High prevalence of head and neck lesions in stranded seals: cause of death?

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Abstract: In 2021 Belgian beaches witnessed 101 deceased, washed ashore seals. This number is extremely high compared to the one in previous decades, with figures never exceeding 50. Of these animals, 21 grey seals (*Halichoerus grypus*), 13 harbour seals (*Phoca vitulina*) and 2 unidentified seals were collected for necropsy, and photographs were available for an additional 49 seals. Of the 90 animals that were necropsied or for which information was available, such as clear photographs, 58 (64%) presented severe head and neck lesions, which in 27 cases we described as a circular lesion around the neck, known in forensic medicine as ligature marks. Most of the animals with circular neck lesions were juveniles. We suspected that bycatch was the most probable cause of death in these 27 cases, though the characteristic lesions often seemed to have occurred post-mortem. Due to the nature of the lesions, we could exclude other possible backgrounds such as knife cuts or predation marks left by grey seals. We hypothesize that the animals were caught in nets and died due to asphyxia, while the hauling of the net caused the typical lesions. Some seals, however, survived: three live seals with similar neck lesions were found, still bearing parts of a nylon monofilament fishing net. The observations warrant a further investigation of the phenomenon, including of the system of bycatch, the spatial and temporal extent, the number of seals bycaught and the type of fishing vessel involved.

Keywords: *Phoca vitulina*, *Halichoerus grypus*, mortality, ligature marks, bycatch, Belgium.

Introduction

During the last decades, along with growing populations of seals in the southern North Sea (SCOS 2021, ICES 2022), there has been an increase of strandings of deceased seals at the Belgian coast, including both grey seals (*Halichoerus grypus*) and harbour seals (*Phoca vitulina*). The number of seals rose steadily from less than ten per year in the 1990s and the first years of the 21st century to almost 50 in 2019 and 2020 (data RBINS). In 2021, however, a much higher than average number of seals washed ashore: 101 (figure 1). The high stranding rate, including many cases bearing strikingly similar lesions around the head and neck, prompted an exploratory investigation into the reasons for these deaths. This was fuelled by public outcry and wild speculation in social media about the origin of the 'decapitations' observed in many of the animals. We describe the strandings, assess the nature of the lesions observed and investigate possible causes of death.

Material and methods

The Belgian coast is short (67 km), easily accessible and the beaches are often crowded. There is a well-developed strandings network, and data on all marine mammal strandings are kept in a database managed by the Royal

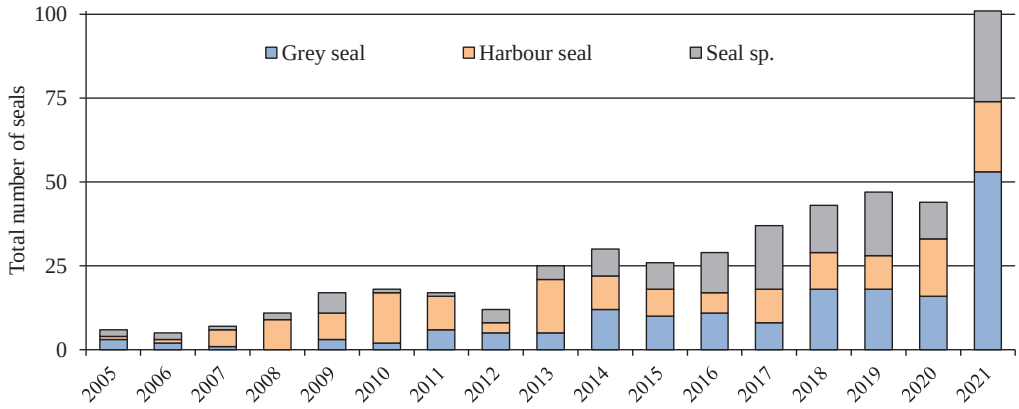

Figure 1. Total number of dead seals washed ashore in Belgium between 2005 and 2021.

Belgian Institute of Natural Sciences (RBINS). We are confident that nearly all stranded seals are registered and collected within an hour of reporting. Usually, the local fire brigade or communal technical services are the first responders. They, and/or the public, provide the RBINS with pictures of the animal, useful in case assessment as they provide information on species, lesions, sex and size/age. Based on species, size and state of decomposition, RBINS decides if the animal is useful for a further examination, with the latter as the decisive selection criterion. Carcasses in an advanced state of decomposition are sent to a destruction facility. Carcasses selected for necropsy are temporarily stored in a freezer (-20°C) prior to transport to the University of Liège (ULg) or the University of Ghent. The main objective of the necropsy is to determine the cause of death. Additionally, as part of long-term monitoring, information is collected about life history parameters, health prior to death, diet, the prevalence of parasites and disease agents, and levels of contaminants in tissues. A standardized protocol for marine mammal necropsy is used (Kuiken & Garcia-Hartmann 1991, Jauniaux et al. 2002, IJsseldijk et al. 2019). Four decomposition codes (DCC) are used here: DCC 1 live animal; DCC 2 freshly dead animal, intact carcass and no rotten smell; DCC 3 moderate autolysis, with organs still intact, moderate swelling due to gas, skin sloughing and discernible smell of decomposition and DCC 4 advanced decomposition, with major bloating, skin peeling, and organs beyond recognition.

Live stranded juvenile seals in difficulty (diseased, injured) are taken to a specialised rehabilitation facility (Sealife at Blankenberge) and released back into the wild after treatment. Adult animals in difficulty are usually left on the spot without further action, unless it concerns animals that can be assisted immediately, such as through disentanglement.

An identification to species level was not always an easy task, given the state of decomposition and in many cases the partial or complete absence of the head. Seal carcasses for which doubt existed, were tentatively identified based on the size of the animals vs. the date of stranding (period of pupping of grey vs. harbour seals), their girth/size and pelage, including remains of typical white fur indicating grey seal pups. Some animals remained unidentified; for these, no attempts were made to assess the species through e.g. a genetic analysis.

Results

Stranding records

In 2021, a total of 101 dead or dying seals

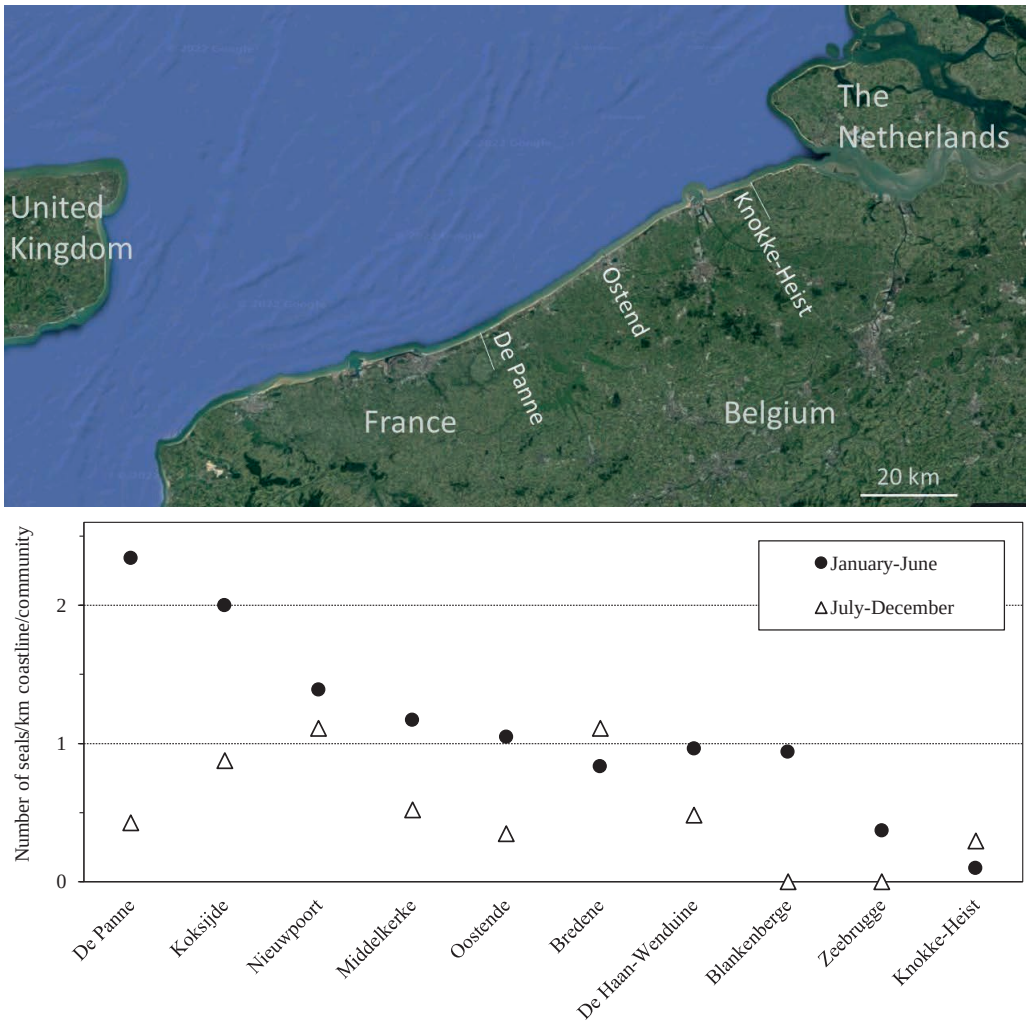

Figure 2. Location of (a selection of) coastal communities along the Belgian coast (top) and number of seals washed ashore per km coastline per coastal community, arranged on the x-axis from west to east.

washed ashore at the Belgian coast. This figure is more than twice as high as the highest number recorded during the last decades (figure 1). Next to this, Sealife took care of eight grey seals and ten harbour seals. Most of these were orphaned, injured or diseased, and only those cases relevant here are discussed further.

In total, 52 grey seals, 22 harbour seals and 27 unidentified seals were recorded dead ashore in 2021. The majority of the seals identified as grey seals were assessed as juveniles (74%), most of them in their first year of life, thus probably born in November or December 2020. A slightly higher percentage of the seals identified as harbour seals were juveniles (86%), born in the summer of 2020 or 2021. Out of the 97 animals we could classify for decomposition, 54 were relatively fresh (DCC 2-3; 30 grey seals, 16 harbour seals and 8 seal sp.) while 43 were very decomposed (DCC 4; 22 grey seals, 6 harbour seals and 15 seal sp.).

Most dead seals (69 animals; 68% of the total number of seals washed ashore in 2021) were found in the first six months of 2021,

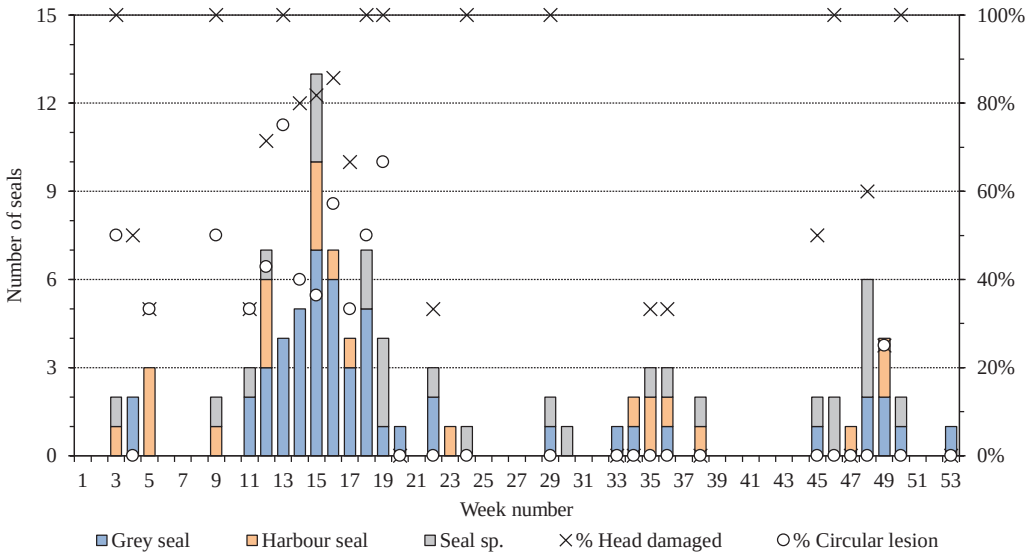

Figure 3. Number of seals per species washed ashore in 2021 (left axis), percentage of seals with damaged head (right axis, X) and percentage of seals with typical circular lesion around head or neck (right axis, ○).

with 50 of these (72% of the total number) found at the western half of the Belgian coast, between Oostende and De Panne, closest to the French border (figure 2). Moreover, strandings showed a distinct peak between week 11 and 19 (10 March to 7 May; 54 animals; figure 3).

We collected 21 grey seals (4 adults, 1 subadult and 16 juveniles), 13 harbour seals (3 adults and 10 juveniles) and 2 unidentified seals (1 adult and 1 juvenile) for necropsy. Additionally, photographs were available for 49 out of 65 animals that were discarded, and a description was provided for five additional animals. This allowed in many cases for identification, estimation of size and a basic assessment of lesions and decomposition (table 1).

External lesions

We were able to collect information on external lesions for 90 animals (89% of the stranded seals), based on the necropsy, photographs, a brief examination on the beach, or an oral description made by members of the public or the fire brigade. Of these, 58 animals (64 %; 31 grey seals, 11 harbour seals and 16 unidentified seals) had lesions to the head, ranging from small wounds to the head completely missing. In 27 of the animals (17 grey seals, 8 harbour seals and 2 unidentified seals) the lesion around the neck was remarkably circular (table 1; figure 4). For 18 additional seals (5 grey seals, 3 harbour seals and 10 unidentified seals) presenting a head trauma, a clearly circular lesion could not be verified due to decomposition or scavenging.

Ten grey seals, four harbour seals and one unidentified seal with the characteristic circular neck lesion were investigated more closely by scientists of RBINS and a veterinarian of the ULg, assisted by a forensic pathologist. The following observations were recorded for these animals:

- There were large skin and soft tissue lesions in the neck up to the skull, with no evidence of knife cuts: the injury could be described as a laceration, exposing fatty tissue in layers, and with no hairs cut. In an experiment trying to mimic the lesions using a sharp blade, hairs were cut. In some animals the

Table 1. Overview of seals that were included in this study and (in brackets) the number of seals presenting a circular lesion around the neck.

Species	Collected for necropsy	Photographs available and/or examination on the beach	No further investigation
Grey seal	21 (10)	31 (7)	0
Harbour seal	13 (4)	8 (4)	1
Seal sp.	2 (1)	15 (1)	10

Figure 4. Moderately decomposed seals identified as grey seals with characteristic circular head/neck injuries. Left: Ostend, 6 April 2021. Middle: Oostduinkerke, 20 March 2021. Right: Lombardsijde, 12 April 2021. Images provided by the communal fire brigades.

lesion could be described as a scalpation, exposing the upper part of the cranium. A striking feature was the almost perfectly circular neck lesion. In most animals the skull was partly present, with the lower jaw and part of the upper jaw missing.

- The body of the seals was mostly intact, with no evidence of fractures or amputations, though in relatively heavily decomposed animals sometimes skin from front and/or hind flippers was missing.
- In relatively fresh animals, the lesions seemed post-mortem, lacking haemorrhages in the exposed fatty tissue. The lungs were congested, with oedema and emphysema, and there was abundant haemorrhagic froth in the airways, indicating asphyxia.
- In general, the necropsied seals with these extensive head lesions were well-nourished. For example, seals of approximately 1 m had a dorsal blubber thickness of 20-30 mm. Due to decomposition (with only 4 out of 15 animals assessed as in DCC 2) other aspects, such as signs of disease, were not investigated.
- In one case, part of a fishing net consisting of monofilament twine was found buried deep into the neck lesion.

For the animals without a circular neck lesion, we add the following observations and conclusions for completeness:

- One juvenile grey seal was torn apart; it showed loose skin and tissue flaps, similar lesions as caused by attacks of a grey seal (see discussion).
- Three grey seals and five harbour seals had died due to other natural causes (age, disease, starvation).
- One juvenile grey seal probably died due to an attack of a dog on the beach.

Figure 5. Live stranded seals showing an extensive ligature mark caused by nylon monofilament twine (ligature) from a fishing net. Left: grey seal, De Panne, 11 April 2021. Right: harbour seal, Ostend, 23 April 2021. Images provided by Sealife.

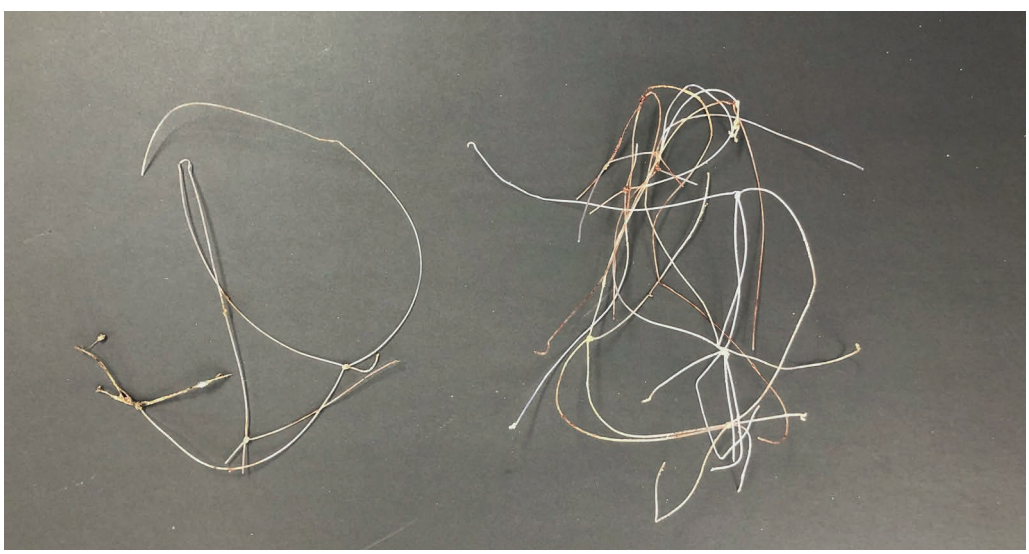

Figure 6. Part of the nylon net (ligature) removed from the neck of a live grey seal (7 April 2021; left) and a live harbour seal (23 April 2021; right); given the many cuts to the twine, it was not possible to measure mesh sizes. *Photo: RBINS.*

- For seven grey seals and four harbour seals not showing typical circular neck lesions, bycatch was suspected as the cause of death, with direct evidence (discovery within a fishing net) or indirect evidence such as lung congestion, the absence of disease agents, a full stomach and a general good body condition.
- In 13 cases (seven grey seals, two harbour seals and four unidentified seals), traces of

scavengers were found. They consisted of fresh lesions to the head and sometimes body (open abdomen), probable fox footprints around the carcass and traces of blood in the sand around the carcass. In two of the cases (juvenile grey seals that were found in dune areas), it cannot be excluded that they were actually killed by foxes. Traces of scavengers on the sand can easily be wiped away by wind, rain or incoming tides, and they were not always recorded prior to removal from the beach. Scavenging by seabirds could have occurred on the beach and at sea.

Strandings of live seals

During 2021, three live juvenile seals showing lesions similar to those observed in dead seals were found on the beach. Their age was estimated based on their size. They were gravely injured by a part of a monofilament fishing net, still around their neck and cutting deep into their tissues, exposing raw flesh (figures 5-6). The location of the injury was similar to the one in the deceased seals showing the circular neck lesion described above.

- Case 1. Juvenile grey seal, born in winter 2020-2021 (approximately 4 months old), stranded on 7 April 2021 at Koksijde. The animal showed a severe injury encircling its neck, caused by a piece of nylon monofilament fishing net; the net was removed on the beach.
- Case 2. Juvenile grey seal, born in winter 2020-2021 (approximately four months old), stranded on 11 April at De Panne. The animal showed a severe injury encircling its neck, caused by a piece of nylon monofilament fishing net. The net was removed and collected. The wound was 15 mm deep and 6 cm wide in the chin region and 3 cm wide in the neck region.
- Case 3. Juvenile harbour seal, born during the pupping season in summer 2020 (approximately ten months old), stranded on 23 April 2021 at Oostende. It suffered a similar lesion as in the two previous cases, with a severe injury encircling its neck caused by a piece of nylon monofilament fishing net.

All three animals were admitted to the rehabilitation facility at Sealife Blankenberge where their neck injuries were treated (which included stitching). After rehabilitation they were released into the wild.

Discussion

Assessment of the external lesions

Given the speculation about the seal deaths, we discuss different options for the origin of the typically circular lesions and their probability.

1. Incidental catch

We have good evidence of the cause of death in one dead animal. It had part of a monofilament net around its neck, buried deep within the neck tissue, so we suspect that it died directly or indirectly due to bycatch. However, given the very similar nature of the lesions in 26 other cases (animals necropsied or lesions clearly visible in photographs), and the nature of the lesions in the three live seals with the remains of fishing gear still around their necks, we suspect that circular head/neck lesions are a result of entanglement in fishing nets.

Typical circular neck lesions are well-known in forensic literature as ligature marks (Di Maio et al. 2001). They are caused by a piece of cord, string, nylon netting or similar material that has been used for strangulation or hanging. If the ligature is a hard and fine material, the groove is usually recognizable and clear, and deep, with well delineated margins (Di Maio et al. 2001), as was the case in many of our animals. In humans, suicide by hanging can even lead to a decapitation, although complete decapitation is very rare (e.g. Törö et al. 2008, Hejna & Bohnert 2013, Leccia et al. 2017). Also in this study we noted a (partial) decapitation of some animals. The

Figure 7. Fresh carcass of an emaciated, juvenile harbour seal suspected of having been scavenged or predated upon by foxes, 29 January 2021. Notice the traces of blood around the head and the irregular wound edges. The scavenging may have concealed primary lesions. Image provided by North Seal team.

crucial factor for the state of decapitation of the body is the kinetic energy, determined by the weight and the squared velocity of the falling body (Törö et al. 2008, Hejna & Bohnert 2013). Here, we hypothesize that this energy is obtained when the net in which a seal was entangled is hauled.

In this study, we could not definitely link the cause of death with the ligature marks. We suspect that the main cause of death was asphyxia due to entanglement, with the ligature causing deep lacerations peri- or post-mortem. To determine the exact cause of death, other, more sophisticated forensic techniques are needed.

2. Predation and scavenging by birds and foxes

Foxes are known to scavenge on grey seal pups and other stranded marine mammals (Haelters et al. 2016, IJsseldijk & Geelhoed 2016, Heers et al. 2017, ICES 2017) and even predate on unattended seal pups (Culloch et al. 2012). Also gulls are known to scavenge on stranded seals, often first damaging the head as this is the easiest way of entry (own observations; ICES 2017). Quaggiotto et al. (2016) investigated scavenging of seal carcasses and noticed that the umbilicus region and the eyes were the first areas to be fed upon. Birds often leave a ragged pattern of wounds corresponding with stabbing with their beaks. Van Neer (2021) described lesions induced by scavenging foxes to be characterized by skin and soft tissue missing on different areas of the body.

Unlike in the cases of scavenging described above, many of the dead seals in 2021 only presented typical lesions to the head area. Also, as the seals in this study were often collected upon stranding, land scavengers would hardly have had the opportunity to scavenge on the carcass. However, in a few cases, scavenging on the beach had clearly occurred, and even predation by foxes cannot be excluded (figure 7). Scavenging can mask traces that could have provided clues about the cause of death in some animals. We conclude however that it is very unlikely that scavenging was at the origin of the circular lesions.

3. Grey seal predation

Grey seals are known to prey on harbour and juvenile grey seals (van Neer et al. 2015, 2021, Bishop et al. 2016, Brownlow et al. 2016). In these cases, lesions were described as severe 'corkscrew' lacerations often following a helical course with smooth, linear and cut-like wound margins and the detachment of large parts of skin and underlying tissue extending from the head to the caudal region (Thomson et al. 2015, van Neer 2021). Such wounds were found in only one dead seal in 2021. In all others, the lesions were very different; for instance, skin and underlying tissue was only damaged in the head region, and unlike typical grey seal victims, no skeletal trauma was found.

4. Sharp trauma from anthropogenic origin

There were no amputations or fractures to the body of the seals, making propellor injuries or ship strikes unlikely. Also knife cuts

are unlikely, given that the necropsies could not identify cut hairs, and the use of a blade to mimic the lesions did not result in a similar injury.

5. Decomposition

We consider that the lesions in 27 animals were too typical to have been the consequence of a random factor such as decomposition after a natural or anthropogenic cause of death.

Conclusion on cause of death

We conclude that the most likely cause of the circular lesions is entanglement and we therefore suggest that the cause of death of the seals was probably related to bycatch. We hypothesize that the ligature marks in 27 seals were most likely sustained post-mortem by the mechanical action of a fishing net. The net, consisting of fine monofilament twine (as observed in one dead and three live seals), would cause lesions on the head and/or neck when a strong force is exerted on it, such as when seals try to escape, or post-mortem during hauling, with additional damage caused by the hauling system (pulley/drum). In juvenile seals with relatively soft cranial bones, the lower and upper jaw would be crushed by a high tension on the twine, and the skin and underlying tissue of the upper skull could be removed, leading to a partial decapitation or a lesion that can be described as a scalpation.

Fine monofilament twine is used in bottom set gill- or trammel net fisheries. The mesh size for bottom set gill and trammel nets should be at least 120 mm, except for directed fishing for European bass (*Dicentrarchus labrax*), whiting (*Merlangius merlangus*) and dab (*Limanda limanda*) (100 mm) or for directed fishing for flatfish (Pleuronectiformes) (90 mm) (EC, 2019). Passive fishery with gill and trammel nets often involves setting many kilometres of net left in place for up to 24 hours.

The most important season for these passive fisheries in the southern North Sea is spring (March to May), when flatfish such as the highly prized Dover sole (*Solea solea*) enters shallower waters to spawn. This period concurs with the spring peak in strandings in 2021. While gill- and trammel net fishing is widely practiced in Belgian and adjacent waters, it is most popular in waters near the eastern Channel and further to the west. This could explain the fact that significantly more seals that are presumed to have died due to bycatch, had washed ashore in the western part of the Belgian coast vs. the eastern part. Though unassessed up to now, seals bearing similar lesions regularly wash ashore in neighbouring countries (social media communications from northern France, southern England and the Netherlands; personal communication Jacky Karpouzopoulos and Jaap van der Hiele; www.waarneming.nl; figure 8). SCOS (2021) assessed bycatch of seals around the UK, with observer schemes recording most cases in ICES area VII (south and south-west of the UK), with fewer seals caught in the eastern Channel and in ICES area IV (North Sea), but it also acknowledged that the eastern Channel and ICES area IVc (southern North Sea) would benefit from a better sampling, giving high fishing effort and a high density of seals.

High number of juvenile seals

It is striking that only relatively small seals that were presumed bycaught, showed typical ligature marks. Reasons for this can be: 1. Larger seals are less vulnerable to bycatch given their experience in the vicinity of nets and their strength to pull out and escape once bycaught. 2. The heads of larger seals do not fit into the maze. 3. Larger bycaught seals will fall out of the net due to their weight before high tension is exerted on the twine near the drum/pulley system. 4. The skull bones of juvenile seals are more fragile. Finally, it is possible that in the area high numbers of dispersing juvenile seals were present. Also SCOS (2021) mentioned that the majority of bycaught seals

Figure 8. Two examples of seals found live stranded in neighbouring countries, and presenting similar lesions. Left: harbour seal, Vlieland, the Netherlands, 4 April 2022. *Photo: Anthony Grymonprez*. Right: grey seal, Cap Blanc Nez, France, 20 March 2016. *Photo: Jacky Karpouzopoulos*.

around the UK were small animals.

A new phenomenon?

Checking strandings data and images of seals stranded in previous years (database of stranded animals kept by the RBINS, including images) yielded a few seals with similar lesions; these had remained mostly uncollected due to their state of decomposition, and their cause of death remained unassessed. However, their number is negligeable compared to the number in 2021.

It seems unlikely that fishing activity, including the type of net deployed, effort and fishing areas, would have changed profoundly in 2021 compared to previous years. A possible background for this striking phenomenon in spring 2021 can be a combination of the following:

1. There were more juvenile grey seals present in the southern North Sea with growing populations and steadily increasing numbers of pups being born in the November – December pupping season, including at colonies on land such as Donna Nook, Blakeney Point and Horsey where seals became habituated to human disturbance. In 2019, more than 10,000 grey seals were born in the colonies in eastern England (ICES 2022).
2. There were more grey seals present in the southern North Sea due to a changed dispersal pattern after weaning; this can be confirmed by more observations than ever before of live grey seals on Belgian beaches in winter 2020/2021 and spring 2021. These seals can be considered as occasional visitors, with only two permanently used haul-out sites in Belgium holding very few seals (Nieuwpoort: maximum 20 harbour seals; Ostend: <5 seals, mixed grey/harbour seals).
3. The southern North Sea experienced continued periods with meteorological conditions favouring strandings in Belgium – an objective assessment of this, using data on wind direction and wind speed, was however not made for this study.

Conclusions

The number of dead seals stranded on Belgian beaches during 2021, especially in the first half of the year, was unprecedented. A large proportion of the animals were juvenile grey seals. Many of the seals (27) presented characteristic ligature marks, of which we hypothesize that they can be attributed to bycatch in gill or trammel nets in the southern North Sea and eastern Channel.

The recovery of seal populations in the southern North Sea leads to conflicts: more seals are incidentally caught in fishing gear (data RBINS 1995-2021). The number of bycaught seals washed ashore is an unknown fraction of the total number of seals caught incidentally but based on the figures from a relatively short stretch of coastline it can be safely assumed that in the southern North Sea and eastern Channel hundreds of juvenile seals were bycaught in spring 2021.

The high level of bycatch in 2021 could in theory be explained by either more intense use of trammel- and/or gillnet fisheries during the first months of the year, but there is no evidence for this. It is more likely that there was a higher influx of especially juvenile grey seals after record-high numbers of pups born in colonies around the southern North Sea, and that additionally, or alternatively, long periods of northerly winds, which characterized late winter and spring 2021, drove carcasses to the Belgian coast. Potentially, different dispersal patterns of young grey seals or other prevailing wind directions in former years might have prevented or obscured this bycatch.

Both harbour and grey seal populations have recovered from near extirpation in the southern part of the North Sea. Given possible effects on the resilience of populations to future threats, animal welfare considerations and commitments and obligations in international fora protecting marine mammals, the suspicion of a high bycatch rate warrants further investigation. In addition, bycatch can also affect fishermen, including through loss of time and damage to gear and catches, but also through public perception of fisheries and the sale of fishery products that require proof of sustainability.

Incidental catches of marine mammals are assessed by the OSPAR Convention, the International Council for the Exploration of the Seas (ICES) and in reports to the European Commission. However, on board observer schemes in which bycatch is assessed are generally in place only in larger vessels, while trammel and gillnets are typically operated from small ships. Given the commitments made, there should be a further investigation of the causes of death of seals washed ashore. In cases of suspected bycatch, the fishery and net type involved, the bycatch mechanism, the location of bycatches, the origin of the animals bycaught (colony) and the effect on populations should be assessed. The evaluation of the number of bycaught seals washed ashore should be extended to cover the coastlines of neighbouring countries, with as an objective to assess mortality covering a larger area. To this end, fishermen should also be encouraged to report and document bycatches. Reverse drift modelling of stranded animals could help elucidating areas with high bycatch rates (Peltier et al. 2013, 2016). This information is essential when assessing bycatch against precautionary thresholds, such as potential biological removal (PBR) levels.

Our findings could aid to shed light on cases of similarly mutilated marine animals in other parts of the world. Indeed, the phenomenon of strandings of (partly) decapitated marine mammals and of live seals or sea lions with severe neck injuries is apparently a worldwide one not limited to the southern North Sea or to the species described here, with a search on the internet revealing tens of pictures of a variety of marine mammals showing similar severe injuries. Because of their gruesome appearance and their exposure on the Internet and in press articles, these photos often spark outrage and speculation about the possible perpetrators and the methods used. It is

up to scientists to try and explain '*beheadings*', '*decapitations*' and '*laser-precision cuts*'.

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Samenvatting

Hoge prevalentie van hoofd- en neklaesies bij gestrande zeehonden: doodsoorzaak?

In 2021 werden op de Belgische stranden 101 dode zeehonden aangetroffen. Dit aantal is extreem hoog in vergelijking met dat van de vorige decennia, waarbij de aantallen nooit boven de 50 uitkwamen. Van de aangespoelde dieren werden 21 grijze zeehonden (*Halichoerus grypus*), 13 gewone zeehonden (*Phoca vitulina*) en 2 niet-geïdentificeerde zeehonden verzameld voor het uitvoeren van een autopsie, terwijl van nog eens 49 zeehonden foto's beschikbaar waren. Van de 90 dieren waarbij een necropsie werd verricht of waarvan informatie zoals duidelijke foto's of beschrijvingen beschikbaar waren, vertoonden 58 (64%) ernstige letsels aan kop en nek. In 27 gevallen kon die beschreven worden als een cirkelvormige laesie rond de nek, in de forensische geneeskunde bekend als een spoor van een ligatuur. De meeste dieren met cirkelvormige nekletsels waren jonge dieren. We besluiten dat bijvangst de meest waarschijnlijke doodsoorzaak was in deze 27 gevallen, hoewel de kenmerkende letsels vaak post-mortem leken te zijn ontstaan. Door de aard van de letsels konden wij andere mogelijke achtergronden uitsluiten, zoals insnijdingen met een mes of predatie door grijze zeehonden. Wij vermoeden dat de dieren in netten werden gevangen en stierven door asphyxie, terwijl het ophalen van het net mede verantwoordelijk was voor de typische letsels. Sommige zeehonden overleefden echter: er werden drie levende zeehonden met soortgelijke nekletsels gevonden; delen van een nylon monofilament visnet waren nog aanwezig, diep in de weefsels doorgedrongen. De waarnemingen rechtvaardigen een nader onderzoek van het verschijnsel, inclusief naar het systeem van bijvangst, de ruimtelijke en temporele verspreiding, het aantal gevangen zeehonden en de betrokken typen vissersvaartuig.

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