Whaling, Seal Hunting and the Effect of Fisheries on Marine Mammals

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Learning goals

- Understanding interactions between marine mammals and fisheries, and how to mitigate them
- Gaining knowledge about the views of different interest groups concerning whaling and seal culling
- Learning how to determine the diet of marine mammals by studying fish ear bones

1 Introduction

Marine mammals are important top predators in the world's oceans. Many species are opportunistic feeders, catching the most abundant, convenient and easiest caught prey, depending on region and season (■ Table 1). For example, Baltic grey seals (*Halichoerus grypus*) feed mostly on herring, sprat and cod in the Baltic Proper, but further north in the Bothnian Bay they also feed on whitefish and salmon.

Apart from being an important part of marine food webs, marine mammals are indicators for the state of the marine environment. This is one of the reasons why stranded marine mammals undergo extensive post-mortem investigations, including stomach content analysis and including monitoring levels of toxic substances in various tissues. Large abundances of whales or seals in certain regions indicate good environmental conditions. For example, decreasing numbers of hauled-out seals could indicate that various human activities and environment alterations prevent them from thriving. Additionally, if marine mammals maintain a low *fertility rate* (having very few or no offspring) or a high level of diseases in a particular region, it is likely that their environment and prey are contaminated with toxic substances. Common toxic substances are persistent organic pollutants such as pesticides (for example DDT) or industrial chemicals (such as PCB). Similarly, the presence and good health status of marine mammals indicate a marine environment of high quality.

Overlap in human and marine mammal diets can lead to competition and result in bycatch, catch depredation and fishing gear damage. To study such issues, it is essential to know the diet of marine mammals in the area of interest. The identification and size of fish prey can be derived by measuring *otoliths* (fish ear stones; see ▶ Exercise 4.1 and ■ Fig. 4) often found in the stomach or faeces of marine mammals.

■ **Table 1** Daily food consumption for adult Baltic and North Sea seals and harbour porpoises

Grey seal	Harbour seal	Ringed seal	Harbour porpoise
5–9 kg/day	3–5 kg/day	4 kg/day	3–6 kg/day

Sources: Bergman (2007) and Rojano-Donate et al. (2018). The food consumption is affected by body weight, diet composition and season

2 Bycatch

Fisheries operate in many areas that are natural foraging grounds of marine mammals. This inevitably leads to interactions and conflicts between fisheries and marine mammals. One type of interaction is incidental entanglement and death of marine mammals in fishing gear, called bycatch. Another major issue is gear and catch damage caused by marine mammals.

In the Baltic and North Sea region, bycatch is one of the major anthropogenic threats to marine mammals, although quantitative estimates of mortality in fishing gear are scarce. A few extensive reports suggest that the bycatch rate can be higher than reported in official statistics. For Baltic grey seals, the yearly bycatch may be higher than 2300 individuals. For some species, there has luckily been a documented reduction in bycatch: In the 1990s, the estimated bycatch was 7,000 harbour porpoises (*Phocoena phocoena*) in the Danish part of the North Sea. Nowadays, the estimated porpoise bycatch is lower due to altered fishing efforts as well as the use of

acoustic deterrent devices (so-called *pingers*). Still, bycatch remains one of the largest threats to marine life, including marine mammals, in many regions, including the North Sea and the Baltic.

Bycatch

Incidental catch of non-target marine species in fishing gear. Marine mammals, fishes (non-targeted species and undersized specimens), birds and turtles, as well as invertebrates constitute a substantial part of bycatch in certain fisheries.

The main fishing gear responsible for marine mammal bycatch are gillnets, which are anchored on the sea bottom. Gill nets form very long, nearly transparent walls in the water column, constituting traps for marine mammals and other animals. Unfortunately, incidents of marine mammal bycatch, although fairly numerous in certain regions, are rarely reported by fishermen and not always adequately monitored, which makes a proper assessment of this threat difficult. Frequently, stranded cetaceans show characteristic net marks around their heads or other parts of the body, indicating previous entanglement in fishing nets (◘ Fig. 1). Post-mortem examinations often reveal a full stomach and bleeding in several organs, most likely caused by death struggle. Net wounds around the neck, snout or flippers are also observed in seals. Even though scientists sometimes judge bycatch as a likely cause of death, they are often unable to obtain information on the location, date and type of fishing gear in which the animal may have been caught. Such data are crucial for the implementation of effective conservation measures for the species in question.

Changing fishing gear to newer types known to be less harmful to marine mammals does not always provide an environmentally responsible or economically feasible solution. For instance, bottom trawling (dragging a trawl over the seafloor) has little direct impact on marine mammals but causes severe damage to *benthic* communities, as well as it may result in a large bycatch of juvenile fish and invertebrates. Thus, switching to 'marine mammal friendly gear' will not always solve the overall problems.

The worldwide demand for fish will increase in the coming decades. Due to overfishing and the huge quantity of bycaught and discarded smaller sized fish, the amounts of fish obtained by fishing no longer meet the global need. Therefore, most of the fish consumed today is farm-raised, not wild. Aquaculture is regarded as a solution to the burning issue of ocean overfishing. The main advantage of aquaculture is that, unlike fishing, it relies on bred and harvested fish, not on depleting wild fish stocks. Prospects of aquaculture are promising, but some types, such as offshore open systems, pose serious environmental threats, resulting in unhindered interactions between farmed fish enclosed in cages or netting systems and the surrounding environment. Aquaculture can spread diseases, parasites and chemicals (e.g. antibiotics) into

◘ **Fig. 1** Left: Bycaught harbour porpoise with net marks around the snout. © Katarzyna Jęczkowska. Right: Stranded grey seal entangled in fishing net. © Mateusz Puzdrowski

the wild. Faeces and nutrients released into the environment may cause the rise of algal blooms and eutrophication. Damaged cages result in farmed fish escaping. Escapees of farmed fish not belonging in a certain habitat can compete for food and place with indigenous species. The escaped fish can also interbreed with the wild stocks, which may lead to questionable mixing of gene pools. In addition, aqua-cultured fish needs to eat. To grow them to harvestable size, a large amount of additional smaller fish is needed, which is usually wild-caught. Thus, there are both positive and negative sides of marine fish aquaculture.

3 Seal-safe fishing gear and catch damage

Marine mammals can cause catch loss or gear damage by feeding on fish caught in nets (Fig. 2). Since the 1990s, the conflict has escalated between Baltic fisheries and grey seals. The grey seal population of historically about 100,000 individuals suffered a drastic decline in the 1970s after decades of hunting and exposure to pollution. After being protected in the 1980s, the Baltic grey seal population have recovered, reaching over 40,000 individuals in the late 2010s. Meanwhile, the biomass of several commercial fish species has decreased in the Baltic for various reasons, and seals have increasingly been perceived as being in competition with fisheries. The seals may affect the fish stocks not only by directly feeding on them but also through the spreading of parasites, for which seals and fish are part of the life cycle.

The most severe gear damage and catch loss due to Baltic grey seals is reported from the Gulf of Bothnia. The problems are worst in coastal fisheries using static fishing gear, such as salmon traps, as well as in gillnet fisheries for herring and whitefish. Fisheries using active fishing gear, such as trawling, are less affected. Various methods have been tested to minimise the seal-fishery interactions. One option is financial compensation for seal-induced catch damages. However, this solution is short-term and does not solve the actual problem. Additionally, it does not take the seal mortality in fishing gear into account, unless special constructions preventing seals from becoming entrapped in the gear are used voluntarily by fishers. The implementation of so-called *alternative fishing gear* may both reduce catch and gear damage, as well as bycatch of seals.

4 Bycatch mitigation measures

There are four main approaches to reduce bycatch of marine mammals:

- Reduce fishing efforts,
- Use pingers or other acoustic deterrent devices,

Fig. 2 Marine mammals, in particular pinnipeds, can cause severe catch loss or gear damage by feeding on fish entrapped in fishing nets. © Annika Toth

- Implement time restrictions and area closures for fishing, and
- Use alternative fishing gear.

The most effective way to curb bycatch is to reduce fisheries that incidentally catch marine mammals. Implementation of he total allowed fishing effort using, for example, gillnets, is nowadays made.

Acoustic deterrent devices of the so-called *pinger* type (Fig. 3) are effective in minimising bycatch of harbour porpoises. Pingers emit acoustic signals of rather low intensity, with frequencies between 10 and 180 kHz. They are attached to gill nets at a few hundred metres distance from each other. According to EU legislations, fishing vessels above 12 m length using some types of gillnets in certain areas are obliged to use pingers. Unfortunately, gillnets are widely used in Baltic waters, and the areas and gill net types where pingers are mandatory does not always overlap with the areas having the highest abundance of harbour porpoises.

Pingers can almost entirely eliminate bycatch of harbour porpoises, when used properly. However, it is unclear if porpoises habituate to pingers in the long run. Also, pingers may not scare off but instead attract grey seals to the nets. This complicates the efficiency of pingers in regions where seals are abundant, since the pingers may act as *dinner bells* for seals and thereby intensify seal depredation. Since seal depredation is already a large problem in the Baltic Sea, Baltic fishermen are reluctant to use pingers. Currently, there are attempts to develop pingers that are inaudible to seals but audible to porpoises.

Temporal and spatial closure of fisheries is another way to successfully reduce bycatch. The deployment of gillnets could be banned during certain times of the year and in locations important for marine mammals. Proper implementation of such regulations requires thorough information on the distribution of marine mammals and an in-depth understanding of the needs of fisheries in the designated area.

Another way to reduce seal-induced catch loss is the development of new fishing techniques. There are different types of alternative fishing gear that have been introduced in the Baltic Sea, for example, *pontoon traps* and *cod pots*. The construction of alternative fishing gear aims to protect the fish catch from the seals, but also the seals from being bycaught. In addition to new fishing devices and techniques, traditional fishing gear could be modified by using stronger net materials, and wire partitions or grids in the entrance of traps and fyke nets.

Fish and seafood consumers need to be aware of the impact their *shopping behaviour* have on adequate bycatch protection of marine mammals. Various official certificates have been introduced to ensure that labelled fish was caught using techniques that minimise bycatch. Choosing a certified instead of

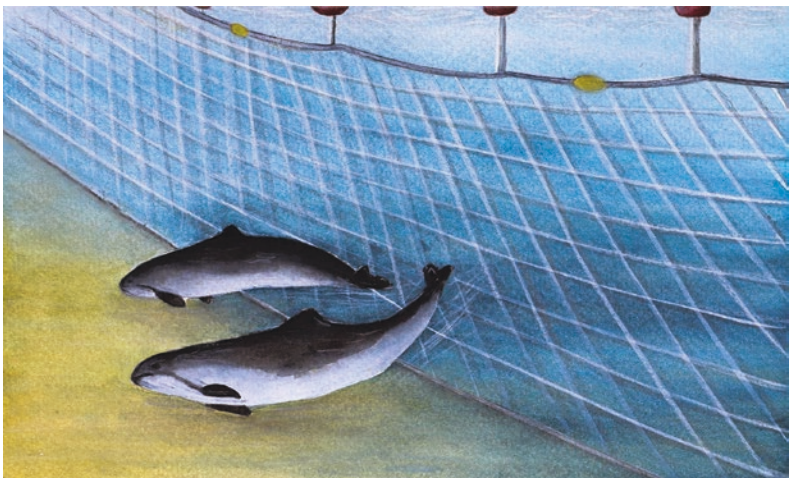

Fig. 3 Yellow acoustic deterrent devices, so-called 'pingers', are attached to a fishing net in order to minimise bycatch. Harbour porpoises are scared away by the sounds the pingers produce. © Annika Toth

an uncertified product helps ensure that bycatch caused by traditional and more harmful fishing techniques will finally be replaced by modern and marine mammal-friendly gear, limiting bycatch.

Seafood certification schemes span from self-certification to third-party ecolabelling schemes. Some of the most well-known certifications of fisheries are the international *Marine Stewardship Council (MSC) and* the *Friend of the Sea (FOS)*. Some countries have their own certifications, such as the Swedish *KRAV* and German *Naturland*. Out of the 50 or more seafood ecolabelling schemes that are out there, MSC and FOS cover over 25% of the global seafood certifications.

Seafood certification schemes

The *Marine Stewardship Council (MSC)* assesses if wild capture fisheries are sustainable and well-managed. MSC was established in 1997 as a partnership between WWF and the food company *Unilever*. A certain amount of marine mammal bycatch is accepted under the condition that it is sustainable and only has a small impact on populations. The certification is carried out by third-party certifiers. About 15% of the world's fisheries are covered by MSC programmes. Assessments of fisheries is based on scientific verification of the sustainability of targeted fish stocks, the ecosystem impact and the quality of management of the fishery. In the future, MSC will adjust its assessment methodology to FAO (*The Food and Agriculture Organisation*, United Nations) guidelines for the ecolabelling of fish and fishery products.

Friend of the Sea (FOS) was founded in 2006 by the Earth Island Institute's 'Dolphin Safe Project', which has been managing the 'Dolphin Safe' label. FOS is one of the most diverse seafood ecolabels and certifies both aquaculture and fisheries. The sustainable fishery criteria require no overexploitation of target stock, not more than 8% discards, no bycatch of endangered species, no impact on the seabed, compliance with regulations, social accountability and gradual reduction of the carbon footprint. The 'Dolphin Safe' label played a role in the reduction of dolphin bycatch in tuna fisheries. Despite these efforts, the affected dolphin populations have not recovered, which indicates that both fishery management and the 'Dolphin Safe' label are not effective enough. Dolphin-safe catch methods may be used by the industry primarily as a marketing tool rather than a genuine attempt to protect dolphin populations. Consumers should look for actual certified labels on tuna cans rather than general 'dolphin friendly' prints. Also note that some dolphin-safe fishing practises can have a substantial bycatch of other threatened species of, for example, sharks and turtles.

The Swedish *KRAV* label for organic food has implemented a system for the certification of sustainable fisheries. Sustainability is evaluated using three criteria: safe fishing methods, sustainable stocks and *traceability*. Safe fishing methods require the use of fishing gear that eliminates capture of non-targeted species or undersized individuals. Sustainability ensures that fishing is carried out on stocks that can be maintained in the long term. Traceability allows checking the location of fishing vessels, ensuring they only fish from approved stocks in authorised areas.

Naturland was founded in Germany in 1982 as an organic farming certification scheme. It later developed certification schemes for aquaculture and fisheries. Naturland standards on sustainable fishery focus on the careful use of fish stocks while protecting entire ecosystems, avoidance of harmful fishing methods, and supporting fair working conditions for fishermen.

Seafood certification schemes are not without flaws. Scientists and NGOs have been objected to some fisheries certifications. For example, a substantial part of seafood certified by MSC or FOS lacks stock status information. Target species are sometimes overfished and therefore not worthy receiving the label. Some of the MSC certifiers have been paid by the fisheries. Still, we believe it is sensible to purchase certified seafood, as the fraction of less exploited or healthier fish stocks is 3–4 times higher in certified than in non-certified products.

5 Whaling and seal hunting

5.1 Whaling

Whaling is the practice of hunting whales, dolphins or porpoises. In some parts of the world, whaling started at least 3,000 B.C., mainly as a food resource. In the 1800s, whales were also hunted for blubber (which was used for, lamp oil, lubrication and soap) and baleen (*whalebone*, used for, corsets and umbrella ribs). During the era of industrial whaling in the twentieth century, many larger whale species were hunted for meat to near extinction. The industrialised hunt had such an impact on populations that several species of large whales are still listed as endangered. Nowadays, whales are protected by several national laws and international conventions. The *International Convention for the Regulation of Whaling* was ratified by many countries in 1946. Even though most countries have banned whaling, there are still a few countries hunting whales (Table 2).

Table 2 Examples of modern whaling operations, regulated by the IWC

Type	Purpose	Where?	Concerns
Aboriginal subsistence whaling	Cultural and nutritional requirements of remote aboriginal communities	Alaska, Chukotka, Greenland and Bequia	May also have commercial purposes by selling whale meat to tourists. Traditional killing methods are often less efficient than modern ones
Scientific whaling	Research	Japan (until 2019)	If meat is sold, these operations are not only scientific but also commercial
Commercial whaling	Economic	Iceland and Norway; Japan	These countries object the IWC moratorium. They have established their own catch limits, not regulated by IWC

IWC and ASCOBANS

The IWC (*International Whaling Commission*) manages whaling and is involved in cetacean research and conservation. The IWC regulates commercial, scientific and aboriginal subsistence whaling. Membership of the IWC is open to any country that formally adheres to the 1946 Convention. In 1986, IWC implemented a *whaling moratorium* on large whales, pausing commercial whaling. The moratorium has given many whale populations a chance to recover from the extensive exploitation during the nineteenth and twentieth centuries.

The moratorium was affirmed in 2018 and is still effective. A few countries object to the moratorium and pursue whaling, targeting, for example, minke whales (*Balaenoptera acutorostrata*, e.g. Norway) and fin whales (*Balaenoptera physalus*, e.g. Iceland). In addition, some countries are allowed to pursue *scientific whaling* to evaluate the status of certain populations. However, scientific whaling has been suspected to be used as a 'loophole' to pursue commercial whaling under the moratorium. Japan is an important country in these discussions. After having conducted scientific whaling sanctioned by IWC for decades, Japan resumed commercial whaling and left IWC in 2019.

ASCOBANS (Agreement on the conservation of small cetaceans in the Baltic, North East Atlantic, Irish and North Seas) was ratified in 1991 and extended to its present extent in 2008. The objective of ASCOBANS is to restore or maintain a favourable conservation status for cetaceans in the area covered by the agreement. Working groups of scientists and conservationists within ASCOBANS develop area- or topic-specific management strategies for the protection and recovery of local populations of marine mammals, such as harbour porpoises.

During the twentieth century, the era of industrial whaling, almost 3 million cetaceans were killed. Measured as total biomass, this constitutes one of the largest animal harvests in human history. In the North Atlantic, over 280,000 cetaceans were killed, in the North Pacific 560,000, and in the Southern Hemisphere an estimated 2,000,000 animals. These are only the officially documented numbers; the real numbers are likely much higher.

Once stocks of larger whales had been depleted, the whalers moved on to hunt other stocks, and eventually smaller species. Sail-powered whaling ships took around 300,000 sperm whales (*Physeter macrocephalus*) between the early 1700s and the end of the 1800s. Technological advances of the late nineteenth century made whaling extremely efficient. Engine-driven vessels and the *exploding harpoon* were introduced, as well as factory processing on huge ships or at whaling stations. In the first 60 years of the 1900s, the same number of sperm whales were caught as during the previous two centuries. In the following decade (1970s), the same number of sperm whales were again harvested, this time due to a special interest in the waxy fluid inside their heads, called spermaceti.

5.2 Seal hunting

Seal hunting also goes back several thousand years of human history. Seal bones and teeth are found in human-made deposits in Northern Europe from stone, bronze and iron ages. Seals have been hunted for fur, blubber and meat. They have also been hunted as pest control to reduce competition with fisheries.

During the past few hundred years, the two main target species for seal hunting in Northern Europe were the harbour and grey seal. In the late 1800s and early 1900s, a bounty system was established in several countries as an attempt to reduce seal stocks and their influence on fishing. The bounty system led to an overexploitation of both species. With the additional detrimental effects of DDT, PCBs and other toxic substances, the populations plummeted in the 1950s and 1960s. Both grey and harbour seals have been protected from hunting since the 1980s in most Northern European countries. Since protection, the populations of Northern European seals have steadily increased, except for a few viral disease outbreaks with a high mortality in harbour seal populations in 1988 and 2002. Today, the abundance of both harbour and grey seals has reached a sustainable level. Still, the nutritional and health status of individual seals have not reached a satisfactory level.

Limited seal hunting (mainly for fishing gear protection, but in some areas also for food) is allowed in several Baltic countries, including Finland, Sweden and Denmark. In Germany, harbour seals belong to huntable game, but they have been exempted from this practice since 1974. Officially appointed and trained seal hunters help the German authorities to collect dead animals, and to decide if seals in a poor health condition found alive on the beach should be sent for rehabilitation or *euthanised* with a rifle.

Current topics of seal- fishery interaction research

Improved Fishing Gear

Grey seals exhibit remarkable adaptability and cognitive abilities. In regions of high abundance, like the Baltic Sea, they locally create conflicts with commercial fisheries by eating fish from nets and destroying gear. To protect catch, fishermen may replace traditional fishing gear (such as gillnets) with alternative seal-safe gear (e.g. pontoon traps or cod pots). Despite the large progress that has been made in preventing seal-induced catch damage, none of these new types of gear are 100% seal safe. Seals quickly improve their skills in raiding fish traps, and therefore constant modifications of fishing gear are essential. It is necessary to continue the development of effective and sustainable seal-safe fishing methods, while at the same time prevent damage caused by seals. In order to improve fishing gear and to test new prototypes, a close cooperation between scientists, fishing gear technologists and fishermen is required.

At the Swedish *University of Agricultural Sciences* (SLU) in Lysekil, Dr. Sara Königson and her student, Jasmine Stavenow, investigate conflicts between seals and fisheries. The aim of their research is to develop seal-proof fishing gear. In one of Sara's research projects, she has developed and tested pots as an alternative to gill nets used for cod. Sara and Jasmine attached waterproof cameras to the pots so that they could study both fish and seal behaviour around the pots. They spent many hours on the pier or in small boats preparing the pots for the experiments, as well as in front of their computers, analysing the footage and summarising the results into reports and scientific publications. Some of Sara's and Jasmine's seal-proof pots are now commercially available. Sara and Jasmine continue to invent or improve other types of fishing gear.

You can watch the video of their typical day of field work and a video showing the behaviour of grey seals visiting fishing gear here ◘ Videos S1 and S2.

6 Teaching materials

? Exercise 4.1: Fish dissection and otolith examination

Did you know that bony fish have *ear stones*, which can be used for species identification? How can you determine the age of a fish?

Bony fishes have a sensory organ to detect gravity, balance and movement. Within this

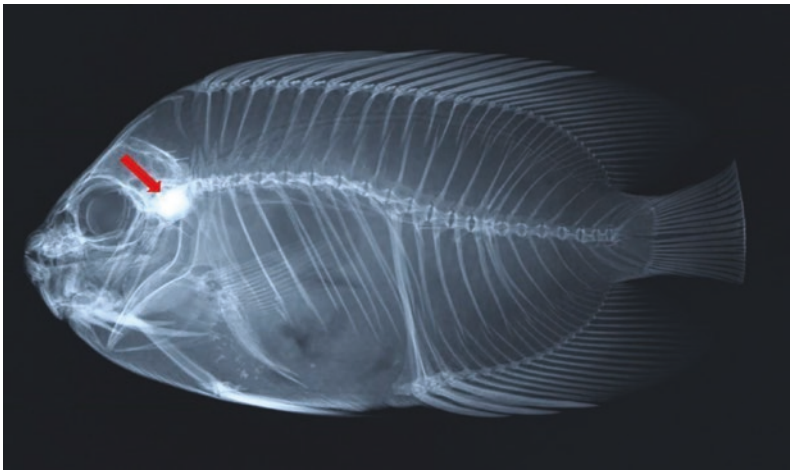

Fig. 4 X-ray image of a marine angelfish showing the location of an otolith (indicated with an arrow). © Frédérich Bruno

organ, the fish ear is also located. No external ear (such as our *pinna*) is necessary for fish to hear underwater. Essential to fish hearing is the *otoliths*, meaning ear- (oto) stones (liths). Each otolith is made of calcium carbonate crystals. Bony fish have six otoliths, three on each side of the head in posterior end of the cranial cavity (Fig. 4). Some of them are small, and usually only two of them (which in some species can grow very large, with a length of several cm) can be seen without a magnifying glass. When the fish is rocked in a sound field, the otoliths lag slightly behind due to their higher density, and the relative motion between fish and ear stone is picked up by sensory hair cells.

Otoliths show *annual growth zones*, very much like growth rings on trees. Therefore, they can be used to age fish. In herring and flat fish, the annual growth zones can be seen without any kind of special preparation. In other species, such as cod, the otoliths must be prepared before the growth zones are visible. These otoliths are sectioned, polished or washed in weak hydrochloric acid solution in order to enhance the contrast between the different growth zones. Sometimes it is also necessary to break the otolith and burn the cracked surface with a burner or candle before age determination is possible.

There are many other applications to these stones besides age determination. Their toxic content may indicate ecosystem pollution. The growth layer in which toxins are detected may indicate at what age fish encountered toxins. Otoliths are shaped differently depending on species, and they are therefore used for taxonomic studies and species identification. Even though otoliths found in marine mammal stomachs and faeces may be eroded by digestion, they still provide useful information on prey species. Such data can also enhance our knowledge on the magnitude of competition between wildlife and fisheries. Consequently, analysing otoliths makes it possible to study fish, their predators, ecosystems, fishery interactions and environmental contamination.

In this exercise, you will learn how to remove otoliths from herring.

Required materials

- Dead herring
- Petri dish
- Small scissors (e.g. nail or surgical scissors)
- Tweezers
- Disposable gloves
- Paper towels
- Binocular microscope or smartphone microscope

Tasks

1. Cut carefully through the top of the head with small scissors and expose the brain. The otoliths are located near the bottom of the brain case.

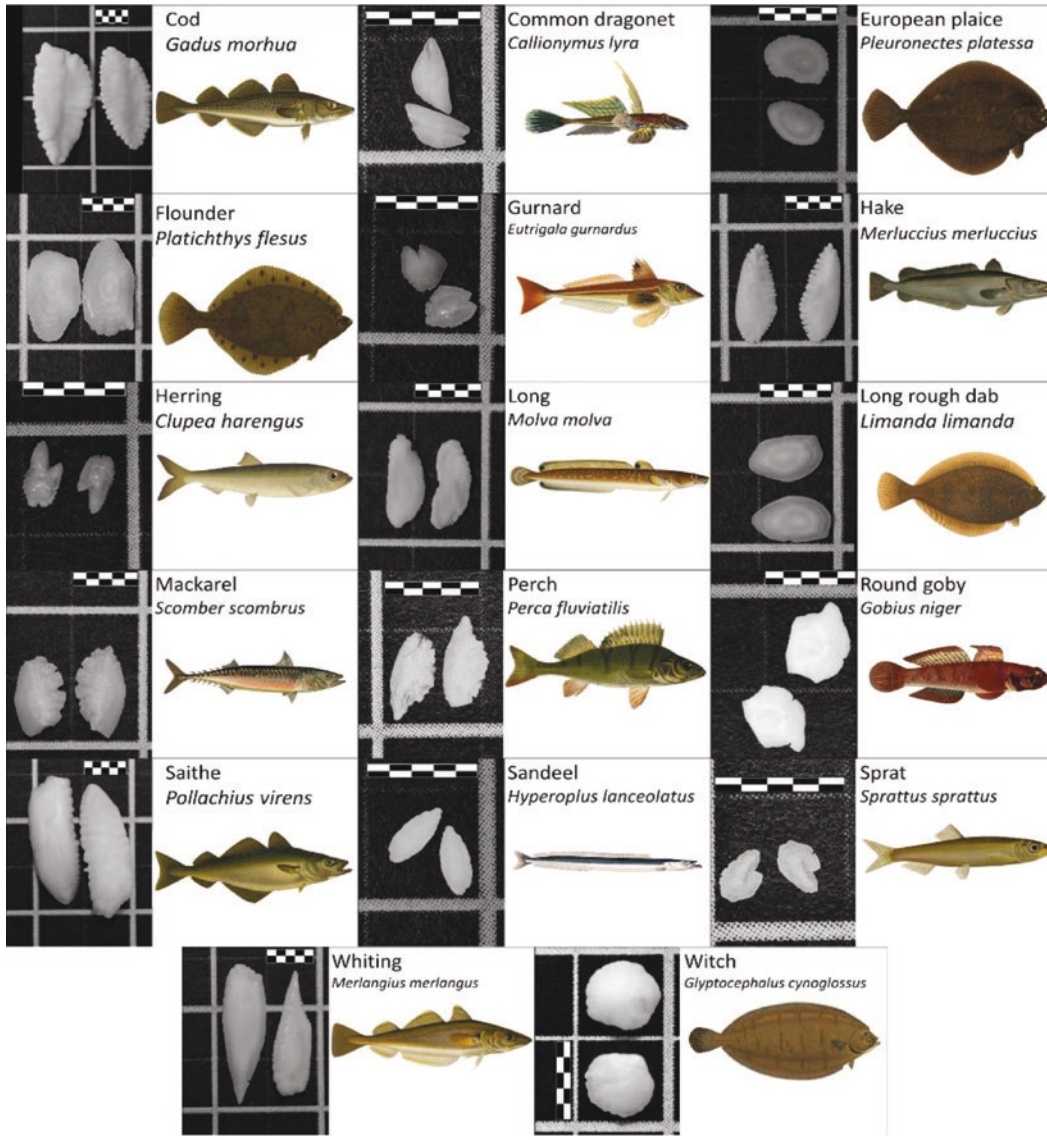

Fig. 5 (▶ Exercise 4.1) Otoliths of different fish species. The black-and-white scale on top of each otolith is 5 mm long. Fish illustrations under public domain (CC0) © Wilhelm von Wright, Gervais and Boulart

2. Use tweezers to push the brain out of the way or extract it completely so that the two largest otoliths can be removed on each side of the head.
3. Place the otoliths on a petri dish and observe them under a binocular microscope, or with a smartphone microscope. What do you see? Are the edges smooth or rough? Do you observe any layers? Compare Fig. 5. to the otoliths you just extracted.

Exercise 4.2: Whose scat is it?

Have you ever wondered how scientists determine what aquatic predators eat? Why are dietary studies of marine animals important?

In this exercise you will investigate marine animal scat. You learn how scientists identify marine animals through the help of otoliths and other animal parts found in scat. This information is used to understand the feeding behaviour of marine

mammals, their health status, their habitat range, the abundance of fish and other animals within their local habitat, and much more. For example, in a study from 2013 the scientists used stomach contents to predict how much giant squid is eaten worldwide by sperm whales each year. The result was an astonishing 131 million individuals!

Required materials

- Information on marine animal feeding preferences, provided below
- A compilation of different fish species and their otoliths (Fig. 5)
- Pictures of scat samples (either from Fig. 6 or collected by you)

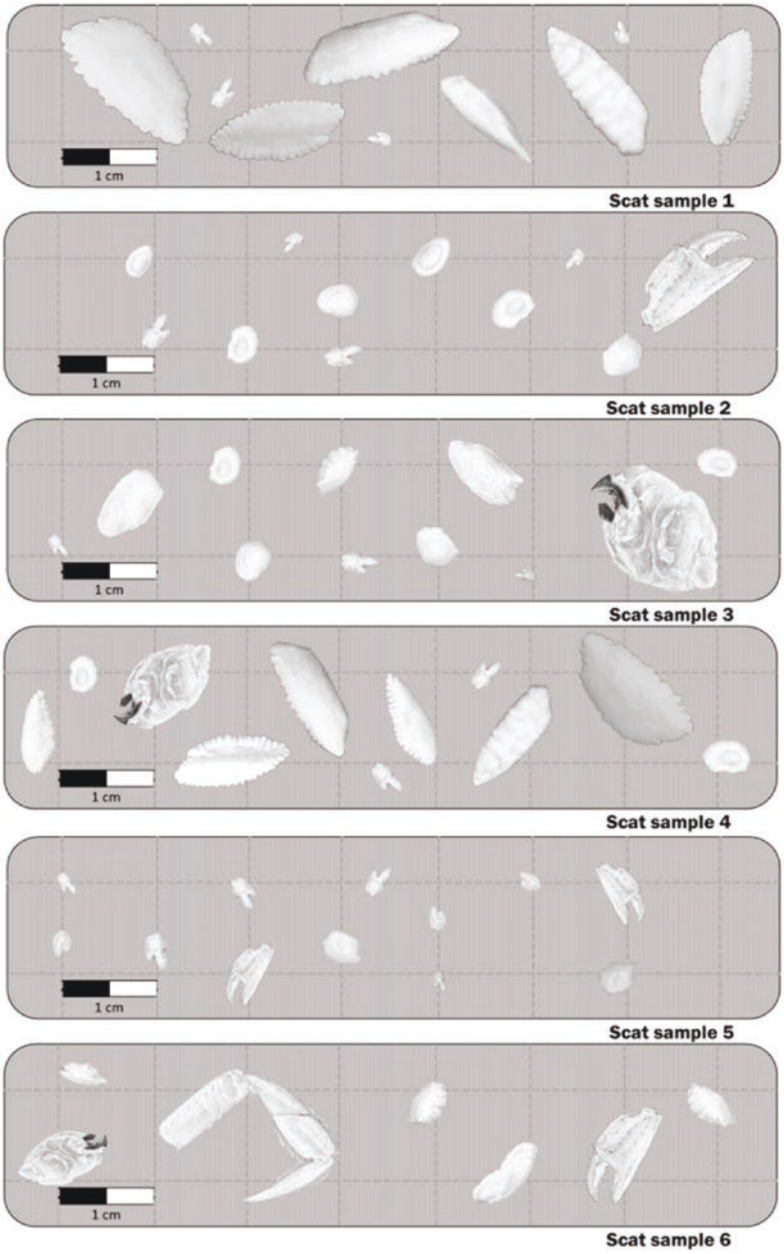

Fig. 6 (► Exercise 4.2) Scat content examples from six different marine mammals and birds. It is possible to determine which animal each scat originates from by using the marine animal feeding preferences (provided in ► Exercise 4.2), and Fig. 5

Tasks

Your task is to identify the consumed fish species by its otoliths and the bony fragments you found in the scat sample, and to identify the most likely predator by the prey remains present in their scat.

1. Identify the otoliths and animal parts in your scat sample (Fig. 6) by using the provided information on fish and their otoliths (Fig. 5). Some animal parts are not depicted; in these cases, you have to guess what it is. Write down your results; try to identify the entire content of the scat sample. Otoliths are species specific, but there can be a natural variation in their shape between individuals. Try to match the sample to the most likely otolith in Fig. 5.
2. Once you have identified the content of your scat sample, use the information on marine animal feeding preferences below to see if the scat content matches the feeding preferences of a certain species of marine mammal or bird. Remember that there is an overlap in feeding preferences between species, so it could be that several animals fit the criteria. In this case, you need to find the most likely species.
3. Write down your answer and describe how you identified the species. If you are using Fig. 6. for your scat sample, then check if your answer is correct here: link.
4. Start over again using a different scat sample and see if you can figure it out faster.

To identify the predator, here is some information on marine animal feeding preferences.

Grey seals
Often eat herring, cod, haddock, dab, sprat and whiting
Sometimes eat hake, plaice, salmon, crustaceans and molluscs

Harbour seals
Often eat plaice, herring, dab and gobids
Sometimes eat crustaceans and molluscs

Ringed seals
Often eat herring, round goby and sprat
Sometimes eat crustaceans and molluscs

Porpoises
Often eat herring, sprat, cod
Sometimes eat round goby, saithe and sandeel

Herring gulls
Often eat crustaceans, echinoderms, herring, mackerel and molluscs
Sometimes eat saithe and sandeel

Common guillemots
Often eat herring, sandeel and sprat
Sometimes eat dab, sticklebacks and whiting

Great cormorants
Often eat eelpout, perch, roach and sticklebacks
Sometimes eat common ling, mackerel, molluscs and crustaceans

Exercise 4.3: Whaling role play

You have probably heard about discussions about whaling in the news. Did you ever consider why it is so difficult to pass a ban on whaling, and why some people and nations are opposing it? Should whaling be continued in order to preserve cultural heritage? Can humans use whales as a source of food, just like we use many other types of animals?

Here, in a panel discussion, stakeholders from different interest groups with different opinions debate whether or not there should be a worldwide ban on commercial whaling.

There are very few countries that still pursue commercial whaling. Whale meat for human consumption is usually sold on local markets. The IUCN (*International Union of Conservation of Nature*), the worldwide authority on the status of nature, lists the minke whale, the major target species of whaling, as being of least concern. Countries that are objecting to the IWC's moratorium decision and establish their own catch limits must provide information on their catches to the IWC, while Japan is no longer obliged to report to the IWC as a non-member.

Required materials

- Role cards

Moderator

You lead the panel discussion and examine the topic as comprehensively as possible. You should remain independent, neutral and not biased towards one opinion throughout the entire discussion, and you are in charge of controlling a fair distribution of the voiced contributions. You are also responsible for calling the different stakeholders to reason if the discussion gets too heated, and you should encourage active participation by more reluctant participants through direct questions.

To begin the discussion, you ask the participants to present themselves and to outline their position on commercial whaling. Watch the time during the introductions: Each participant only has 2-3 min. If you feel they would have needed more time to explain their views, you can always ask them questions during the debate.

Subsequently, you will start the discussion. Here are some ways to get started:

- Ask a pro-whaling participant what they think of the anti-whaling opinions, or the other way around,
- Ask the whaler why he is whaling in spite of a large international opinion being opposed to it,
- Ask an anti-whaling participant for valid reasons to make exemptions from a ban on whaling.

Make sure to engage all stakeholders in the discussion by giving alternative suggestions or asking about their opinion on that matter. If the discussion comes to a standstill, keep the conversation going. You may, for example:

- Ask a pro-whaling participant whether he or she can imagine an alternative to whaling,
- Ask an anti-whaling participant if he or she thinks we have the right to enforce a ban on whaling for indigenous people, and
- Ask about ethics behind whaling, and about the necessity of whaling to sustain a livelihood; point out examples of a whaling nation that was successfully transformed into a whale-watching nation.

Stakeholders

Whaler: Whaling is my job. I need to earn my money to feed my family. It is what I learned and what I grew up with. I don't have a university degree or much other working experience; I don't think I could provide for my family if I would have to stop this job. I don't understand why most people are so angry about my job. Compared to what humans do to other food production animals, the whaling I practice is much less harmful. Our modern methods guarantee a quick and humane death. Whaling is sustainable; there are plenty of whales out there in the ocean and the stocks keep growing. The whales have a good life, are free and happy and get killed without any notice. They had a better life and a better death than many animals raised for their meat in farms.

Pro-whaling fisherman: Fishing is our livelihood, and the whales eat too much fish. We are not able to use our fishing quotas any longer due to whales. Fish remains our main export businesses. We need to reduce the whale population in order to fulfil our fishing goals. Some whales even eat fish directly out of our nets!

Anti-whaling fisherman: Fishing is our livelihood, and the whales support us because they are ecosystem engineers. Many people believe that they eat fish and thus compete with our catches, but that is not true. The larger whales eat plankton and small fish that is not our target species. They defecate in the water, which enriches the ocean with nutrients and gives small plankton and krill food, which again serves as food source for larger creatures. Whales basically help the fish—that we want to catch—grow. Additionally, whales that feed on the same species that we fish always know where the highest fish abundance is. We just need to go where the whales are and we will have good catches.

Local politician: This is a sovereign country making its own decisions. Foreigners do not rule it, and neither does IWC. We decide ourselves whether whaling should be carried out or not. Whaling has a long tradition here, and we are a traditionalistic country. We value

our history and our ancestry. Additionally, whaling is sustainable. Why is it OK to slaughter millions of cows, pigs and chickens for food, but not a couple of happy, free-living whales? That is hypocritical.

Whaling industry economist: Whaling has a long tradition in this country. My family has been whaling for centuries. Whales have been an accessible, healthy and sustainable food source for decades. Additionally, it is worth a good amount of money to sell whale meat. There still is a demand on whale meat because people grew up eating it. We are a small business, targeting only species that are abundant. Therefore, our practice is sustainable and our takes are not leading to a population decline or extinction.

The conservationist: The world's oceans are vast. There is no international police force operating on the high seas. If commercial whaling is permitted to start up again, there will be no way to control international trade of whale meat and blubber. Each large whale might be worth hundreds of thousands of dollars. Illegal and unregulated whaling could once again drive the large whale species to the brink of extinction, just like it happened in the past.

Animal welfare advocate: We think that commercial whaling must be halted. No one knows how populations of whales will be affected by hunting, on top of other daily threats they face. Whaling is unethical, and whales are not suitable for human consumption. Whales live long lives and reproduce slowly. They cannot be killed in an ethical manner. Explosive harpoons often miss the right area on the whale's body, subjecting them to suffering a long, slow and painful death.

Scientist: Whales have been recognised as ecosystem engineers (their faeces enrich the ocean with nutrients, which feeds plankton and thus substantially supports the bottom of the food chain). Many whales have fixed migration routes, and we often notice that the same animal is mistaken for several. Therefore, populations can be misinterpreted as being larger than they really are. One species may be divided into subgroups, ecotypes or even completely different species, which we are not yet aware of and that we may exterminate through whaling. Additionally, whales are on top of the food chain, and with their extensive blubber reserves and their longevity, they accumulate all kinds of toxins. The accumulation of pollutants in stranded whales can be so high that they have to be disposed as toxic waste. Whaling nations give out warnings that pregnant women should not consume whale meat. This is clearly not healthy food.

Citizen Robinson: Only few citizens eat whale meat. I myself grew up never tasting whale meat and I have no ambitions in doing so. Whaling is an outdated tradition that should stop. Many tourists coming here don't like the fact that we are a whaling nation, and we probably have economic losses from people who decide to boycott this country due to our whaling activities. In my opinion, whaling harms our country by degrading its economy and reputation.

Citizen Johnson: Whaling is a tradition in this country and therefore we take a lot of pride in it. Many citizens of this nation support whaling because it is sustainable, healthy and good for the economy. Whale hunting creates jobs and provides a locally sourced food source. Also, whale meat is better than farmed meat, because the whale lived a happier life than a cow or pig. Why can't you have both whaling and whale safaris going on in the same country? In Sweden, people are hunting moose, and there are also moose parks where people can enjoy them.

Tourism expert: Tourism is one of the most important and fastest growing businesses in our nation. Tourists come to see our nature and also for whale watching. It is absurd that we keep killing whales, but the behaviour of tourists is as baffling to me. Some whale watching tourists even eat whale meat. But other tourists boycott our country as a holiday destination due to our whaling reputation.

Tasks

1. In this role play, the participants will assume characters of different parties involved in this conflict of interest. Choose one of the potential roles (or have one assigned by your teacher) and collect arguments for your position in order to

develop a basis for the discussion. Multiple students can form groups of parties. However, make sure that the number of stakeholders in each party of interest is equally distributed. Some additional reading material for more information can be provided by the teacher or obtained from the internet (e.g. the IWC and the IUCN websites). Prepare yourself for your stakeholder position and for possible *counter arguments*. One contestant (teacher or a student) is the moderator of the discussion and should be especially aware of the instructions given above for this role.

2. Prepare your arguments for about 15 min with your *stakeholder colleagues* before presenting them to the other participants/parties of interest.
   - What is your position on whaling?
   - What are your main arguments?
   - What compromise could be proposed in the interest of yourself or your organisation?

   Choose one person of your stakeholder group to represent your party of interest during the discussion.
3. The moderator will start the discussion. Before the panel discussion begins, participants present themselves, their position and their arguments in 2–3 min. All participants are thus given the opportunity to get to know each other and their positions on the topic. After the introduction, the moderator will take the lead on the discussion between the different parties of interest and keep the debate alive.
4. In the end, all students should collectively summarise all pro-whaling and anti-whaling arguments and see if the class can come to a differentiated and objective consensus on their opinion on commercial whaling.

Suggested reading

1. Calamnius L, Lundin M, Fjälling A, Königson S 2018. Pontoon trap for salmon and trout equipped with a seal exclusion device catches larger salmons. PLoS ONE 13(7):e0201164. https://doi.org/10.1371/journal.pone.0201164.
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3. Hansson S, Bergström U, Bonsdorff E, Härkönen T, Jepsen N, Kautsky L, Lundström K, Lunneryd SG, Ovegård M, Salmi J, Sendek D, Vetemaa M 2018. Competition for the fish—fish extraction from the Baltic Sea by humans, aquatic mammals, and birds. ICES J Marine Sci. 75(3):999–1008. https://doi.org/10.1093/icesjms/fsx207.
4. Rocha RC, Clapham PJ, Ivashchenko YV 2017. Emptying the oceans: a summary of industrial whaling catches in the 20th century. Marine Fisheries Rev. 76(4):37–48. https://doi.org/10.7755/MFR.76.4.3.
5. Varjopuro R 2011. Co-existence of seals and fisheries? Adaptation of a coastal fishery for recovery of the Baltic grey seal. Marine Policy 35:450–6. https://doi.org/10.1016/j.marpol.2010.10.023.