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Male gray seals specialize in raiding salmon traps

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ABSTRACT

In the Baltic Sea there is a severe conflict between small-scale fisheries and gray seals. One fishery severely affected by seal predation is the salmon trap fishery. Underwater cameras were placed in two pontoon traps to study the behavior of raiding gray seals. Seals observed on film were identified and a catalog of 'problem' seals was created, totaling 11 individuals. As part of this study, 8 pontoon traps modified for live-trapping raiding seals were set out in the same area. Trapped seals were killed and their markings photographed in order to try to match them with seals in the catalog. The eleven identified seals were responsible for 426 out of 600 visits to the two traps with cameras. Four of the eleven seals raided at least two traps and returned to raid traps frequently over the 2-year study period. Seals caught in the pontoon traps modified for live-trapping were mainly adult male seals. Three of these seals were identified as cataloged seals. This study has shown that it is generally adult male gray seals which have specialized in raiding fishing gear. These specialist seals have developed a characteristic behavior pattern and have persisted with it over a long period of time.

1. Introduction

The trap net fishery for salmon (*Salmo salar*), sea-trout (*Salmo trutta*) and whitefish (*Coregonus lavaretus* spp.) in the Baltic Sea is subject to severe levels of interference by gray seals, sometimes spelled as gray seals (*Halichoerus grypus*). Foraging seals cause both damage to fishing gear and catch losses. A new design of trap, which reduces their vulnerability to seal attacks (Lunneryd et al., 2003; Suuronen et al., 2006), was successfully introduced and implemented in this fishery in the 2000s (Hemmingsson et al., 2008). With this new trap design, known as the large mesh pontoon trap, the seals experience greatly reduced hunting success. However during recent years, reports of seals moving in and out of the trap entrances and trying to get into the fish chambers have become more common, indicating that there is still a problem in this fishery.

A prerequisite for finding effective mitigation measures is a detailed knowledge of the behavior of both seals and target fish in relation to the fishing gear. In situ studies can be carried out with the aid of underwater video recording; knowledge gained in this way was central in the development of the pontoon trap (Lunneryd et al., 2003). However, there remained several specific unanswered questions regarding the behavior of seals in and around fishing gear. One such question of immediate importance in the seal-fishery conflict is whether or not the gray seals raiding fishing gear are 'specialists'. Individuals with specialized behavior, often characterized as 'problem' animals, have been described in many studies, such as in Linnell et al. (1999) where support was given to the removal for management purposes of seals identified as 'problem' individuals. Graham et al. (2011) showed that the gray seals which specialize in foraging for salmonids in the rivers of the Moray Firth in Scotland, and which are labeled as 'problem' seals because they thereby come into conflict with fishing and angling interests, constitute less than 1% of the local gray seal population. Königson (2011) found that harbor seals (*Phoca vitulina*) raiding fyke nets off the west coast of Sweden were indeed the same individuals, repeatedly returning to the nets. If only a specialized and limited number of seals make a habit of raiding fishing gear, a promising management strategy would be to remove these individuals. Studies of seal behavior at salmon traps incorporating underwater photo-identification are therefore in the mitigation of this conflict.

Photo-identification techniques for marine mammals, involving recognition and recording of individual markings, have been developed and successfully applied to a number of species including both seals and whales (Würsig and Würsig, 1977; Katona and Kraus, 1979; Hiby and Lovell, 1990; Anderson et al., 2010). The photo-ID method has proved to be a reliable tool when applied to gray seals (Karlsson and Helander, 2005; Vincent et al., 2005; Gerondeau et al., 2007). It is mainly the markings on the head and neck of the

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seals which have been used as identifying features (Karlsson and Helander, 2005; Hiby et al., 2007; Vincent et al., 2005; Gerondeau et al., 2007). Almost all studies have been based on photos taken in air, although underwater photo-identification has been applied in the case of turtles (Schofield et al., 2008) and harbor seals (Königson, 2011). The present study is the first to use underwater photos (from video recordings) to identify individual gray seals.

Culling seals has been used for centuries as a mitigation measure for reducing damage to fisheries. When carrying out a seal cull, it is preferable to retrieve the carcases, both to ensure that the animals are in fact killed rather than injured and so that biometric data can be collected. Retrieval is complicated when it comes to marine mammals since they normally sink when dead, and as Baltic gray seals typically weigh between 100 kg and 300 kg, a general seal cull is not something to be undertaken lightly. It has been suggested that if trap-raiding seals can be shown to be specialists within the wider population, then selective culling of these individuals would be the most effective way of reducing damage to fisheries (Lunneryd and Fjälling, 2004; Lehtonen and Suuronen, 2010). For these reasons, both practical and ethical considerations led to a proposal to live-trap those seals raiding salmon traps in order to eliminate them in a controlled manner. In the second year of this two-season study, therefore, pontoon fish traps were modified to also function as seal traps. Seals caught in such traps could be expected to give important biometric information about the individual seals raiding the traps which is highly relevant for our understanding of the process. This data was therefore collected at the same time as we carried out the necessary procedures to gain type-approval of the modified trap. National agreements state that all new models of traps for catching and holding and/or euthanizing animals must be acceptable in terms of animal welfare. This means, among other things, that a pre-set number of trapped animals, in this case 20 individuals, must be examined for signs of stress and physical trauma before the traps can receive official approval.

The goals of the present study were: (i) to determine whether or not gray seals raiding salmon traps are 'specialists' who habitually raid such traps, (ii) to describe the pattern of visits of any identifiable seals, and (iii) to establish the biometric characteristics of the animals involved. After answering questions (i) and (ii) above, selective culling of specialist seals was introduced and some preliminary data on its effect on the fishery are also presented.

2. Materials and methods

In this study we analyzed and compared data from three sources; (a) a 2-year field study in which pontoon traps were filmed with underwater cameras in order to identify seals raiding traps, (b) a 1-year project identifying and examining seals live-trapped in specially modified pontoon traps and subsequently put down, and (c) reports from fishermen including fishing effort, fish catch data and notes on seal-induced damage to catch and gear.

2.1. Underwater filming in traps

The field study was carried out over two fishing seasons from June through August in 2006 and 2007, which is the time of the year when the salmon run peaks in the Bothnian Sea in the Northern Baltic. The study area is located about 300 km north of Stockholm, Sweden (Fig. 3). Trials were carried out in collaboration with local fishermen fishing for salmon, sea-trout and whitefish and using seal-safe pontoon traps (Fig. 2) (Hemmingsson et al., 2008; Lunneryd et al., 2003). The pontoon trap has several sections made from net panels. The leader net extends from the shore line and guides the fish to the entrance of the trap. The trap has 'wings' consisting of funnel-shaped sections, with gradually smaller openings.

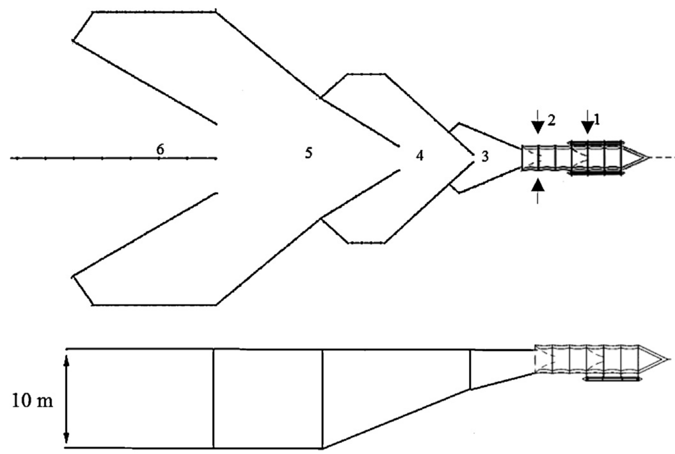

Fig. 1. Overall outline of the salmon pontoon trap, top and side view including the holding chamber (1) and the entrance part (2). These two sections are attached to a large mesh salmon trap consisting of: (6) leader net, (5) wings, (3–4) middle chambers. Arrows indicate camera positions.

The trap wings are connected to the fish chamber, which consists of two sections, the entrance part and the actual holding chamber, which can be raised to the surface for emptying by means of inflatable pontoons. The entrance part is cylindrical, with a diameter of 2.8 m and a length of 6 m (Fig. 1). The entrance to this section is funnel-shaped and narrows to 700 mm by 700 mm. Seals may pass through all openings in the trap except the last one which leads into the holding chamber. This opening has a square metal frame with sides of 450 mm, divided vertically in the middle of the frame (225 mm from each side) by a 3 mm stainless steel wire to stop raiding seals wriggling through.

In 2006 two traps were deployed at a distance of 3.3 nautical miles apart. The traps were each fitted with three digital cameras. Two of the cameras were positioned to cover each side of the opening to the entrance part from a distance of approximately 1 m, and the third camera was positioned to cover the opening to the holding chamber (Fig. 2) at the same distance. This arrangement allowed for a full body image of both sides of each seal to be recorded. If the seal tried to get into the holding chamber, a close-up of the head could also be obtained. In 2007 three cameras were mounted on a trap placed at one of the locations used in 2006. The video system in both seasons included monochrome Watec WAT-902H2 Ultimate cameras. Images were stored on a CamDisc Recorder with exchangeable hard disks of 80-200GB powered by a 12 V Global deep cycle gel type lead-acid battery. This allowed 36 h recording between charging. Recording was done at a frame rate of 3–4 frames per second, and a time-stamp was displayed in each frame. The recorder and battery were contained in a floating waterproof case

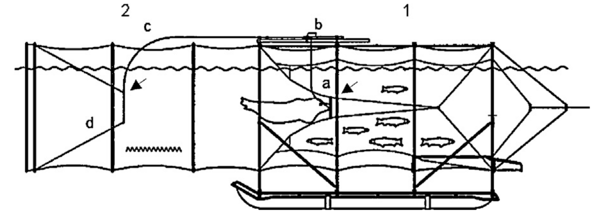

Fig. 2. Side view of the final section of a pontoon fish trap (the fish chamber) modified for trapping seals live, with the fish holding chamber (1) and the entrance part (2). The seal is caught in the entrance part. The triggering device is placed at the entrance to the holding chamber (a). The pneumatic closing mechanism including a GSM alarm (b), the trigger wire connecting the servo system with the closing mechanism (c) and the closable opening to the entrance section (d) are shown. Arrows indicate camera positions in pontoon fish traps without the modification for live trapping of seals.