups indicated that about 50% were Sable production. If we estimate a total pup production of 10,600 with a Sable production of 2687, the May 50:50 estimate indicates the Sable pups are overrepresented on Sable. Thus it is probable that the Sable production is underrepresented on the Eastern Shore, at least in early summer. If this is true, the pup estimates used in the first scenario will be high and this thus is an upper limit. However, this has yet to be tested and there are wide bounds on the estimate so it is possible that the population in 1977 was greater than 43,000. However, we feel that we now have reasonable estimates on the rates involved in the population changes and that we know the order of magnitude of the population.

PROJECTIONS

The populations estimated by cohort analysis under scenarios 1 and 2 were projected to 1982. The projections assume pupping rates stay the same and the average pup mortality derived from the cohort analysis applies.

Three projections were run for each population estimate. All three assumed a pup kill of 1000 and a fully recruited F equal to the 1977 level for 1978. In addition, the first projection assumed hunting stopped after 1978; the second assumed a pup kill of 1000 and a fully recruited F equal to the 1977 level; and the third assumed the pup kill and fully recruited F in 1979-1982 was double the present level.

Under both scenarios the population increases at a rate of 0.07 (or 7.5% per year) if hunting is stopped. If hunting is continued at present levels, the population rises slowly. If hunting is doubled, under scenario 1 the population starts to level off and under scenario 2 it begins to decline in 1980. These projections, along with the cohort population sizes are shown in Figure 4.

CONCLUSION

In this assessment, higher population levels have been estimated than in the 1977 assessment. This is due to the new lower estimate of natural mortality and the higher pup production estimated in scenario 1. The natural mortality appears to give a more realistic explanation to the apparent increase in population size currently observed. In last year's assessment we also had an unrealistically high estimate of pup mortality. This, however, was due to misinterpretation of the pupping rate data which has now been corrected. The major weakness of the analysis is the lack of knowledge of the exact present level of the population. It is hoped that this will be improved by results of tagging programs over the next few years.

All indications are that the grey seal population has been growing since the mid-sixties and that this growth has been slowed by the imposition of a bounty in 1976. In 1979 the cull of ice breeding seals will be curtailed so that part of the Gulf pup production can be tagged to help determine mixing rates. However, proposed changes in the bounty regulations may lead to an increased bounty kill that will offset the reduced level of the cull and increase the size of the sample available to estimate age composition of the population. If the cull is continued in 1980 it is important that we get jaws from all culled animals as the present method of assigning ages to the culled seals is unsatisfactory and this is one of the largest gaps in our data.

References

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J. Harwood and J. H. Prime, 1978. Some factors affecting the size of British grey seal populations. Journal of Applied Ecology, 15, pp 401-411.

A. W. Mansfield and B. Beck, 1977. The grey seal in Eastern Canada. Fisheries and Marine Service Technical Report No. 704.

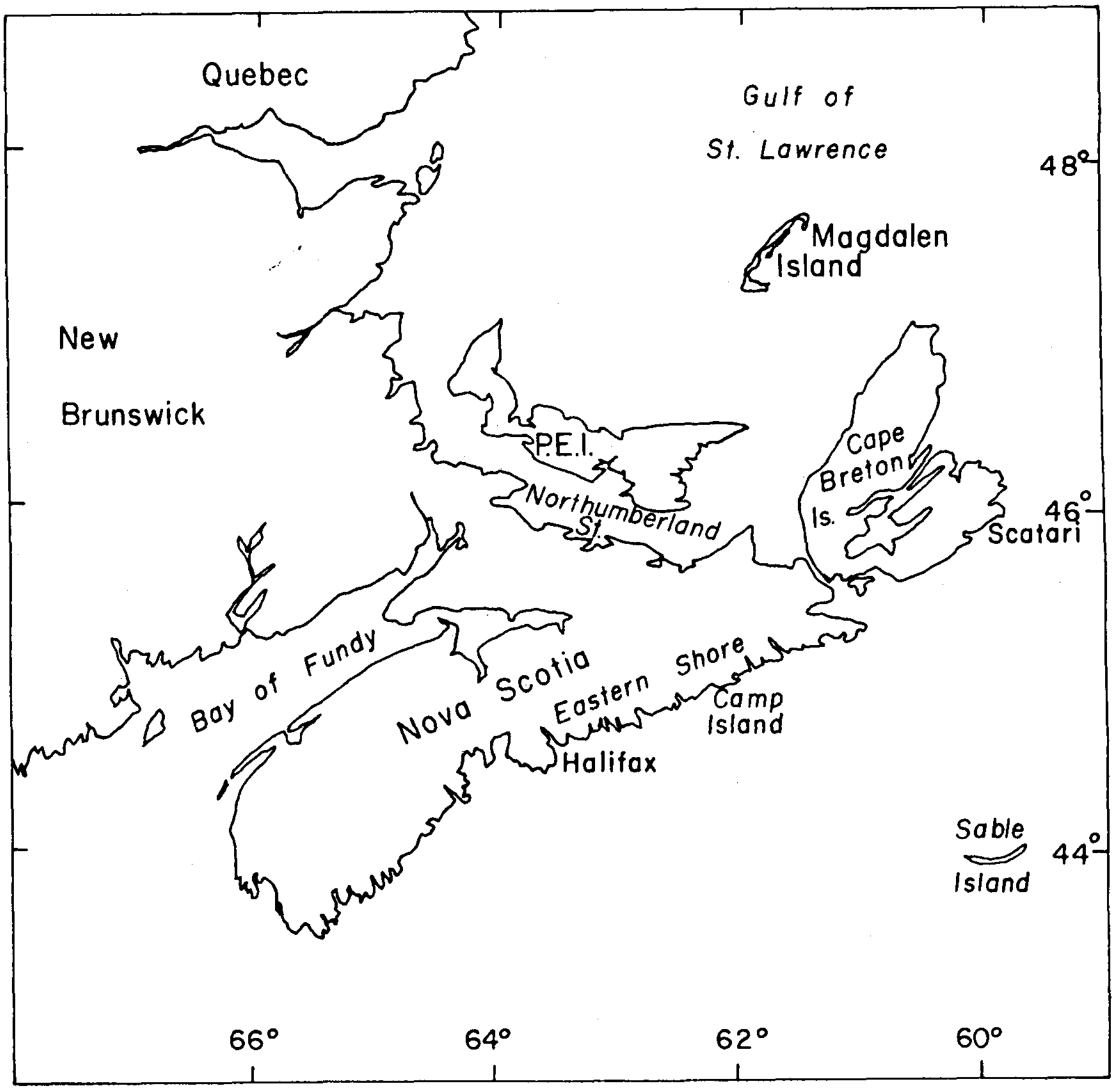


Figure 1. Map showing areas discussed in the paper.

Figure 2. Age Distribution of Random Samples

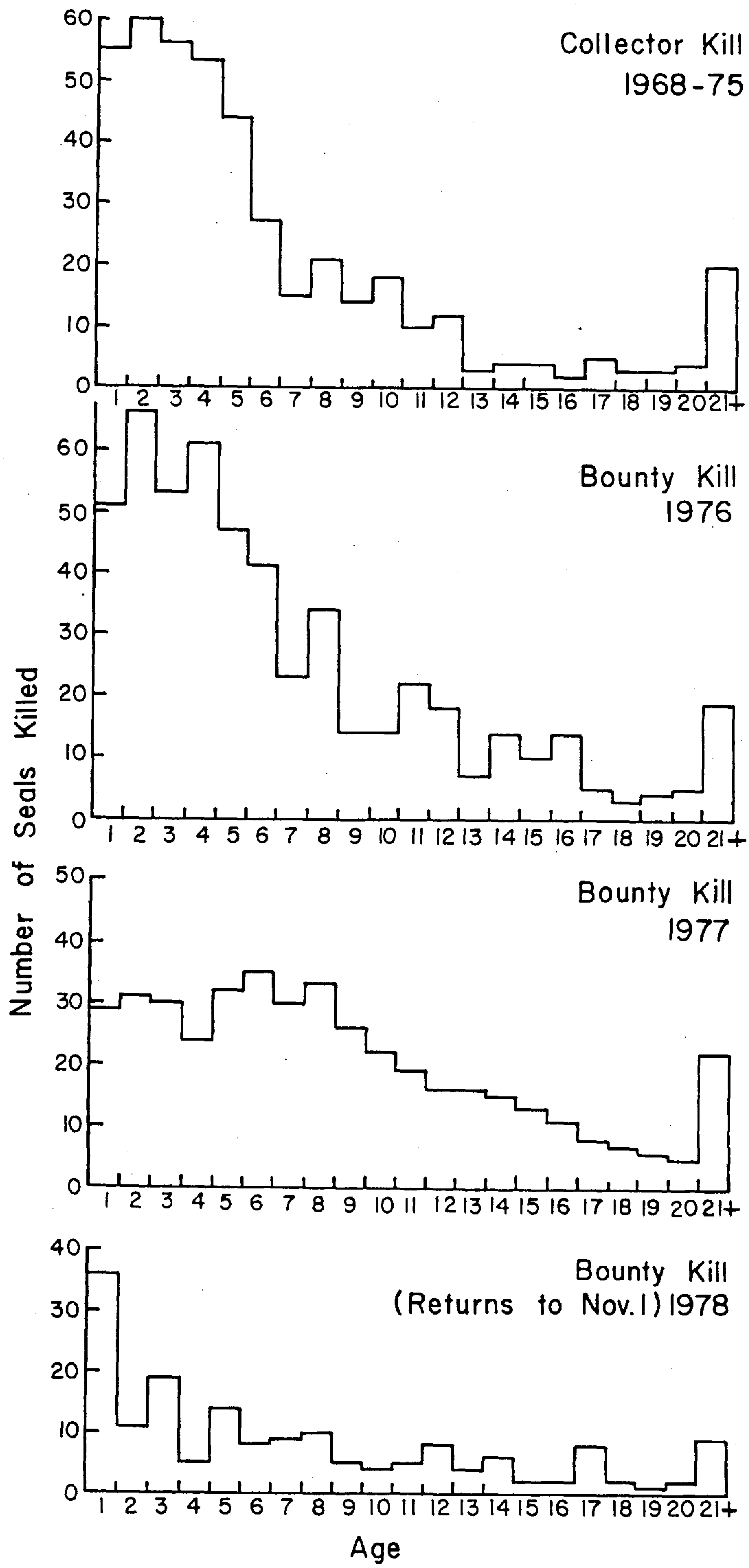
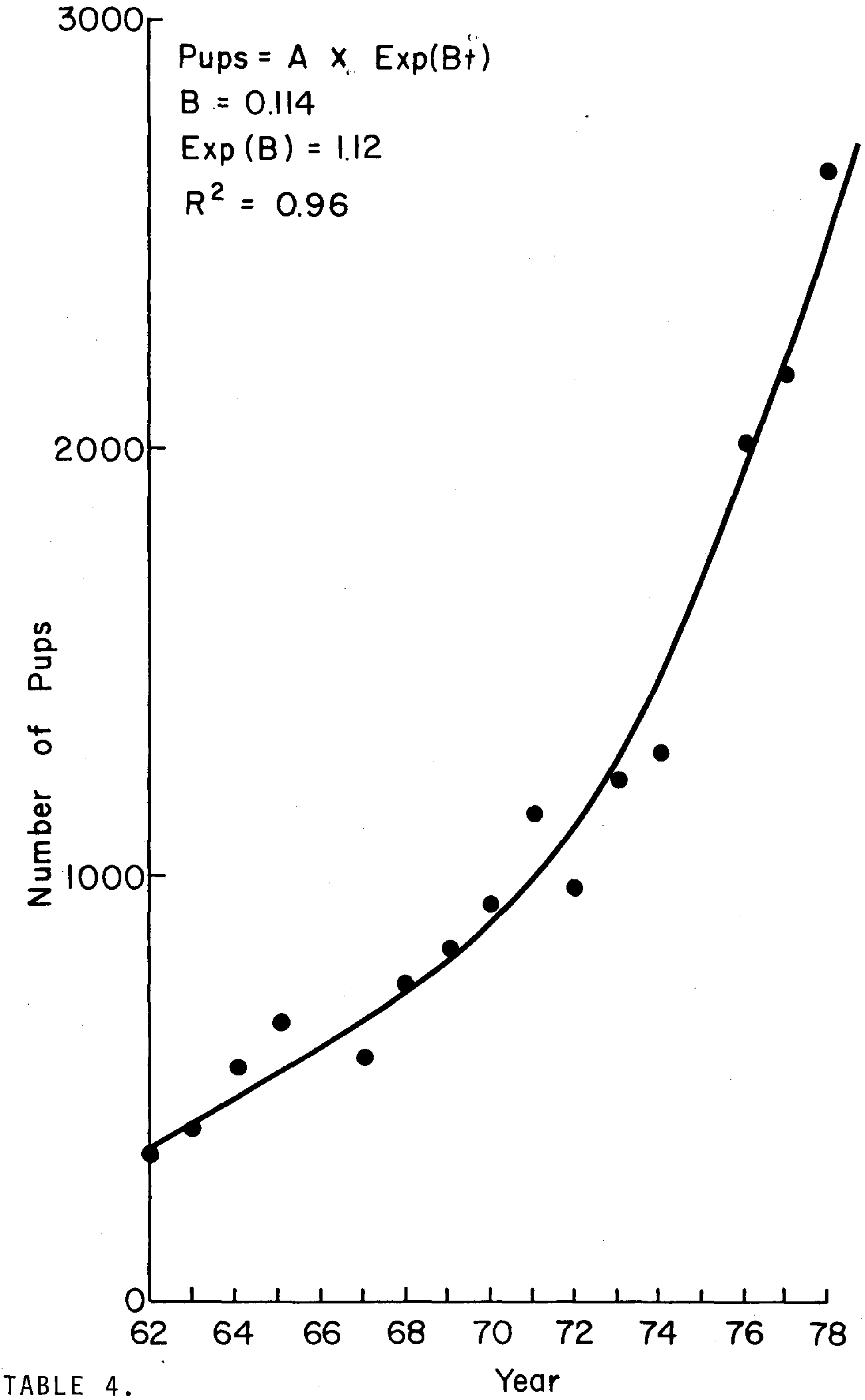


Figure 3. Grey Seal Pup Production, Sable Island



NOTE: SEE TABLE 4.

Figure 4. Population Estimates and Projections

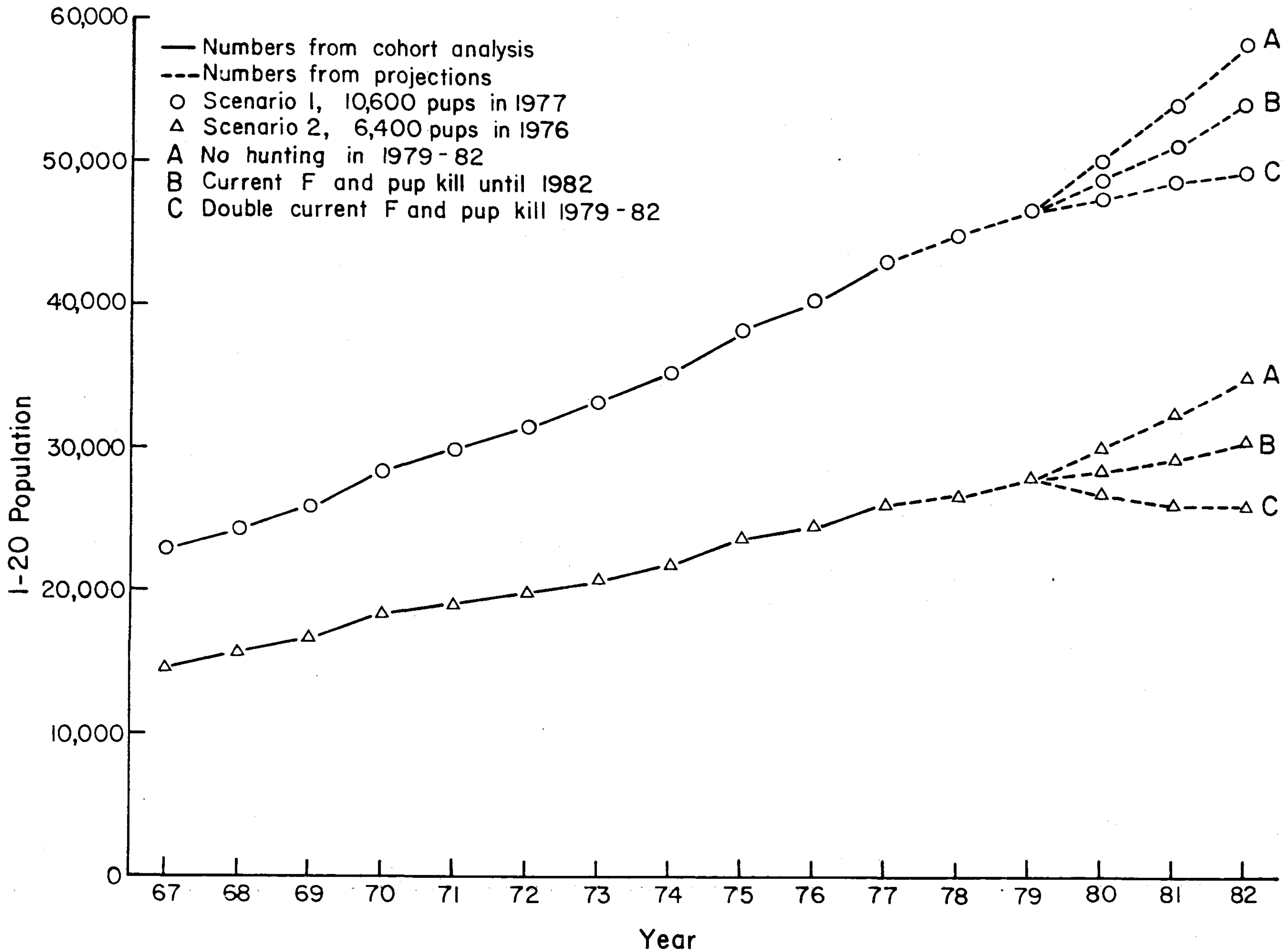


Table 1: Controlled Cull (1)

Year	Male	Female	Total Adult (2)	Pups	Total
1967	14	3	17	212	229
1968	16	2	18	134	152
1969	3	19	189	589	778
1970			125	520	645
1971			122	743	865
1972	22	110	132	599	731
1973	4	35	64	558	622
1974	17	109	126	1042	1168
1975	54	480	534	1619	2153
1976	13	83	96	545	641
1977	150	192	342	1046	1388
1978	59	88	147	569	716

Note: (1) includes seals killed by others and found during cull.

(2) not all adults sexed so total may be different from males plus females.

Table 2. Age Distribution of Random Samples

Age	Collector's Kill 1968-75	Bounty 1976	Bounty 1977	Bounty 1978 (1)
0	196	188	190	169
1	55	51	29	36
2	60	66	31	11
3	56	53	30	19
4	53	61	24	5
5	44	47	32	14
6	27	41	35	8
7	15	23	30	9
8	21	34	33	10
9	14	14	26	5
10	18	14	22	4
11	10	22	19	5
12	12	18	16	8
13	3	7	16	4
14	4	14	15	6
15	4	10	13	2
16	2	14	11	2
17	5	5	8	8
18	3	3	7	2
19	3	4	6	1
20	4	5	5	2
21^{+}	20	19	22	9
Total 1+	433	525	430	170
Total 0+	629	713	620	339

(1) Incomplete (includes all returns to 1 Nov. 1978)

Table 3. Estimated Catch-at-Age
(see text for explanation)

AGE	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
0	212	144	635	630	743	599	558	1042	1649	733	1236
1	0	2	6	28	0	0	0	0	19	51	29
2	0	5	10	28	0	0	0	0	17	66	31
3	0	9	11	28	0	0	0	0	8	53	30
4	1	8	14	26	5	6	3	5	66	65	29
5	3	9	40	40	19	20	10	19	120	59	60
6	3	0	30	36	19	20	10	19	93	54	73
7	2	6	17	10	15	16	8	15	56	30	63
8	2	6	34	19	11	12	6	12	19	45	69
9	1	3	30	5	9	10	5	10	56	19	54
10	1	6	26	19	7	8	4	8	5	19	46
11	1	3	4	14	6	6	3	6	19	29	40
12	1	2	13	19	5	5	2	5	5	24	33
13	1	2	0	5	4	4	2	4	5	9	33
14	0	0	4	5	3	3	1	3	19	19	31
15	0	2	4	2	3	3	1	3	19	13	27
16	0	0	4	0	2	2	1	2	19	19	23
17	0	3	4	2	1	1	1	1	19	7	17
18	0	0	9	0	1	1	1	1	19	4	15
19	0	2	4	2	1	1	0	1	5	5	13
20	0	2	0	5	1	1	0	1	19	7	10
20+	2	6	17	26	11	12	6	12	19	25	46
1+	18	76	281	319	123	131	64	127	626	622	772
0+	230	220	916	949	866	730	622	1169	2275	1355	2008

Table 4. Pup Production on Sable Island

Year	Number of Pups (1)
1962	350
1963	400
1964	550
1965	660
1966	No data
1967	580
1968	750
1969	836
1970	930
1971	1060
1972	982
1973	1226
1974	1278
1975	No data
1976	2006
1977	2181
1978	2687 (2)

(1) Data actual counts or estimated from Mansfield and Beck, 1977

(2) May include part of Camp Island group disturbed by hunters early in the pupping season.

Table 5 Results of Cohort Analyses

	Scenario 1	Scenario 2
Controlling pup production	10600 in 1977	6400 in 1976
Fully recruited F in 1977	0.028	0.046
Population in 1977	42941	26284
Natural mortality, M	.067	.067
Average rate of population increase	.061	.056
Estimated average pup mortality	.473	.432
Estimated average fully recruited F	.010	.016
Estimate of R + M + F over past few years	0.14	0.14

Table 6. Estimated Numbers-at-age: Scenario 1

	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
1	3199	3329	3701	4368	3772	4983	4269	4463	5176	5509	6133
2	2629	29992	3111	3456	4058	3527	3725	3992	4174	4822	5103
3	2653	2459	2793	2900	3205	3795	3299	3484	3734	3887	4446
4	2398	2481	2291	2601	2685	2997	3549	3085	3258	3484	3584
5	2103	2241	2312	2129	2408	2506	2797	3316	2880	2983	3195
6	1824	1964	2087	2124	1952	2233	2324	2606	3082	2577	2732
7	1404	1703	1837	1923	1951	1807	2069	2164	2419	2793	2358
8	1217	1311	1587	1701	1789	1810	1674	1927	2009	2208	2583
9	1043	1136	1221	1451	1573	1662	1681	1560	1791	1861	2021
10	812	974	1059	1112	1352	1462	1545	1568	1449	1620	1722
11	564	758	905	965	1022	1258	1360	1441	1458	1351	1497
12	706	526	706	843	889	950	1171	1269	1342	1345	1235
13	336	659	490	648	770	827	883	1093	1181	1250	1235
14	332	316	614	458	601	716	769	824	1018	1100	1160
15	295	301	296	570	424	559	667	718	768	934	1010
16	287	276	279	273	532	393	520	622	669	700	861
17	323	268	258	257	255	495	366	485	580	607	636
18	239	302	248	238	239	238	462	341	453	524	561
19	443	223	283	223	222	222	221	431	318	405	486
20	207	414	207	261	207	207	207	207	402	293	374
1-20	23016	24645	26296	28511	29913	31657	33568	35605	38170	40261	42941
pup production	5554	6115	6554	6949	7386	7934	8578	9343	9962	10291	10790

Table 7 Estimated Numbers-at-age: Scenario 2

	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
1	2070	2115	2368	2774	2411	2509	2650	2755	3193	3380	3739
2	1697	1936	1976	2209	2567	2255	2346	2478	2577	2968	3112
3	1721	1587	1805	1838	2039	2401	2109	2194	2318	2393	2712
4	1523	1610	1476	1678	1692	1906	2245	1972	2052	2160	2187
5	1341	1423	1498	1367	1544	1577	1777	2097	1839	1855	1957
6	1175	1251	1322	1362	1239	1425	1456	1652	1943	1604	1678
7	924	1096	1170	1207	1239	1141	1314	1351	1527	1727	1448
8	793	862	1019	1078	1119	1144	1051	1221	1249	1374	1586
9	786	740	801	920	990	1036	1058	977	1130	1150	1241
10	529	631	689	720	856	917	959	985	904	1002	1057
11	365	494	584	619	655	793	850	893	913	841	919
12	407	341	459	542	565	607	736	792	830	836	758
13	229	380	317	417	489	524	462	687	735	771	758
14	219	213	353	296	385	453	4896	524	638	683	712
15	199	204	200	326	272	357	421	454	487	578	620
16	197	186	189	183	303	251	331	393	421	437	528
17	218	184	174	173	171	282	233	309	365	375	390
18	160	204	169	159	160	159	262	217	288	323	344
19	295	150	191	150	148	148	147	244	202	251	298
20	138	276	138	174	138	138	138	138	228	184	229
1-20	14887	15892	16907	18201	18991	20033	21142	22342	23849	24902	26284
pup production	3602	3952	4223	4441	4687	5013	5401	5877	6254	6387	6624

APPENDIX 1

Trip Report to Sable Island

January - February, 1978

Hoek, Petalas, Bruemmer (ABS), Beck, Stobo, Gray (MFD), A. Lucas (Sable Island Advisory Committee) on Sable Island for various periods between January 19th and February 9th.

Haig, Rowsell, Hughes (COSS) worked as an independant group on a drug testing programme on the West spit.

A total of 2, 687 grey seal pups were born on Sable.

Tagged live	-	2,266	
Untagged live	-	1	
Dead		365	
Small Island live	-	55	Not tagged
		2,687	

The 55 pups referred to as small island live, were born on a small island which formed about 1/2 mile west of West Spit. They were counted from the air on February 9th, all were white coats. It appeared that only the females giving birth towards the end of the season had used this island, and the 55 white coats probably represent the majority of pups produced there.

Of the 2,266 pups tagged, 1,025 were branded in the lower back with the letter 'S' to test tag retention - during the branding operation all tags were re-examined. Three (3) pups had lost their tags, and two (2) others showed signs of the tags pulling through the flipper. The cause of this tag loss appeared to be caused by swelling of the tagged flipper. This was rectified in later tagging by placing the tag lower down on the web, which appeared to over-come the problem.

All dead young were stained with a picric/alcohol solution when counted. Due to the almost constant good weather, the numbers of dead recorded appear to be as realistic as can be obtained, and probably represent a large percentage of the total dead.

Numerous branded adults were seen, data recorded elsewhere, but of interest were 4-'G1' females with pups, marked as pups in the Gulf in 1971 and 'U' branded female with pup, marked as a pup on Basque Island in 1964. Three (3) one year old tagged females were seen, from the cohort tagged on Sable in 1977.

Two (2) Phocoena phocoena had stranded on East Spit relatively fresh, they had been largely consumed by gulls, and the sex not determined; one was 6 ft. long and the other 3'6" long. One (1) male Globicephala 3 metres long stranded on West Spit and one (1) Lagenorhynchus actus had stranded at Old Main on the South Beach.

The dune at the back of East Light appeared to be stable, but the dunes at the West and East sides of the house are starting to move across the front. The encroachment of the East dune across the garage door, means modifications will have to be made. The pump house was raised approximately 3 ft in a feat of construction wizardry.

The MF tractor continues to work well, but its general condition (severely rusted wheels and body) indicates it must be replaced if the field station on Sable is to continue to function. The trailer wheel split on the first day on the Island, we used one from the West end for the entire period. A new axle and wheels are needed before next season.

B. Beck
February 15, 1978

/mmci

TAG LOSS EXPERIMENT 1978

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During the winter of 1978, 2688 grey seal pups were tagged on Sable Island, of these 1025 were branded with the letter 'S' on the lower back. The purpose of the double marking programme was to provide information on tag retention over time, data from the programme should continue over the next decade.

During the tagging programme it was noted that tags placed too far up the web, tended to pull through the hole made by the pin, as a result of swelling caused by the tag application and subsequent local infection.

We found that if the tags were placed a little lower on the web, with the distal end of the tag approximately ½ inch inside the outer edge of the web, the reduction in the web thickness allowed the swelling without the tag pulling through.

During the branding phase of the program the seals were selected on a "first come first served" basis with no bias towards high or low placed tags.

Todate (August, 1978) 60 tags, and the tag and brand combination has been recovered:

Seals with Tags 31
Seals with Tags & Brands 27
Tag only 1
Brand only 1

Evidence of tag loss

There are two direct sources of tag loss evident, the tag only recovery came from a gill net fisherman. He found the tag caught in a tangled and torn gill net, no seal was in the net. The other loss shows in the Brand only recovery when a branded seal was shot, but despite a thorough search, no tag was found. Other evidence of tag loss produced in 1978, but not directly involved with the double marking programme came from two tags recovered from the 1977 tagged cohort. These tags were also found in tangled gill nets, no seals were present. The information presented indicate the biggest single source of tag loss is accidental encounters with fishing gear. Modifications to tag design could increase the possibility of entanglement, thus such potential results should be considered before any new tag designs are used.