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A new approach to estimating harp seal production

by

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Abstract

It is proposed that large scale tagging be carried out of young harp seals in the Gulf of St. Lawrence and on the Front in the same season. The young on the Front would be tagged from a helicopter in late March, between the time of ships' catching and that by landsmen. As well as short-term capture-recapture estimates, which are not new, a successful experiment would within one year give an estimate based on longer-term recoveries, both from the first summer in the arctic and from the first winter-spring at age 1 year. The new method is based on the ratio of recoveries of young seals tagged in the two areas from either or both of these fisheries, which take animals from both areas of origin fully mixed. Also used are the relative numbers of animals born in each area, obtained from the best or most recent aerial photographic surveys available. Catches of young seals in each area are also used from statistics for the year of tagging. The resulting simultaneous equations are solved to calculate production in each area. Three worked examples are given from past tagging which approximated the required experimental design. The mean estimate of production obtained is about 315,000 pups for both areas in the period 1966-1976; the individual results show too much variance to indicate a trend.

The Method

Methods of estimating stock size or, more usually, production of harp seals have been reviewed by Sergeant (1975). Two methods in common use both have disadvantages. Aerial photographic survey of the young requires that a large number of variables of logistics and weather and ice conditions be optimal for a complete count of production to be made. A capture-recapture tagging experiment, tagging being carried out immediately before the hunting of the young and returns obtained from this hunt, suffers from the defect that neither tagging nor recaptures can normally be distributed at random.

The newly proposed method is suitable for the northwest Atlantic where the harp seals whelp in two separated areas (Gulf and Front herds) with fair annual constancy of respective group size. It also depends on the observed phenomenon that during the first year of life the immatures of both groups mix very thoroughly. This is true not only for summer recaptures, which come in the first year almost exclusively from West Greenland, but also from first winter recoveries which come almost exclusively from Notre Dame Bay and White Bays, Newfoundland. The first year animals appear from tag recoveries to be almost totally mixed (Sergeant MS 1977a). The result is that, in comparing relative tag returns from experiments carried out in the two areas in the same season with the same tag type, we can ignore the natural mortality of the seals, and the loss rate of the tags, as well as relative non-reporting of tags by fishermen, all of which will be equal for the two sets of tagged animals.

When tag recoveries are complete we can set up an equation which will express the relative mortalities of animals from the two groups or subpopulations as a function of the unknown subpopulation sizes and the known ratios of tag return to tag application.

In addition the catch of young animals must be subtracted from the estimate of subpopulation size if this catch occurred subsequent to tagging.

A second equation is needed in order to solve for population size. Aerial photographic surveys, whatever their completeness, usually allow a fairly accurate estimate of the relative sizes of young produced, and/or attendant adults, in Gulf and Front areas.

Letting $\bar{g}$ and $\bar{f}$ be estimates of production in Gulf and Front areas respectively, and $\bar{t}$ their sum.

(1) from aerial survey

$$\bar{g} = x\,\bar{f}.$$

(2) from tag recoveries t_g and t_f where $t_g = yt_f$

$$(\bar{g} - \text{catch}) = y(\bar{f} - \text{catch})$$

and we can then solve for $\bar{g}$ and $\bar{f}$.

For the aerial survey, the 1977 results will most probably provide the best available data when results are complete, as expected at time of appearance of this document.

Tagging of young harp seals in the Gulf of St. Lawrence has been carried out annually in recent years and poses few problems, because the whelping groups form up close to the Magdalen Islands. Tagging on the Front is more difficult. One experiment from an icebreaker off the Labrador coast tagged 3,581 in 1966, but in an experiment using a helicopter from the Labrador coast in 1973 only 934 young seals could be tagged. In 1976 results on the Front were even poorer with only 99 tagged from a helicopter as compared with 361 in the Gulf. Early tagging at the Front therefore requires an icebreaker and the services of such a vessel are very hard to obtain in early March when their duties aiding shipping are still heavy.

Recently, however, Mr. Brian Beck (in litt) has suggested that tagging from one or more helicopters would be feasible in late March. By this date the natural drift of the young past Belle Isle will have brought them into Notre Dame Bay. Because the ships' catch is governed by a quota, which is usually attained without difficulty by late March if the starting date is March 12, tagging can follow the ships' catch. The landsmen's catch and that of small craft however begins in early April when the seals approach land in Notre Dame Bay and the ice begins to loosen; tagging as proposed can precede this catch. Successful tagging can then give, first, an estimate of production based on landsmen's catches. This first estimate will probably be more accurate than an estimate based on earlier tagging and ships' catches (a) because the seals reaching the moulted 'beater' stage are more mobile than the whitecoats (b) there are many more units of small craft than large ships. Both factors will help

to randomise returns. Later returns will contribute to the main experiment as described above.

Worked Examples

There are a number of past examples of tagging experiments, the results of which can be used to approximate the method. These experiments suffered from the defects, either that the same tag type was not used in the two areas (1966); the cohort tagged on the Front was not large enough (1976); or the two parts of the experiment were not done in the same year (1973 cp 1975). As expected therefore, results of calculations of production show a fairly wide variance even in years close together when such variance cannot be real.

Equation 1. relates relative numbers of Gulf and Front whelpers. Our own surveys (Table 1) counted attendant adults at whelping groups because we did not have the technology fully to count pups. The 1977 experiment should improve this knowledge by giving counts of both adults and pups and bringing the relative numbers up to date: recent hunting controls have probably favoured relative increase of the Gulf herd.

The considerable variance in relative size of the 2 herds shown in Table 1 could be due either to real annual variations in relative herd size or to incompleteness and inaccuracy in delineating herd size. The second is likely to be the greater source of variability. Pooling the data without weighting reduces the second set of errors and the result, about 39% of animals born in the Gulf, is used in equation (1); so that

$$(1) \quad \bar{g} = .39\ (\bar{g} + \bar{f})$$
$$= \frac{.39}{.61}\bar{f} = .639\ \bar{f}$$

Equation 2. Catches of young seals by area for the years in question are shown in Table 2, tagging and recovery data in Table 3. The three worked examples follow:-

Example 1. 1966.

Although there were no recaptures from the Front-tagged cohort of 1966 in the second spring, there were a few recaptures from it in the third and fifth springs. Clearly the 1966 cohort was

almost eliminated at the Front by catching of young. We therefore use relative rates of summer and fall returns for the two experiments. Tag types were different; monel metal disc tags for Gulf, monel metal strap tags for Front, both applied to the tails. This difference is here ignored.

Calculation

Ratio recoveries first summer and fall (from Table 3) were 35 Gulf-tagged, 5 Front-tagged, so that Gulf recoveries were 7 x Front recoveries. However the numbers tagged were:-

Gulf - 1,550, Front - 3,581, so that the real ratio of recoveries (y) was (7x2.31):1 = 16.17:1

Then (1) $\bar{g} = .639\ \bar{f}$

(2) $\bar{g} - 73{,}246 = 16.17\ (\bar{f} - 178{,}489)$

Solving, $\bar{f} = 190{,}549$

$\bar{g} = 121{,}760$

$\bar{t} = 312{,}309$

Comments. Survivors, on this basis were:

Front 12,060

Gulf 48,514

- approximately satisfying the observed ratio of tag recoveries. By comparison, calculation of production on the Front using immediate tag returns from Canadian ships, which were believed complete, was 188,913 (Sergeant 1975).

Example 2. 1973 Front cp 1975 Gulf.

Tag type in 1973 was a small metal strap tag applied to the tails; in 1975 a plastic "Rototag" attached to the hind flippers. Recovery rates (Table 3) were exactly half as great for the 1973 tagging as the 1975 tagging for both arctic recoveries in the first summer, and spring recoveries in the second spring. Catches of immatures in the second spring were about equivalent, as were number tagged; the slight imbalances offset one another.

Catches of young in the first spring (Table 2) were:

1973 F 87,658

1975 G 7,223

Therefore - (1) $\bar{g} = .638\ \bar{f}$

(2) $\bar{g} - 7{,}223 = (\bar{f} - 87{,}658)$

Solving $\bar{f} = 123{,}506$

$\bar{g} = 78{,}920$

$202{,}426$

Comments - Estimated survivors are:

F = 35,848

G = 71,697

which fit well with the ratios of returned tags.

Example 3. 1976 Gulf and Front

Rototags were used in both areas.

Tagging and recapture data are shown in Table 3.

Catches of young in 1976 (Table 2) were:

Gulf 15,009

Front 116,724

Ratio of 1 yr recoveries of Gulf tags to tagged animals was .022, of Front animals .020, taken as the same.

Therefore -

(1) $\bar{g} = .639\ \bar{f}$

(2) $\bar{f} - 116{,}724 = \bar{g} - 15{,}009$

Solving, $\bar{f} = 266{,}968$

$\bar{g} = 165{,}253$

$432{,}221$

Comments. This seems too high. Front survivors would be 100,000. Gulf survivors 150,000, which does not agree with tag recovery rates. Variance is clearly high due to the small scale of the Front tagging.

The mean of the three estimates is 315,652 young harp seals.

References

Sergeant D. E. 1975. Estimating numbers of harp seals. Rapp. P.-v. Reun. Cons. int. Explor. Mer, 169: 274-280.

———— MS 1977(a). Studies on harp seals of the western North Atlantic population in 1977. ICNAF Res.Doc. 77/XI/58. 16 pp. Mimeo.

Table 1. Comparison of aerial counts of adult whelping harp seals

Year	Gulf Dates (March)	Gulf	Front Dates (March)	Front	Total	Percent Gulf
1959	6,9	154,725	10,12	176,121	330,846	46.7
1960	2,16	89,390	13	161,884	251,274	35.5
1964	1,3	93,076	10	96,140	189,216	49.1
1970	8,10	64,000	14	115,503	179,503	35.7
1972	10	114,320	11,13	101,373	215,693	53.0
1973	5	15,041	10	77,756	92,797	16.2
1974	13	25,768	14	41,979	67,747	38.0
7 year unweighted mean						39.2

Table 2. Catches of young seals by area (by ships and landsmen) for the years and areas of experiment. From ICNAF statistics.

Year	Gulf	Front
1966	178,489	73,246
1973	(N.A.)	87,658
1975	7,223	(N.A.)
1976	15,009	116,724

Table 3. Tag returns form Notre Dame Bay of one year old harp seals tagged in the Gulf.

Area	Year	tagged	No. recovered		Surviving tags[1]	Recoveries NE Nfld.		
			Spring	Summer and fall		Landsmen	Ships	Total
G	1966	1,550	84	35	1,431	5	7	12
F	1966	3,581	1,551	5	2,025	-	-	-
F	1973	934	138	7	789	8	2	10
G	1975	903	79	14	810	18	2	20
G	1976	361	25	6	330	8	-	8
F	1976	99	43	2	54	2	-	2

[1]less unknown no. of tags lost.