Author(s): Esa Lehtonen, Roope Lehmonen & Petri Suuronen

Title: Potential of creating seal-free fishing areas with seal deterrents

Year: 2023

Version: Published version

Please cite the original version:

Lehtonen, E., Lehmonen, R., & Suuronen, P. (2023). Potential of creating seal-free fishing areas with seal deterrents. Fisheries Research, 264, 106736.
https://doi.org/10.1016/j.fishres.2023.106736

Fisheries Research 264 (2023) 106736

Contents lists available at ScienceDirect

Fisheries Research

journal homepage: www.elsevier.com/locate/fishres

Short communication

Potential of creating seal-free fishing areas with seal deterrents

Esa Lehtonen[a,*], Roope Lehmonen[a], Petri Suuronen[a,b,1]

[a] Natural Resources Institute Finland, Latokartanonkaari 9, 00790 Helsinki, Finland
[b] International Seafood Consulting Group (ISCG), Dagmarinkatu 13 B 15, 00100 Helsinki, Finland

A R T I C L E I N F O

Handled by: A.E. Punt

Keywords:
ADD
Seal fence
Seal-fishery conflict
Baltic Sea

A B S T R A C T

Damages to fisheries caused by growing seal populations have markedly increased in recent decades in many coastal regions around the world. In the Baltic Sea, solutions to reduce these damages have largely focused on modifying fishing gear but this has been insufficient for solving the problem. We tested whether straits to shallow inshore areas could be “closed” from seals by seabed-mounted acoustic seal deterrent devices (ADDs) and thereby create seal-free fishing areas. So far, we have tested such “sound-fences” only on relatively narrow straits, up to 200 m in width. Our experiments suggest that seabed-mounting would be a technically feasible method to discourage seals from entering through straits into inshore bay areas. Additional methodological development is needed to close wider straits and to make the method both easy to use and reliable. We discuss the challenges and potential of this new method.

1. Introduction

Grey seal (*Halichoerus grypus*) population in the Baltic Sea has been growing rapidly since the mid-1990s (from a few thousand up to approximately 60,000 individuals) and thereby seal-induced catch losses and gear damages have dramatically increased in coastal fisheries (Kauppinen et al., 2005; Fjälling, 2005; Königson et al., 2009; Svels et al., 2019; Vetemaa et al., 2021). Seals are considered by fishers to be biggest threat to the viability and continuation of their livelihoods (Svels et al., 2019; Waldo et al., 2020; Blomquist and Waldo, 2021).

Intensive research has been conducted to find gear modifications such as seal-proof pontoon traps and alternative gear designs, which would help to mitigate seal-induced damage in the Baltic coastal fisheries (Lunneryd et al., 2003; Lehtonen and Suuronen, 2004; Suuronen et al., 2006; Hemmingsson et al., 2008; Königson et al., 2015; Ljungberg et al., 2022). Nevertheless, in many fisheries, gear modifications do not facilitate adequate protection. Recently, promising results in reducing the damage caused by grey seals have been obtained in the Baltic salmon pontoon trap fishery by using acoustic seal deterrent devices (ADDs) in the vicinity of the gear (Lehtonen et al., 2022).

With the growth of the population, Baltic grey seals have increasingly entered shallow coastal waters and river mouths in search of food, causing major damage to commercial gillnet and trap-net fisheries in those areas. This has launched an interest to close off entire water areas from seals with the help of ADDs. The most potential lies in coastal inshore areas, where the straits leading to them are narrow enough to be closed with the help of ADDs. Along the Finnish southern and western coastal areas there are more than 30 such inshore bays with a total area of almost 800 km^2 (Fig. 1).

In our early pilot tests, we used raft-mounted ADDs to close a strait (for more details of raft-mounting, see Lehtonen et al., 2022). In the experiments described here, we mounted the ADDs on the seabed and assessed the technical feasibility of such a set-up. To our knowledge, there are no studies where seabed-mounted ADDs had been tested in closing a strait for seals. In this paper we discuss the challenges and present potential approaches for improving the methodology.

2. Experiments with seabed mounted ADDs

The experiments with seabed-mounted ADDs were conducted in 2022 in the southwestern archipelago of Finland, in the inshore area northwest of the city of Naantali (Fig. 2). It is a typical coastal area where several narrow straits lead to an inner shallow water bay. The depth of the sea at straits varies from 6 m to 25 m. The bottom is mainly mud and sand with stones and rock on the shorelines.

Mounting the ADD pod on the seabed requires the pod to be connected to the control unit (on land) by means of a low-voltage marine cable. Ace Aquatec Ltd provided systems whereby the ADD pod can be

* Corresponding author.
E-mail address: Esa.Lehtonen@luke.fi (E. Lehtonen).
[1] orcid.org/0000-0001-7743-4091

https://doi.org/10.1016/j.fishres.2023.106736
Received 20 December 2022; Received in revised form 28 April 2023; Accepted 29 April 2023
Available online 10 May 2023

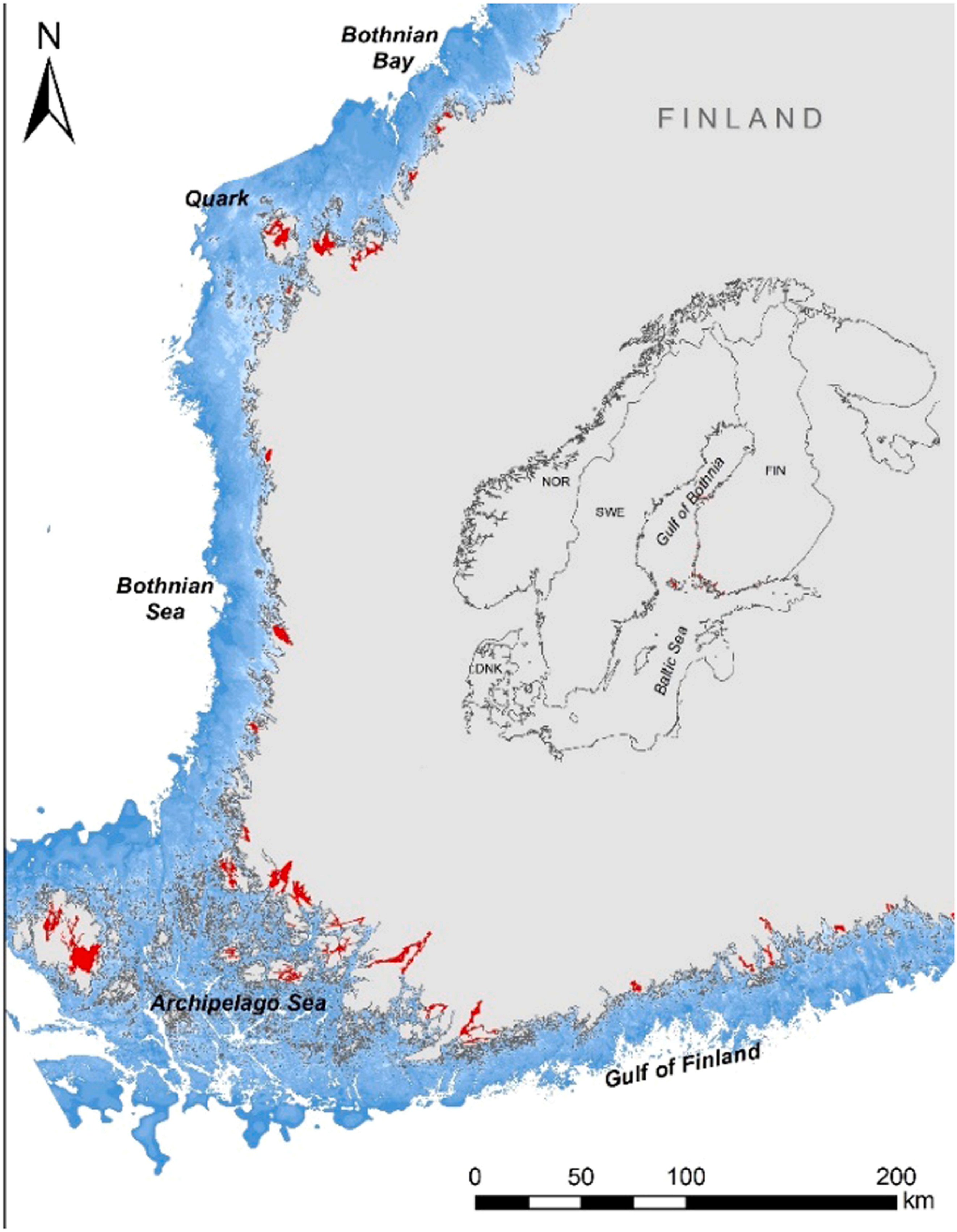

Fig. 1. Potential seal-free areas (marked with red colour) along the southern and western Finland Baltic coast, and Åland Islands (the most western island area).

separated from the control unit with a cable up to maximum 200 m without the performance of the device being impaired.

Ace Aquatec model US3, a medium-frequency (8–11 kHz) seal deterrent, was used in the experiments. It provides a modulated frequency output with short, randomized sound pulses (optional 12–144 scrams per hour). According to the manufacturer, effective maximum deterrence distance for seals by the US3 is 45–50 m. The operation of a US3 device can be monitored and parameters changed remotely via a 4 G mobile or LAN connection.

The principle for how the ADD pod was lowered onto the seabed is shown in Fig. 3. The ADD pod was attached with an adjustable (1–3 m) rope to a concrete weight, which was lowered onto the seabed. A float attached to the pod lifted it upwards. A diver checked that the pod was standing in the proper vertical position and that the cable was not entangled. The possibility to have 230 Volts secure utility power for the control unit was essential to ensure an easy, uninterrupted operation of ADDs during the tests. Boaters were warned about the ongoing investigation and the underwater cables by warning boards installed on both shores.

A hydrophone logger (broadband digital Ocean Sonics icListen) was used in the study area to measure the intensity of the sound emitted by the ADDs and the attenuation of the sound by distance. Water depth at the measurement points varied between 4 and 30 m. The measurements indicated that a typical duration of US3 sound-signal is 1–4 s and it is emitted on average every 40 s. The strength of signal was higher in surface water than in deeper water. This is likely due to the shape and quality of the seabed but may also partly been due to water temperature profile. The sound signal settings and set-ups were equal in all the US3 units measured. The attenuation of signal with increasing distance was strong apparently due to the soft bottom of the strait.

Fig. 3. Lowering the ADD pod down towards the seabed. The ADD pod is connected to the weight with an adjustable rope and the floats keep the device in a vertical position during deployment. Photos: Esa Lehtonen / Luke.

3. The challenges and the way forward

Our experiments suggest that mounting ADDs on the seabed and

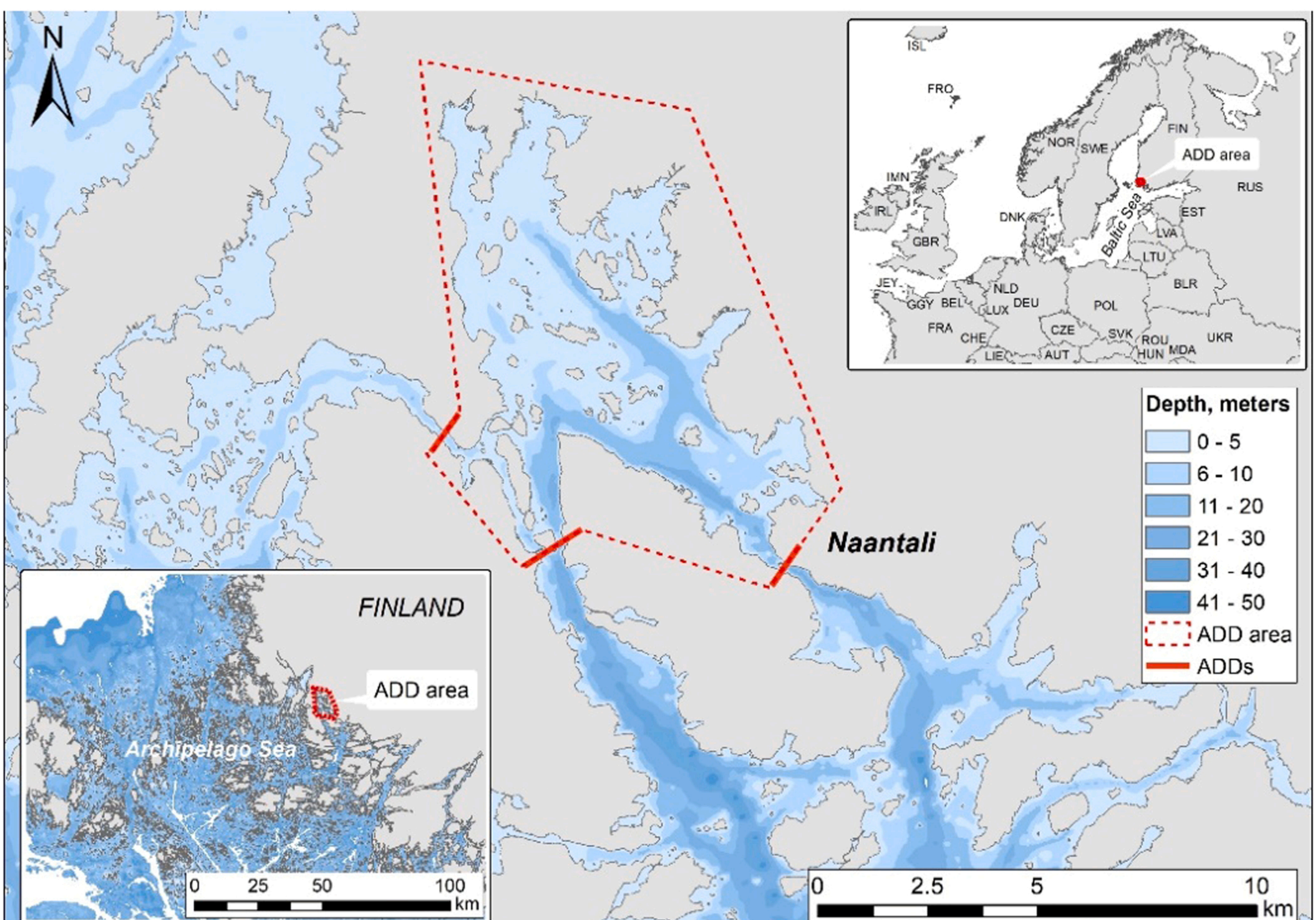

Fig. 2. The experimental area near the city of Naantali in the archipelago of southwestern Finland. Positions of ADDs in the straits are marked with red solid lines.

connecting them to control units with a seabed cable is a technologically feasible approach and enables the use of ADDs near busy boat lanes where ADDs, which are mounted on rafts, cannot be used. An additional advantage of seabed mounting is that ADDs are invisible and do not cause visual harm to nearby residents and are not impacted by neither wind nor wave action.

The limited log-book data collected in the pilot tests does not allow any statistical analysis yet to assess the effectivity of the system. Nevertheless, the empirical evidence collected during the experiments suggests that the method described is functional and will reduce the interaction rate. Fishers working in the “closed area” have noted that their catches have included less fish with external seal-caused damages and there has been less damaged gillnets than in previous years when there were no ADDs. More comprehensive log-book data will be collected in the coming years.

Creation of seal-free areas through seabed mounted ADDs appears to be a potential solution in conditions where the straits are narrow enough. It is noteworthy that not only commercial fishers but also recreational fishers and fishing guide entrepreneurs would benefit from such seal-free areas. Moreover, because shallow inshore areas and river mouths are the essential spawning areas of many coastal fish species, they could be protected from seal predation during the spawning period.

A major advantage of an “ADD-fence” is that, once it is established, it will operate until the device is switched off. Nevertheless, underwater surveillance systems operated by navies need to be taken into consideration and may restrict the use of deterrents in certain areas. A potential inconvenience with ADD systems is their relatively high price although also gear modifications involve considerable costs and additional work to fishers.

In further experiments, the optimal density (distance to each other) of ADDs for various situations must be defined. The effective distance, at which an ADD keeps seals away, depends on the conditions. Sound propagation is affected by bottom shape and material, water depth, and by the background noise at sea. Furthermore, water temperature profile, which changes according to the season, plays a role in the propagation of sound. To guarantee a full deterrence across the strait, the density of ADDs should match the conditions. The set-up we are planning in our further experiments in a strait of 200 m in width is shown in Fig. 4. Such a strait needs four or five ADDs.

In terms of the device’s efficiency, it is not yet clear whether installing ADDs near the seabed is the most optimal solution. In order to guarantee 360° coverage of an ADD signal, the transmitter preferably should be installed high enough above the seabed to avoid any potential “shadowing effect” due to the potential unevenness of sea floor. In our set-up, the adjustable ropes allowed for the ADD pods to be lifted several meters above the seabed. In order to reduce the impact of sea currents, the rope could be replaced by a rigid plastic pipe that is fixed to a weight. This set-up would require further development and testing.

The method has so far been tested in fairly shallow (up to 25 m) straits. There is not yet data available to determine the maximum depth of deployment. However, based on our experience, we consider that for practical reasons the maximum effective depth for the system is about 50 m. It is also noteworthy that the deeper the strait, the closer the ADDs must be installed to each other to maintain the full coverage. In case there is a need to close markedly wider straits than was done in our study, instead of having a row of stationary ADDs on the seabed, one pendeling device could take care of the task. Such an autonomously moving seal deterrent system is under development in Finland.

It is important to ensure that the underwater sound of ADDs does not adversely affect seals and other living organisms. An ADD should produce sound of sufficient intensity to cause discomfort but not threaten the hearing sense and welfare of a seal. Particular concerns have been raised on how ADDs may affect the behavior, foraging and reproduction of co-existing cetaceans, such as harbour porpoises (Johnston, 2002; Olesiuk et al., 2002; Brandt et al., 2013; Kastelein et al., 2013). As cetaceans only rarely appear along the northern Baltic coast, this potential problem is of a smaller scale in the region of this study (see also Fjälling et al., 2006). In areas with cetaceans, seabed-mounted ADDs should be used with particular care until the impacts are better understood. It is noteworthy, however, that many of the studies indicating negative impacts on cetaceans are based on older versions of the ADDs with different technical characteristics than current ADDs. Furthermore, there are low-frequency devices available which operate largely below cetaceans’ hearing range.

There has been some concern that a prolonged exposure to the sound of an ADD may impair the hearing sense of a seal (e.g., Götz and Janik, 2010). Nonetheless, there is little direct data available of such effect on seals which apparently would tend to avoid such an unpleasant experience. In addition, in the Ace Aquatec US3 device, as in most ADDs available on the market, the sound signal is not sent immediately at full intensity, but at first the signal strength is low (soft start function). This gives a seal the opportunity to move further away from the ADD before the sound signal reaches full intensity. It is also worth of noting that porpoises and seals respond very differently to ADD sounds (Mikkelsen et al., 2017).

In creating seal-free areas, it is important to ensure that there are no seals in the area that will be closed by ADDs. Those seals should preferably be removed. It is noteworthy that older seals with impaired hearing may be able to swim through the straits despite ADDs. In theory, a seal can also bypass the ADD by swimming with its head above the surface of the water although we do not have any knowledge of such observation. Finally, there may be challenges in using ADDs in remote archipelago areas. In case there is no community mains power, the electricity needs to be produced at site. Solar and wind energy as well fuel cell generators are potential solutions.

CRediT authorship contribution statement

All authors equally participated in the conceptualization, methodology development, project administration, writing and funding acquisition of this study.

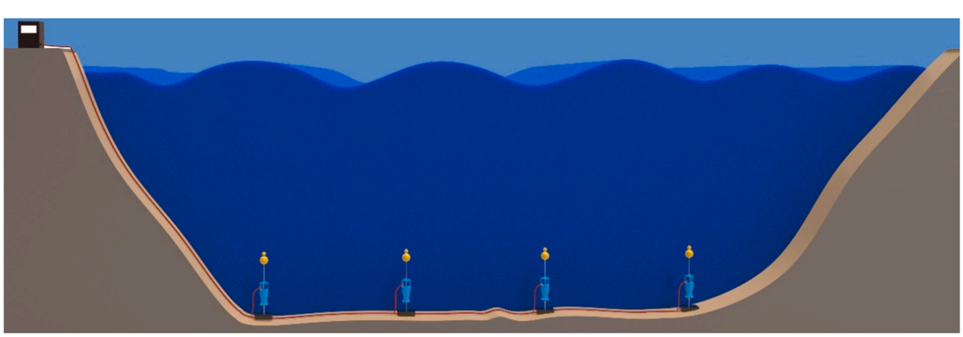

Fig. 4. Schematic set-up for ADDs mounted on the seabed in a strait of about 200 m in width (not in scale). The seabed cable is marked in red colour.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

No data was used for the research described in the article.

Acknowledgements

We are grateful to JMPajala Ltd, TR Marine Diving and Marine Service Ltd., and Ace Aquatec Ltd and Mr. Andrew Gillespie, for the collaboration in the development of the method described in this article. We highly appreciate the help given by Dr. Lari Veneranta and Mr. Jari Niukko in producing the maps presented in this article. The study was financed by the European Maritime and Fisheries Fund (EMFF).

References

Blomquist, J., Waldo, S., 2021. Seal interactions and exits from fisheries: insights from the Baltic Sea cod fishery. ICES J. Mar. Sci. 78, 2958–2966. https://doi.org/10.1093/icesjms/fsab173.

Brandt, M.J., Höschle, C., Diederichs, A., Betke, K., Matuschek, R., Witte, S., Nehls, G., 2013. Far-reaching effects of a seal scarer on harbour porpoises, Phocoena phocoena. Aquat. Conserv.: Mar. Freshw. Ecosyst. 23 (2), 222–232.

Fjälling, A., 2005. The estimation of hidden seal-inflicted losses in the Baltic Sea set-trap salmon fisheries. ICES J. Mar. Sci. 62, 1630–1635.

Fjälling, A., Wahlberg, M., Westerberg, H., 2006. Acoustic harassment devices reduce seal interaction in the Baltic salmon trap-net fishery. ICES J. Mar. Sci. 63, 1751–1758.

Götz, T., Janik, V.M., 2010. Aversiveness of sound in phocid seals: psycho-physiological factors, learning processes and motivation. J. Exp. Biol. 213, 1536–1548.

Hemmingsson, M., Fjälling, A., Lunneryd, S.-G., 2008. The pontoon trap: description and function of a seal-safe trap-net. Tech. Note Fish. Res. 93, 357–359.

Johnston, D.W., 2002. The effect of acoustic harassment devices on harbour porpoises (*Phocoena phocoena*) in the Bay of Fundy, Canada. Biol. Conserv. 108, 113–118.

Kastelein, R.A., Gransier, R., Hoek, L., Rambags, M., 2013. Hearing frequency thresholds of a harbor porpoise (Phocoena phocoena) temporarily affected by a continuous 1.5 Hz tone. J. Acoust. Soc. Am. 134, 2286.

Kauppinen, T., Siira, A., Suuronen, P., 2005. Temporal and regional patterns in seal-induced catch and gear damage in the coastal trap-net fishery in the northern Baltic Sea: effect of netting material on damage. Fish. Res. 73, 99–109.

Königson, S., Lunneryd, S.-G., Stridh, H., Sundqvist, F., 2009. Grey seal predation in cod gillnet fisheries in the Central Baltic Sea. J. North. Atl. Fish. Sci. 42, 41–47. https://doi.org/10.2960/J.v42.m654.

Königson, S.J., Fredriksson, R.E., Lunneryd, S.-G., Strömberg, P., Bergström, U.M., 2015. Cod pots in a Baltic fishery: are they efficient and what affects their efficiency? ICES J. Mar. Sci. 72, 1545–1554.

Lehtonen, E., Suuronen, P., 2004. Mitigation of seal-damages in salmon and whitefish trap-net fishery by modification of the fish bag. ICES J. Mar. Sci. 61, 1195–1200.

Lehtonen, E., Lehmonen, R., Kostensalo, J., Kurkilahti, M., Suuronen, P., 2022. Feasibility and effectiveness of seal deterrents in coastal trap-net fishing – development of a novel portable deterrent. Fish. Res. 252, 106328 https://doi.org/10.1016/j.fishres.2022.106328.

Ljungberg, P., Königson, S., Lunneryd, S.-G., 2022. An evolution of pontoon traps for cod (Gadus morhua) fishing in the southern Baltic Sea. Front. Mar. Sci. 9, 981822 https://doi.org/10.3389/fmars.2022.981822.

Lunneryd, S.-G., Fjälling, A., Westerberg, H., 2003. A large-mesh salmon trap: a way to mitigate seal impact on a coastal fishery. ICES J. Mar. Sci. 60, 1194–1199.

Mikkelsen, L., Hermannsen, L., Beedholm, K., Madsen, P.T., Tougaard, J., 2017. Simulated seal scarer sounds scare porpoises, but not seals: species-specific responses to 12 kHz deterrence sounds. R. Soc. Open Sci. 4, 170286 https://doi.org/10.1098/rsos.170286.

Olesiuk, P.F., Nichol, L.M., Sowden, M.J., Ford, J.K.B., 2002. Effect of the sound generated by an acoustic harassment device on the relative abundance and distribution of harbor porpoises (*Phocoena phocoena*) in Retreat Passage, British Columbia. Mar. Mammal. Sci. 18, 843–862.

Suuronen, P., Siira, A., Kauppinen, T., Riikonen, R., Lehtonen, E., Harjunpää, H., 2006. Reduction of seal-induced catch and gear damage by modification of trap-net design: design principles for a seal-safe trap-net. Fish. Res. 79, 129–138.

Svels, K., Salmi, P., Mellanoura, J., Niukko, J., 2019. The impacts of seals and cormorants experienced by Baltic Sea commercial fishers. Natural resources and bioeconomy studies 77/2019. Nat. Resour. Inst. Finl., Hels. 50.

Vetemaa, M., Päädam, U., Fjälling, A., Rohtla, M., Svirgsden, R., Taal, I., Verliin, A., Eschbaum, R., Saks, L., 2021. Seal-induced losses and successful mitigation using acoustic harassment devices in Estonian Baltic trap-net fisheries. Proc. Est. Acad. Sci. 70, 207–214.

Waldo, S., Paulrud, A., Blomquist, J., 2020. The economic costs of seal presence in Swedish small-scale fisheries. ICES J. Mar. Sci. 77, 815–825. https://doi.org/10.1093/icesjms/fsz221.