Grey seal induced catch losses in the herring gillnet fisheries in the northern Baltic

Sara Königson, Arne Fjälling and Sven-Gunnar Lunneryd

Institute of Coastal Research, Swedish Board of Fisheries, Box 423, S-40126 Göteborg, Sweden

ABSTRACT

The interaction between grey seals (*Halichoerus grypus*) and the Baltic gillnet fishery for herring (*Clupea harengus*) during the period 2000-2005 was investigated, by comparing and contrasting 3 sources of information: data from the European Union (EU) official logbook system, data from a voluntary logbook system and data from field studies. While the EU official logbooks suggest that seal disturbance occurred in 30% of all herring gillnet fishing events, data from the voluntary logbook gave a figure of 60%. There was a pronounced seasonal variation in the frequency of seal-disturbed fishing efforts, with least interference in the early summer, and greatest at the end of the year. This variation is likely dependent on the life cycle of the seals and their main prey, the herring. Analysis of the EU logbook information also showed that catches were significantly higher on fishing days when there was no seal interference recorded, compared to days when there was such interference. Field experiments demonstrated that herring catches were reduced by 240 kg per fleet of net and fishing occasion when seals were present, which is much more than the observed seals in the area could possibly have consumed, and a very small number of fish remains were found in the nets after seals had been present. These observations suggest that the mere presence of seals does affect catch levels negatively. Nets baited with marked fish were used to estimate hidden losses, i.e. fish removed from the nets, leaving no trace. Seals were assumed to have visited the experimental nets in 14 of the 19 trials. In 11 of these, more than 95% of the marked fish went missing. The 3 different data sources altogether show that the herring gillnet fishery in the northern Baltic is severely disturbed by interaction with grey seals.

Königson, S.J., Fjälling, A., and Lunneryd, SG. 2007. Grey seal induced catch losses in the herring gillnet fisheries in the northern Baltic. *NAMMCO Sci. Publ*. 6:203-213.

INTRODUCTION

The coastal fisheries of the Swedish Baltic are subjected to considerable damage and losses caused by seals. Fishing operations in this area are usually on a modest scale, often carried out by a single fisherman in a small boat. It is mainly the grey seal (*Halichoerus grypus*) that is involved in the conflict (Westerberg *et al.* 2000). The population of grey seals in the Baltic is presently recovering after a severe decline during the 20th century (Hårding and Härkönen 1999). Halkka *et al.* (2005) gave a census count of 17,640 in 2004. The population has increased dramatically during the last decade (Karlsson and Helander 2005). The conflict between seals and commercial fisheries has escalated in parallel with this population explosion (Baltscheffsky 1997, Kauppinen *et al.* 2005).

The herring (*Clupea harengus*) gillnet fishery is vulnerable to seal-induced damage. The staple food for grey seals in the Baltic Sea is herring (Söderberg 1974, Lundström *et al.* 2005). Sjöberg and Ball (2000) suggested that grey seals maximise their feeding effort in areas where the sea floor is steeply sloped and herring schools concentrate. These are often the same sites where fishermen have set their nets for generations. Fishing for herring with small-meshed gillnets has long been the principal coastal fishery in the northern Baltic. It is often combined with other fisheries, such as the set-trap fishery for salmonids and whitefish (*Coregonus lavaretus*), in order to generate a sufficient annual income for the fisherman. The herring spawn in the spring and then aggregate in shallow waters near the coastline. This is exploited by the coastal fishery for this species, which occurs mainly in the spring. In the autumn, herring fishing is usually carried out in deeper waters. However, fishermen have reported that seal interference is most intense during late summer and autumn. In the spring and the early summer, grey seals moult and spend a lot of time in haul-out areas, and their food-intake is then low (Söderberg 1974, Bonner 1994).

The seal-induced economic losses for the fishermen are considerable, amounting to at least 10% to 15% of the total catch value in the coastal fisheries (Westerberg *et al.* 2000). Seal interference is an important reason for the current poor viability of the fisheries concerned, and for the ongoing low recruitment and gradual decline in the number of active fishermen (Anon 2001). Damage by seals consists both of damage to the catch and to the fishing gear. Besides the apparent catch losses such as damaged fish, there may also be significant hidden losses. Such losses would include fish that are removed completely from the fishing gear, leaving no traces. Potter and Swain (1979) estimated parts of these losses in gillnets for salmon. Fjälling (2005) estimated the hidden losses in salmon set-traps to be at least 20% of the total catch, and more than 50% of the potential catch for an average day with a seal visit. In addition to these losses, it is possible that seals scare fish away from the fishing gear, creating additional hidden losses. Herring fishermen have claimed this for a long time and there are numerous anecdotal reports of herring schools suddenly disappearing from the vicinity of the nets when seals approach. One aim of this study is to investigate if the mere presence of seals might affect the catches of herring.

It is difficult to quantify the seal-induced catch losses from official data, which are based on the records from licensed fishermen, since these records often hold very limited information on seal interference. Better data can be derived from contracted fishermen, who keep a detailed logbook on a voluntary basis. Even more detailed information on the interference can be gained from dedicated studies. This study aims to investigate the impact of seal predation on the herring gillnet fisheries in the northern Baltic. To do this, we analysed and compared data from 3 sources: the EU official logbook database, a voluntary logbook database kept by contracted fishermen, and the results of a dedicated field study. With this study we hope to illustrate both the general effect of seals on the herring fisheries and the details of the interaction.

MATERIALS AND METHODS

EU official logbook database

All licensed commercial fishermen in Sweden are required to keep records of their operations in accordance with the EU official logbook system and national requirements, and to report these records to the Swedish Board of Fisheries. There are 2 ways for a fisherman to report his or her fishing effort and catch, depending on the size of the boat. Skippers of fishing vessels with a length of 10 m or more must make a daily report of their catch, net type, number and location of nets. Skippers of fishing vessels with a length of less than 10 m may keep a monthly logbook instead of daily reports. In the latter case, catch and associated data are summed per net type and per month. Fishing locations are not recorded; instead the co-ordinates of the vessel's home base are noted. In the inshore fishery, the main fishing effort is given in the monthly logbook. Information regarding seal interference (*i.e.* damage to the fishing gear or to the catch) can be entered into both types of reports, however this is voluntary.

To quantify seal interference in the fisheries on a yearly basis, daily and monthly records from the EU official logbook for the herring gillnet fisheries during the period 2003 to 2004, and covering the area of the Baltic north of 60º 00' N, were used. These years were chosen since some fishermen reported to the voluntary logbook system in the same area, offering the possibility of a comparison. For further analysis the daily logbook from the same area as mentioned above, but for the period 2000 to 2005, was used. About one third of the gillnet fishermen in this area typically complete the daily reports, while the other two thirds report through the monthly logbook. The number of active fishermen throughout 2003 and 2004, and the proportion of entries with records of seal interference during the same period, were calculated. The number of entries to the EU official logbook with seal interference and the total number of entries, were summed per month for 2000 through 2005. The mean relative frequency per month of fishing events with seal disturbance noted, and the variance (SE) was calculated. This was compared to the voluntary logbook data described below.

The herring gillnet catches for days with records of seal interference, and days without such interference, were then compared. However, since catches of herring are highest in the spring, whereas the frequency of days with seal interferences is highest in the autumn, these days could not be compared directly. A procedure of pairing data was therefore used to reduce such temporal variation. For each seal-disturbed fishing day for a certain fisherman, a matching day without records of seal interference was sought. This day had to be the nearest preceding day (maximum 1 week earlier) for the same fisherman, in the same area and using the same type of nets. If such a day was found, the 2 days together made up a pair. The first of the 2 days was then considered to give an estimate of the expected catch for the second day in the pair. The data were further divided into 2 time periods, March to June and July to December. Mean catch per unit effort (CPUE, kg per metre net and day) was calculated separately for the 2 time periods. Comparisons were made using a t-test for paired data. The same procedure was performed as a comparison on voluntary logbook data.

Voluntary logbook database

A voluntary logbook database holding detailed catch data from contracted commercial fishermen (Lunneryd *et al.* 2005) was used for an analysis. Fishermen participating in the voluntary logbook were chosen from personal contacts and recommendations. Selected fishermen cannot be said to have constituted a random sample of the fishing community. Nevertheless, seal-induced damage is so prevalent throughout the northern Baltic that any group of fishermen can be said to be representative of the whole community in this respect. An enrolment of fishermen using herring nets began in 2003, and the resulting catch data were entered into the database. The aim was to document, in as much detail as possible, all catches and seal-induced damage in the selected fisheries in the northern Baltic. The quality of the data supplied was checked during regular personal contacts and occasional inspections. There was almost no overlap between the voluntary and the official daily logbooks. All but 1 of the fishermen participating in the voluntary logbook system reported only to the monthly logbook system. Voluntary logbook data were used to calculate the mean relative frequency of entries with seal interference per month for 2003 and 2004, as described above for the official logbook data. The CPUE was calculated for days with and without seal interference for comparable time periods, spring and autumn. Comparison between days with and days without seal visits was made using a t-test.

Field studies

The field studies were conducted during September and October in 2003 and 2004 in cooperation with a local fisherman in Skärså, a small fishing village north of Söderhamn in the northern Baltic, latitude 61º 23’ N. The gillnets for herring that were used in the study were 60 m long, 9 m deep and had a mesh size (stretched mesh) of 39 mm. The nets were linked to form 180 m long fleets of nets, and deployed at positions ranging from 3 to 7 nautical miles off the coast. The nets were usually set in the afternoon and lifted the following morning. During a fishing trip on average 3 fleets of nets were set out. According to the daily logbook larger boats do on average set out 4.5 fleets of nets. One or 2 observers joined the fisherman on his regular fishing trips. Systematic seal observations were made while setting and lifting the nets. One person scanned for seals, 1 minute in each of the directions fore, aft, starboard and port of the boat. The numbers of damaged fish per fleet of nets were counted as the nets were hauled in. The catch per fleet of nets was estimated on board the boat since it was not possible to separate the catches later on, at the dockside.

For estimation of the hidden losses, an experimental 30 m long gillnet was used. The experimental net was identical to the regular nets, except for its shorter length. Initially the experimental net was linked to, and deployed together with, the regular nets. Upon hauling the nets, the experimental net was put aside with the fish still gilled in the meshes. The herring were then all marked by removal of their eyes. A minimum of 40 herring (about 2 kg) per net, and a maximum of 260 herring (about 13 kg) per net, were marked in this way. The experimental net with the marked herring was then brought along on the following fishing trip and included in 1 of the fisherman's fleets of nets. When the nets were lifted again, the catch in the experimental net was scrutinized. The number of marked and unmarked fish, both damaged and undamaged, were counted and recorded. The number of marked fish falling off due to handling the nets was estimated by setting nets with marked fish in the regular manner then retrieving them immediately. This was done on 7 occasions. The numbers of intact and damaged fish remaining were then counted. The maximum number of fish that went missing from handling the nets was later used as a criterion to determine whether a seal visit had taken place or not. The controls did not take into account the number of fish that might fall off due to length of time spent in the water. The relevance of this factor was tested by first excluding the occasions when more than 95% of the marked fish went missing, i.e. when seals unquestionably had been present, and then comparing the remaining occasions with the control.

For some time after the field trials were completed, the fisherman continued to report data on catches, fishing effort and observations of seals in approximately the same way as was done by the observers during the initial trials. The numbers of damaged fish in the nets were however not counted, and the seal observations were not performed systematically, although notes were taken when seals were observed close to the nets.

CPUE was calculated for all 3 datasets. When catch figures were not normally distributed, a bootstrap resampling procedure (2000 repetitions) using bias-corrected confidence intervals (Haddon 2001) was used. A Visual Basic macro was used in Excel to simulate the data collection procedure with repeated re-sampling. DPUE (number of fish rests per metre net and-day) was calculated for those datasets when observers were onboard during fishing trips and could count the number of fish rests in the nets.

RESULTS

Data from the daily logbook and voluntary logbook database

Trend over the years

In the official daily logbook, seal interference was reported in 30% of all entries from 2003 until 2004. In the voluntary logbook there were indications of seal interference reported in 60% of all entries during the same period (Table 1). Of all the fishermen who report to the daily logbook system, 50% reported seal interference at least once. Of those reporting to the monthly logbook, 70% reported seal interference. All of the fishermen reporting to the voluntary logbook system reported problems with seals at least once (the reporting of such incidents is expected in this case).

Trend over the season

There were large variations in the proportion of logbook entries with recorded seal interference in relation to the time of the year (Fig. 1). The daily logbook and the voluntary logbook showed the same pattern. Seal attacks were fewest in June and most frequent in October to December.

Table 1. The numbers of fishermen, logbook entries and records of seal interference for the herring gillnet fishery, in the EU official logbook and in the voluntary logbook.

Data	Year	No. of fishermen	Total effort (m net^{-1}day^{-1})	No. of entries	No. of entries with seal interference	Proportion of entries with seal interference (%)
Daily log book	2003	20	721,810	746	232	31
	2004	26	681,420	778	225	29
Monthly log book	2003	70	1,077,796	260	92	35
	2004	75	1,346,886	255	116	45
Voluntary log book	2003	10	11,376	293	170	58
	2004	8	11,320	301	188	62

Table 2. Mean CPUE (kg herring m net^{-1}day^{-1}) in the daily logbook (all data) and in the voluntary logbook (paired data), for days with seal visits (i.e. notes of seal visits in logbooks) and without.

		No seal visit in data			Seal visit in data		
All data:		***N***	**Mean CPUE**	**95% CI ±**	***N***	**Mean CPUE**	**95% CI ±**
Daily logbook	Spring	2,809	1.56	0.10	1,018	1.03	0.26
	Autumn	1,406	0.69	0.07	1,082	0.39	0.06
Voluntary logbook	Spring	126	1.25	0.23	94	0.77	0.16
	Autumn	93	0.76	0.11	250	0.37	0.06
Paired data							
Daily logbook	Spring and Autumn	260	1.01	0.17	260	0.59	0.09

Hidden losses

Comparing CPUE derived from the daily logbook; CPUE was significantly lower for entries where there were records of seal interference, compared to entries where there were no such records, in both spring and autumn (34% and 43% lower catches; $P<0.001$ and $P<0.001$; Table 2). The result was similar in analogous data from the voluntary logbook (38% and 51% lower catches; $P<0.001$ and $P<0.001$; Table 2). In a sub-sample from the daily logbook, using paired data to compensate for seasonal variations and for fishermen underreporting seal interference, the difference was also significant ($P<0.001$; Table 2). The catch was significantly lower by 0.33 ± 0.14 (95% CI) kg m net^{-1}day^{-1}. Another difference between the data groups was the frequency of zero catches. In the daily logbook this occurred only four times out of 4,434 entries while in the voluntary logbooks this occurred in 11% of all records.

Field studies of hidden losses

Loss of marked fish

The experimental net with marked fish was attached to the ordinary fleet of nets at 19 settings during 17 fishing trips (Table 3). A total of 2,601 herring was marked and left in the net. Of these fish, 1,823 were lost without a trace. Seals were observed during 14 of the 19 settings; 12 of the sightings were made in the immediate proximity of the net links. When seals had been observed at the setting or lifting of the net, more than 86 percent of the marked fish were missing, while 5 percent were retrieved damaged. An experimental net with marked fish was set and then

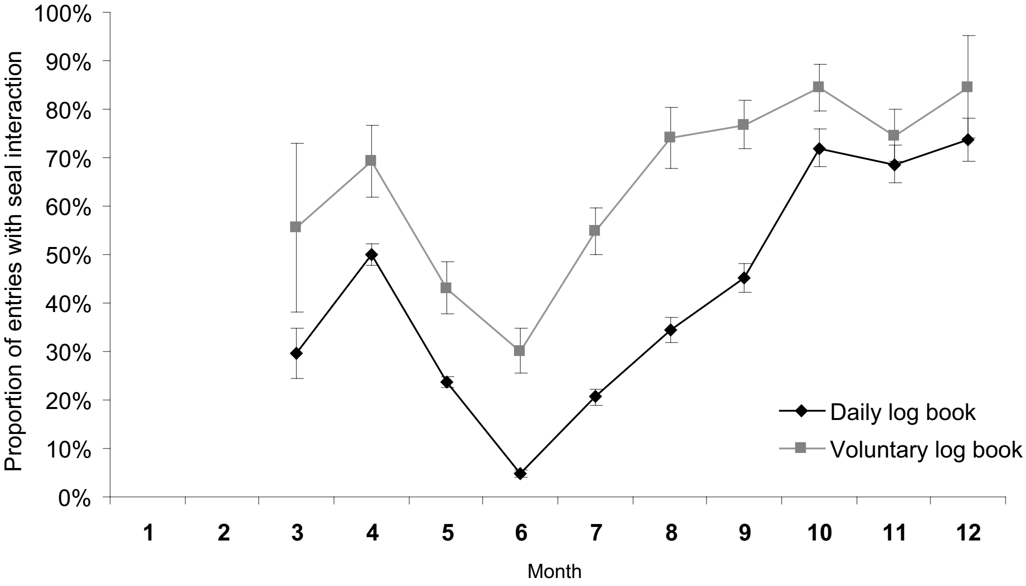

__Fig. 1.__ Relative frequency of seal interaction in the herring gill-net fisheries througout the years, based on entries in the voluntary logbook (mean per month for 2003 and 2004), and in the daily logbook (mean per month for 2000 to 2005), and SE bars. For January and February data from the daily logbook were excluded since there were no data in the voluntary logbook to compare with.

Table 3. Marked and lost fish in 19 experimental net deployments, including CPUE (kg herring m net^{-1}day^{-1}) in the adjoining nets, and the number of observed seals.				
	No. of marked fish	**Loss of marked fish (%)**	**CPUE for the whole fleet**	**No. of observed seals**
No seal visit to net (% of lost bait < 19%)	61	0	2.96	
	146	15.1	1.18	1
	85	15.3	0.88	
	71	15.5	0.83	
	54	18.5	0.04	
Seal visit to net (% of lost bait > 19%)	193	25.4	0.05	1
	42	40.5	1.25	1
	256	52.0	0.11	1
	146	96.6	0.07	1
	264	97.0	0.50	1
	201	99.0	0.00	1
	205	99.0	0.00	2
	102	100.0	0.00	1
	78	100.0	0.00	
	123	100.0	0.00	1
	265	100.0	0.00	
	66	100.0	0.00	1
	80	100.0	0.00	1
	163	100.0	0.07	

retrieved immediately on seven occasions during 2004. The maximum proportion of fish that fell off was 19% (15.2%± 4.1%; 95% CI). There was no significant difference between this figure and the percentage of fish that fell off from nets that had been in the water for a long time, excluding those occasions when more than 95% of marked fish were missing (22.5%±14%; 95% CI), (Mann-Whitney U-test P>0.05). This indicates that soak time did not affect the percentage of fish that fell out of nets. Hence, if more than 19% of the marked fish went missing during a night of fishing, it was considered as an indication that a seal visit had occurred (Table 3).

Effects of seal presence on catches

In the first data set (data from fishing occasions with observers) there were 38 fleets of nets deployed during 25 fishing trips, with observers onboard taking notes and carrying out seal observations. The mean CPUE was 70% lower in fleets where seals had been observed during the setting or lifting of the nets, than in fleets where no seals had been observed (0.13 compared to 0.43 kg m net^{-1}day^{-1}; Figure 2). In the second data set (data from nets adjacent to baited nets), consisting of 19 ordinary non-baited fleets of nets that were set together with experimental pre-baited nets, the CPUE was 88% lower when seals were observed compared to sets when seals were not observed (0.14 compared to 1.18kg m net^{-1}day^{-1}). In the third data set (data from the fishermen´s journals) 184 fleets were deployed in 102 fishing trips by the contracted local fisherman alone. The CPUE in this sample was lower (61%) for days when seals had been observed than for days when no seals had been seen (0.87 compared to 2.23 kg m net^{-1}day^{-1}). In each of the 3 data sets, the difference in CPUE between days with seal observations and days without seal observations was significant (P = 0.035, P = 0.001, P<0.001 respectively, Mann-Whitney U-test; Figure 2).

There was a small number of damaged fish found in all the nets, irrespective of whether seals had been observed or not during the setting or the lifting of the nets. There was no significant difference in the number of damaged fish per unit effort between sets where seals had been observed and those where they had not (P> 0.05 Mann-Whitney U-test; Table 4).

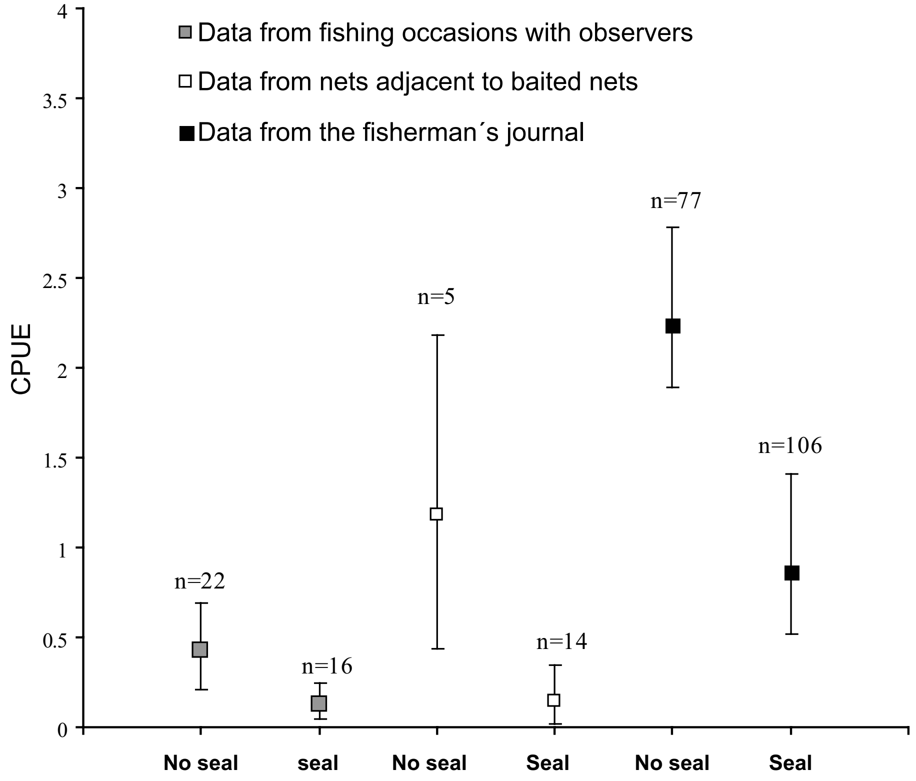

Fig. 2. *Mean CPUE (kg herring m net^{-1} day^{-1}) in net deployments where seals were observed, as compared to deployments where seals were not observed (bars indicate 95% CI).*

DISCUSSION

The results from all 3 data sets support the contention that there is a significant negative impact of grey seals on the herring fisheries in the Baltic. The EU official logbook showed that at least 30% of the reports to the logbook included information on seal interference. The voluntary logbook showed a much higher proportion of entries with recorded seal interference (60%). In the EU official logbook, seal interference is probably underestimated because reporting of such incidents is voluntary and many fishermen keep their paper work to a minimum. One of the primary aims of the voluntary logbook is to document damage caused by seals and therefore such information is specifically requested of fishermen. In addition, we suspect that fishermen usually do not report unsuccessful fishing efforts to the EU official logbook system. Only 4 records out of 4,434 entries in the daily logbook reported a zero catch, whereas 11% of all records in the voluntary logbook reported such results. It is also likely that when seals are not observed close by the fishing gear, zero catches are looked upon as just days with poor fishing, when in many cases they actually were a result of a seal visit (Fjälling 2005). This indicates that the decrease in CPUE when there were records of seal interference, compared to when there were no such records, is also likely to be an underestimate.

Even though it is difficult to quantify the seal-induced loss of catch from the logbook data, it is possible to get an indication of temporal patterns. The EU official daily logbook and the voluntary logbook data showed the same seasonal cycle in the intensity of seals-fisheries interactions (Fig. 1). The voluntary logbook, as mentioned, has a higher proportion of entries with seal interference than the daily logbook. Seal interference was by far the least during May to July, and reached a maximum by the end of the year. This reflects the life history of both herring and seals. Herring spawn in late spring and then accumulate in large masses in shallow waters. This supplies seals with an abundant food source, thus decreasing the motivation to visit fishing gear. Also, fish catches are high at this time of the year, which makes the seal visits that occur less noticeable. In the spring, adult Baltic grey seals focus on mating; this begins right after weaning the pups in February-March. During this time the adults, at least the males, do not eat (Bonner 1972). Somewhat later, in May and June, the Baltic grey seals moult and spend most of their time on land for a couple of weeks (Söderberg 1974).

Hidden losses in the herring gillnet fisheries include fish that are removed completely from the fishing gear, leaving no traces. The field study demonstrated that a very large proportion (86% , 95% CI 70.8% - 96.5%) of the marked fish disappeared without trace from the pre-baited nets during a seal visit. The fall-out of fish during handling the nets was found to be low (maximum 19%, average 15.2± 4.1 (95% CI)). Since all nets were handled the same way, fish fall-out during handling should not have affected the results. We also concluded that soak time did not affect the fall-out since there was no significant difference in bait loss between nets set for a very short time (controls) and nets set for a longer time. We had planned to use the number of missing fish, and the number of unmarked and newly caught fish, to calculate the expected catch if there had not been a seal visit. This proved impossible since too many (100% in half of the cases) of the marked fish disappeared when seals visited the nets. It was concluded that seals are able to efficiently remove gilled herring without leaving any traces. The paired data for CPUE from EU official daily logbook reports gave another estimate of the hidden losses (42% catch loss). However, this figure is probably an underestimate, partly due to the fact that no zero catches were reported as an effect of seal visits, and that such visits were not included in the analysis. To improve the paired data method, a more reliable way to determine whether or not seals have visited the net is needed. This could be done by encouraging or requiring fishermen to provide seal observations. All presented data sets agree and show there are significant hidden catch losses due to depredation by grey seals in the herring fisheries. As demonstrated, several factors need to be taken into account when estimating catch losses.

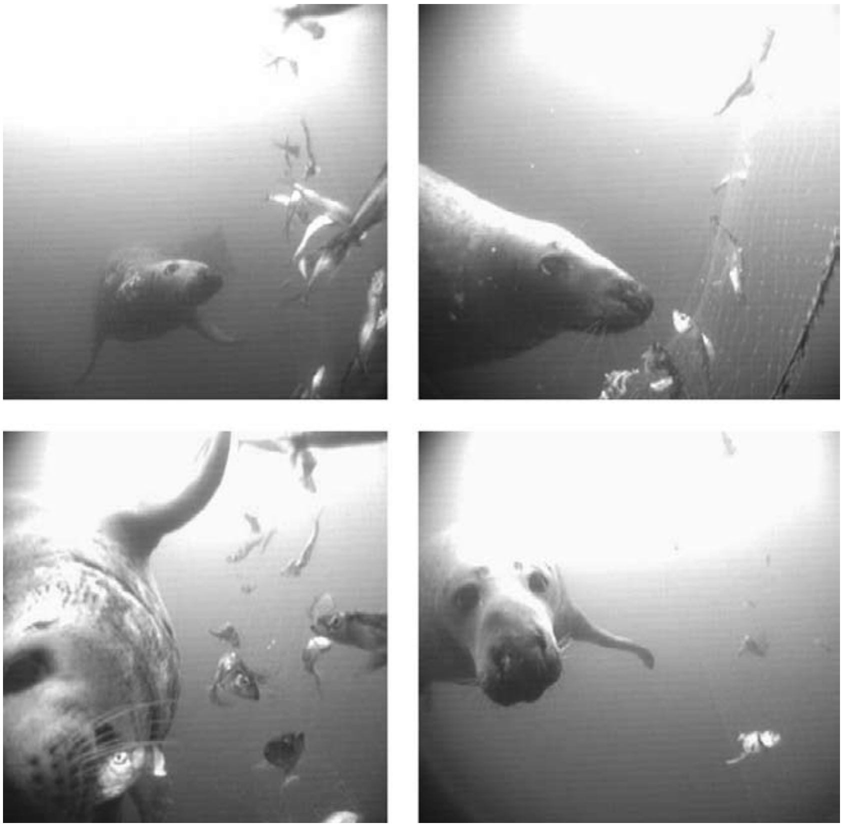

***Fig. 3**. A grey seal raiding a herring gillnet. About 200 herring were placed on the net and 20 minutes later the net was empty.*

Table 4. Mean DPUE (number of damaged fish m net^{-1}day^{-1}) in 2 data sets, relating to whether seals had been observed or not.

Data	DPUE when seals were observed	DPUE when no seals were observed
Data from fishing occasions with observers	0.01	0.00
Data from nets adjacent to baited nets	0.12	0.08

Hidden losses also include fish that are scared away from the fishing gear, and therefore not caught in the nets, due to the presence of seals. Fishermen have alleged that seals scare fish away from the fishing areas. They have watched on their echo-sounders as schools of herring have disappeared from areas around the nets when seals were close by. Our field study showed that catches decreased when seals were observed near the nets. The catch loss was estimated at 240 kg herring per fleet of nets and fishing occasion, assuming that 180 m of net are set in 1 fleet of net and that the decrease in catch is 1.3 kg of herring per metre net and day. On average 3 fleets of nets are set during a fishing trip, although all fleets might not have been subjected to seal damage. The large catch losses estimated raise the question whether it is possible that the few seals observed (maximum 2 at any one time) could eat such an amount of fish. Even if we accept that there might have been 5 times more seals than observed, it is still hard to believe that the seals could devour the 240 kg of fish calculated as lost catch, leaving very few remains. Since gilled fish is a very convenient food resource, a likely explanation is that the seals patrol along the net, taking the few fish that occasionally get caught and causing the majority of the herring to vanish from the vicinity of the net.

Shoaling is an anti-predator device used by herring. Herring aggregate, are highly motivated to stay as a group, continually change position and rapidly respond to noxious stimuli (Baxter 1990). The predator avoiding behaviour of herring schools has also been described by Pitcher *et al.* (1996). Predators accompanying the herring school can frequently cause behavioural modifications, but not dispersal of the school. The herring most likely stay together in a school, and move away from the area where the nets are set and where the seals patrol. Our data do not imply that herring schools were forced into the nets by the seals. If even a small school of herring (say 300 kg which is approximately 6,000 fish) was forced into the net by a seal, the probability of finding fish remains after the seal visit would be high. However, we only found on average 12 remains of fish per fleet of net and day when seals had been present. Very few unmarked newly caught herring were found in the experimental nets after seal visits, which also suggests that the mere presence of seals affects the behaviour of the herring. Therefore, we conclude that the presence of seals is a factor that affects the fisheries negatively, and these losses should be included when seal induced catch losses in the herring gillnet fisheries are estimated.

Fishermen spend more time at sea than researchers, and their observations often constitute valuable information which can be used in scientific studies. If researchers cooperate with fishermen, their knowledge and valuable information can be evaluated and brought to the proper forum.

This study shows that seals affect the herring fishery negatively and seriously. Seals represent a larger threat to the traditional herring fishery in the Baltic than is commonly appreciated. In many fisheries, the development of new seal-safe fishing gear is thought to be the best way forward in reducing seal-induced catch losses. In the herring gillnet fisheries, as in other gillnet fisheries, this is very difficult to accomplish. The only reasonably seal-safe alternative fishing method presently available, namely trawling, has several other negative implications, such as a reduced selectivity as regards the size of herring, and a generally larger bycatch of unwanted fish species. It also has an inherently higher energy consumption. In addition, the low market value for herring in combination with the high initial investments necessary, mean that trawling is not a realistic alternative for most of the coastal fishermen affected by the seal problem. This must be taken into consideration in the management plans for the Baltic grey seal. There is no simple solution to the present problems. It has come to a point where a substantial reduction in the seal population might be necessary if the small scale coastal fishing industry is to survive.

ACKNOWLEDGEMENTS

We are most grateful to Dennis Westlund who taught us everything there is to know about herring fishing and supported us in our work by letting us come along on his fishing trips. Thanks to Anna Söderlind for helping out and putting up with us all while working on her Master's thesis. Irene Weinberger came all the way from Switzerland to learn more about the Swedish seals; her help and good humour were indispensable. We are also grateful to Karl Lundström and Malin Hemmingsson who helped out with field work. This study was financed by the Swedish Environmental Protection Agency and the Swedish Board of Fisheries.

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