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How does hunting grey seals (*Halichoerus grypus*) on Bothnian Bay spring ice influence the structure of seal and fish stocks?

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Abstract

In a traditional manner, seal hunting on Bothnian Bay spring ice in 2003-2004 (16th April - 31st May) resulted in a total of 136 grey seals being shot. From each individual killed, the hunter was obliged to deliver e.g. the alimentary tract, uterus or baculum and the under jaw (for age determination from layers in cement of the canine teeth).

Of the total cull 71% were females and of these 78% more than 5 years old, which already is the age of sexual maturity. This kind of sex and age ratio in the cull fits well with a population management regime that aims to diminish only the number of seals. However, if the goal is to preserve a normal population structure such ratios are disadvantageous. If hunting quotas are to be increased in coming years, culling recommendations that include the shooting of immature seals need to be prepared.

Analysis of fish otolithes and other hard particles in the alimentary tract showed clearly that the herring (*Clupea harengus*) was the most important item of prey. Herring was found in 103 grey seals (83.1%). The number of herring per seal varied from just 1 to 309. The average number per seal was 41.1 (± sd 62.6). Four grey seals (3.2%) had eaten 1-2 salmon/trout (*Salmo salar/trutta*) and two grey seals (1.6%) 1-3 whitefish (*Coregonus lavaretus*). Nine other fish species were found in very limited numbers.

The result suggests that hunting grey seals on Bothnian Bay spring ice may have some influence on herring stock, but it does not, at least direct, help the management of salmon stocks.

The paper includes brief discussion on the size classes of fish eaten by grey seals and the potential advantage of shooting young seals.

Keywords: Bothnian Bay, spring ice, grey seal, hunting, population structure, foraging.

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Introduction

In Finland protection of the grey seal (*Halichoerus grypus*) had a stepwise progression between 1975 and 1982 as knowledge of the scantiness of the seal stock became better known (Stenman 1992). Decision-making was supported by research indicating that damage by seals to salmon fisheries was, in general, less than had commonly been thought to be the case, in Finnish waters, in the middle 70ies (Stenman 1978).

The 1975 historical decision to protect grey seals in Finnish waters referred initially to the reproductive period in spring only. Three years later protection was extended to include the summer period and finally, in 1982, to include the whole year. After the killing of seals near fishing gear was brought to an end in Sweden in 1986 all grey seals in the Gulf of Bothnia (ICES-areas 30/ Bothnian Sea and 31/ Botnian Bay) were by then protected.

Natural mortality aside, increase in the grey seal stock in the Gulf of Bothnia was thereafter limited primarily by entanglement of young individuals in fishing gear (Helle & Stenman 1990, Lunneryd & Königson 2005).

Hunting was re-started in Finland in 1996 with the issuing of special licenses and, in 2001, in Sweden as well, with the introduction of careful quotas, the reason being, once again, an apparent increase in damage caused by seals to fisheries (e.g. Backman & Helle 1998, Lunneryd 2005).

The re-starting of grey seal hunting was made easier by data demonstrating that grey seal was not as dramatically afflicted by the malady of uterine occlusion, a pathological change (Bergman 1999, Westerling et al. 2005), as was the more sensitive ringed seal (*Phoca hispida botnica*) (Helle 1980). At present the reproduction rate of the grey seal is considered to be normal (Helle et al. 2005).

Thus we have witnessed a change from zero protection of the grey seal stock before 1975 in Finland to full protection in 1986 in the Baltic to management of the stock by 'sustainable culling' in 2001 by hunting to set quotas.

How successful has this been in Bothnian Bay where grey seals were traditionally hunted almost exclusively by shooting on spring ice?

When hauled-out during the moulting season most grey seals will only forage lightly. In attempting to evaluate the consequences of the management procedures, we must ask how is the reduction of grey seal numbers impacting on commercially important fish stocks.

In attempting to answer the question raised we studied the grey seals culled (shot) on spring ice in Bothnian Bay in 2003 and 2004, before the salmon run had begun.

Material and methods

In both years the ice in the Bay melted quickly (Fig. 1) which, along the more open parts of the coast, made the hunting season short and quotas difficult to reach. Obtaining a license for shooting grey seals was bound to a condition that from each individual killed the alimentary tract, under jaw, uterus or (in 2004) baculum, and a piece of blubber and a piece of muscle, must be delivered to the Finnish Game and Fisheries Research Institute (FGFRI).

In both years specimens came mostly from the southern part of the Bay (Fig. 2 and Table 1). Because ice fields move across national boundaries taking hunters and seal groups with them, hunters are not always aware of their exact position. This means that notation of the distribution of culled seals across statistical rectangles may not be absolutely accurate.

Hunters were requested to freeze their samples before delivering them to FGFRI, where they were labelled and stored for analysis.

Age was determined by examining under a microscope cross- and longitudinal sections of the lower canine tooth for annual deposits of cement around the root of the tooth (Hewer 1964).

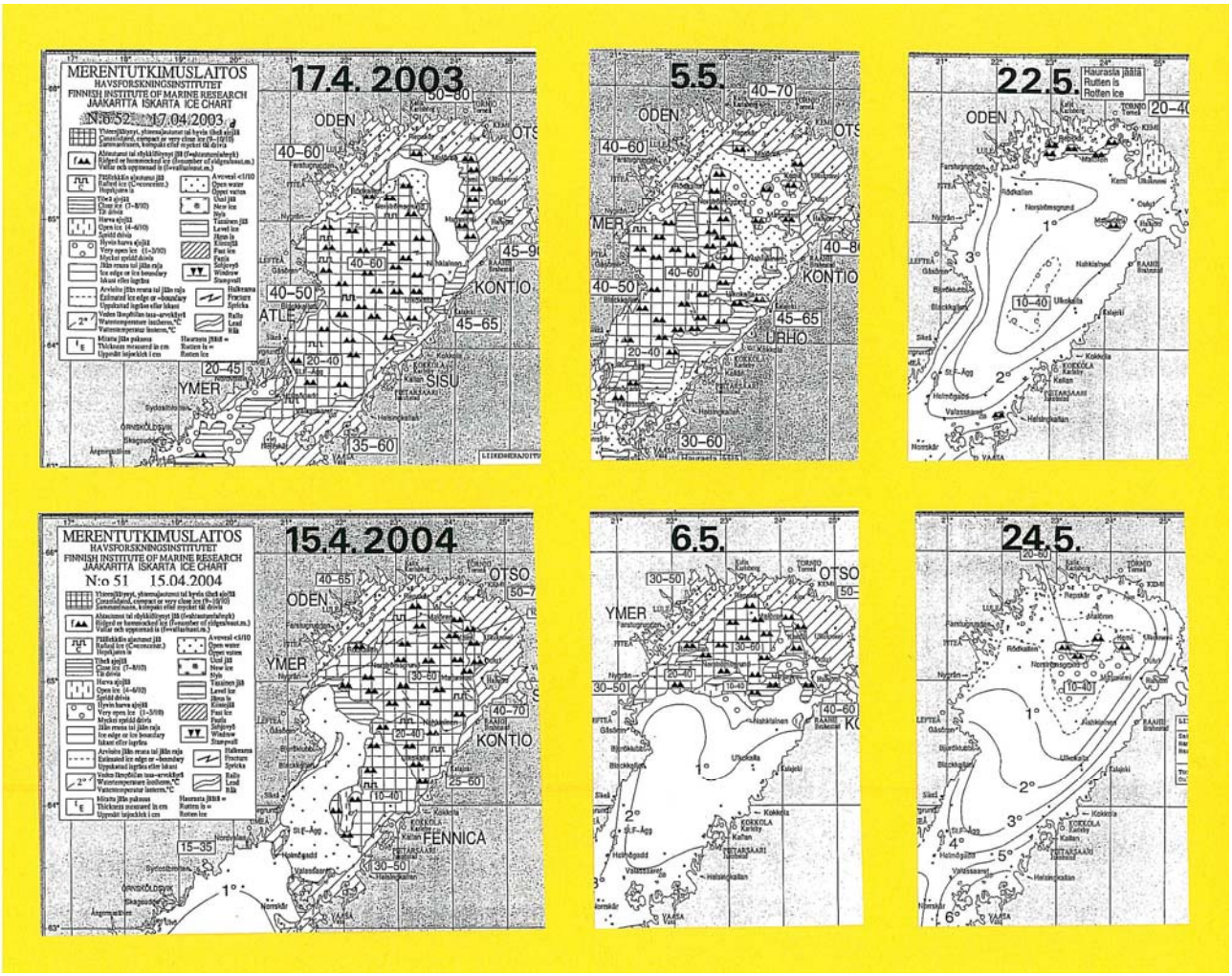


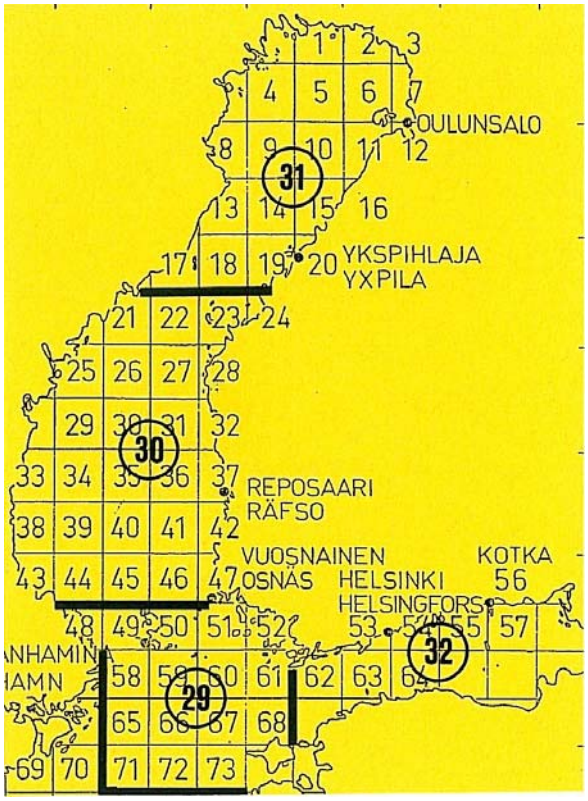
Fig. 1. Development of the ice situation in the Bothnian Bay from the start of grey seal hunting (16th April), which is mainly carried- out on the ice.

Dietary analyses were based mainly on the identification of fish otolithes found after repeated washing and straining of gut content (Stenman & Pöyhönen 2005). Otolithes, which are species-specific, are usually recognizable whatever their position in the alimentary tract (Härkönen 1986, Raitaniemi et al. 2000). With reference to fish material from the sea, other hard fish particles found in the tract e.g. skull parts, vertebrae, gill bones, spines, scales and skin tumors were all used to help determine food fish species. When required the weight of food fish was calculated with species-specific regression based on the length of the *sagitta*-otolithe.

Results

The distribution of sex and age classes showed that culling was concentrated on females in reproductive age i.e. 5 years or older (Table 2). Of the total cull in two years 71,3 % was female and of these 78,4 % were more than 5 years.

Fig. 2, Table 1. Numbering of statistical rectangles according to which the grey seal catch is allocated in the Bothnian Bay, ICES- area # 31.



Rectangles	Grey seal catch April 16 - May 31 2003	Grey seal catch April 16 - May 31 2004	In total
5	0	7	7
6	3	3	6
9	0	1	1
10	0	18	18
11	0	5	5
14	0	8	8
15	20	32	52
18	7	5	12
19	7	9	16
20	1	0	1
?	3	7	10
In total	41	95	136

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Fig. 3. Seal boat at the edge of an ice field and a small group of grey seals hauled-out on a floe.

The female part of the total cull could be a little larger than is shown by the figures based on delivered uterus material. The male organ, the baculum, was not requested in 2003. The question-mark columns in Table 2 may contain cases where the hunter could not or forgot to collect the sex organs. Sex was not verifiable in all the 2004 samples delivered, despite the demand for the baculum.

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Fig. 4. Partly digested salmon in a grey seal stomach and two dried samples of hard particles ready for analysis under stereomicroscope.

If we suppose however that all individuals under the question mark columns are males, we obtain sex ratios of 29 ♀ : 12 ♂ in 2003 and 68 ♀ : 27 ♂ in 2004. The ratios do not differ significantly (Square-test, p>0,1), and we may say that hunting was concentrated on females in both years more-or-less equally.

By lumping males and females together we find an age class distribution showing no more than 9 individuals to be pups (6,6 % of samples) and 30 (22,1 %) in the age of 1-5 years

Of interest to fisheries is the amount and weight of herring and salmonids consumed. Analysis of food fish from the alimentary tract showed herring to be greatly predominant (Table 3).

Because of abrasion and break-down of otolithes in stomach and intestine, random sampling of bulk material from alimentary tract is very difficult, so the otolithe regression was not used to estimate the mean weight of herring in the alimentary tract. Instead a value of comparison was used derived from the mean weight of herrings sampled from sea in April-May between 1973 and 1997

(35,5 g / N = 4 203; R. Parmanne, pers. comm.). According to this research the weight of the 4 230 herrings eaten by grey seals culled was 150 kg.

It is practically impossible to evaluate reliably the amount of herring consumed by the grey seal stock during any particular period of time by using the content of the alimentary tract, because the age structure of the stock and the different food needs of the different age classes are not known.

The individual weights of the very few salmonids found in the samples were calculated using an otolithe regression and the size of lower jaw. In one sample we had assistance from information on a tag. The total weight for *Salmo*-species came to only 1,5 kg, and for *Coregonus*-species about 1 kg.

Table 2. Grey seal sample divided according to sex and age group.

Age in	2003				2004				Sum		
years	F	M	?		F	M	?		F	M	?
< 1	0	0	0		3	1	5		3	1	5
1…5	8	0	3		10	4	5		18	4	8
6…10	10	0	4		20	6	0		30	6	4
11…15	8	0	4		19	2	1		27	2	5
16…20	3	0	1		15	2	1		18	2	2
> 20	0	0	0		1	0	0		1	0	0
Sum	29	0	12		68	15	12		97	15	24

Discussion

Using various sources, the Baltic Grey Seal Census Working Group estimated the size of the grey seal stock during the 2004 moulting period in the Quark and Bothnian Bay to be around 1 300 individuals (Halkka et al. 2005). Theoretically, the amount of females should have been 650 and of these about half (325) in reproductive age (Helle & Stenman 1990, Helle et al. 2005). With regard to this figure, the females in reproductive age that were culled by Finnish hunters solely in Bothnian Bay in 2004 (55 individuals) accounted for 17 %.

In considering the unknown quantities of females in the Swedish cull and the unknown number of individuals drowned after being shot and not reported or caught in fishing gear, it becomes clear that 2004 was a year that probably did do damage to the viability of the future grey seal stock in Bothnian Bay. Likewise, it could be said that 2004 was successful in diminishing the stock.

It is to be noted that the number of pups in the Finnish cull was relatively low, an explanation for which may be that they had already moulted and were already out foraging, not hauled-out on ice.

Table 3. Fish diet of 124 grey seals shot on ice in the Bothnian Bay.*

Fish species	Number of seals Eating different Fish	Number of fishes eaten	Proportion of seals eating different fish	Percentage occurrence of fish species in total sample
Clupea harengus	103	4230**	83,1	56,9
Sprattus sprattus	1	3	0,8	0,6
Salmo salar	1	1	0,8	0,6
Salmo trutta	2	2	1,6	1,1
Salmo sp.	1	1	0,8	0,6
Coregonus albula	1	3	0,8	0,6
Coregonus lavaretus	2	4	1,6	1,1
Coregonus alb. / lav.	2	3	1,6	1,1
Osmerus eperlanus	4	9	3,2	2,2
Cyprinidae	1	3	0,8	0,6
Zoarces viviparus	3	6	2,4	1,7
Gasterosteus aculeatus	14	69	11,3	7,7
Myoxocephalus quadricornis	6	7	4,8	3,3
Cyclopterus lumpus	1	2	0,8	0,6
Perca fluviatilis	1	1	0,8	0,6
Percidae	1	1	0,8	0,6
Pomatoschistus minutus	3	5	2,4	1,7
Unknown	34	68	27,4	18,8
In total	**181**	**4418**		

*** In addition 12 grey seals with empty alimentary tract. ** Mean = 41,1; sd = 62,6; range = 1-309.**

From the point of view of the hunter, the fur of a second year or older grey seal, if shot on spring ice, is often worthless because of moulting, but this is not so for the pups, which moult earlier and are easily recognised by their size and sport top-quality grey fur (Fig. 5). For the hunter, the fur is usually the most valuable part of the prize, but blubber boiled to oil and the meat of a young individual can also be of economical significance.

Of the 103 seal samples received, the average total weight of herring found in the tract of each seal was a full kilo (see data combined with Parmanne data, Footnote, Table 3). On the other hand Salmonids were found in very few samples. The low number could be a reflection of sampling error e.g. to scantiness of the material delivered due to early melt, hunting patterns etc.

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Fig. 5. Foetus from a grey seal shot early October. The grey seal skin of a recently moulted pup and the white fur of an un-moulted pup.

Conclusions

If annual quotas for hunting grey seals are to be increased, hunting by shooting on ice in Bothnian Bay must be regulated and conducted through close co-operation between the authorities in Finland and Sweden to ensure that it does not threaten fatefully the future structure on the Bothnian stock. Other aspects aside, this means, in particular, finding ways to ensure that hunting is not concentrated on females in reproductive age.

Without more research we cannot know the impact of the Bothnian seal stock on fish stocks. It is obvious that diminishing the grey seal stock by hunting seals on spring ice will have some influence on herring stocks. Evidence available from this research indicates that, at the time of culling by hunting on spring ice, the Bothnian grey seal stock is having a rather insignificant impact on Bothnian herring and salmonids stocks.

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