Stranding and Rehabilitation in Numbers: Population development and stranding data on the Dutch coasts 1990-2016

Analysis of new data from a public database

Author: Sophie Brasseur

Wageningen University &
Research rapport C108/17

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Summary

Seal rescuing has been subject to much debate in the Netherlands. Despite rescue efforts and the large press coverage, there have been only unclear records of the numbers found sick or dead on the Dutch coasts rendering it difficult to evaluate these practices. This report describes a first overview of a unique data set based on a public internet site where individuals can report sightings: waarneming.nl. This is used primarily for birds, but also for example insects and mammals in the Netherlands.

Though there might still be some inaccuracies, thanks mainly to the seal rescue centres Ecomare and Pieterburen and Jaap van der Hiele that have updated their observation records in the database, we have a first insight in the magnitude and distribution of the stranding (dead and live) of harbour and grey seals along the Dutch coasts.

A first overview is given, comparing for the period 1990-2016, these stranding data to the annual aerial surveys which are carried out in the Wadden Sea and the Delta regions. Further comparison is made by subdividing the data into smaller areas most often representing watersheds in the regions and including the areas along the coasts of North and South Holland and lake Ijssel where seals are found stranded even though seals are rarely seen on land.

By far, the number of animals reported to have been taken into rescue outnumber the number of seals found dead. In the peak year 2011, almost 1000 grey and harbour seals were taken into seal centres, while just over 250 were reported dead. Though the dead animals are representative of both adult and juvenile age classes, over 90% of the animals taken in are young of the year. Regularly, during the study period over 50% of all pups counted in the wild were taken into centres. This holds especially for the Delta region and for grey seals.

The study also shows that the stranding of seals do not follow the distribution of wild seals found during the aerial survey results. Locally in the Delta region for example, there are unusually high mortality rates and rescue efforts in the Dollard region were much higher than elsewhere.

Despite the recent drop in numbers of seals brought in, the high numbers of animals taken into care and released after treatment could still affect the wild population. Efforts are needed to help educate the public not to take in every pup they encounter. To create more reliable records with which areas of concern can be identified, it would be advisable to establish an official monitoring program for seal stranding events.

1 Introduction

Seal rescuing has been subject to much debate in the Netherlands. In the 1950's Gerrit de Haan started to take in sick and injured seals in a small natural history museum on Texel, now Ecomare, in the 1950's. In the 1970's a second centre was opened near the village of Pieterburen, hence the name of the centre.

Rescuing seals grew immensely into a well organised and well sponsored activity and currently a total of five centres border the coasts of the Netherlands, with a total capacity of rescuing several hundreds of seals per year. This development has not been without debate as it was argued that rescue rehabilitation and release of seals in the wild could have negative effect on the individual animals and the wild populations (e.g. reviewed in Moore *et al.* 2007). These could include for example unwillingly extracting individuals from the wild that would have survived without intervention to redistributing diseases, changing the genetic selection, or even affect the population structure.

Despite the publicity around these rescue efforts and the public debate, there have been only unclear records of the numbers found sick or dead on the Dutch coasts rendering it difficult to evaluate these practices. This report consists of an overview of the population development in the past decades and a first analysis of stranding data which have recently become available.

This report has been drafted upon request of a scientific commission on seal rescue advising the ministry of Economic affairs in the Netherlands. The commission has requested answers to several questions concerning both the harbour and grey seals. These have been formulated as follows:

1. What are the numbers of seals rescued per year in the period between 1990 and 2016, and how does this relate to the numbers counted?
2. How many were orphaned pups, how may diseased animals or animals with trauma?*
3. What are the differences in the stranding data on sick/rescued and dead harbour and grey seals between the Dutch Wadden Sea and the Delta and what are possible explanations for these differences?
4. Are there any peaks in the number of dead or sick seals and what are the explanations for these?

Ad. 2. The data used does not include the assessment of the health of the animals, therefor the question cannot be answered as such*

2 Population development

2.1 Harbour seals

Around 1900, the harbour seal population size in the international Wadden Sea might have been at least 40,000 animals (Reijnders 1992), despite enduring centuries of hunting (Reijnders 1992, Joensen et al. 1976, de Vooys et al. 2012). Thus even then the population could not be considered wild and unaffected. In the Dutch Wadden Sea numbers were estimated at approximately 15,000 (Figure 1). Hunting pressure increased in the early 20th century due to the more intensive use of fire arms. Seal numbers in the international Wadden Sea dropped dramatically to approximately 8000 harbour seals in 1960 (Reijnders 1992). As a response to the low numbers, seal hunting was gradually prohibited: first in the Dutch waters in 1962, followed by Lower Saxony in 1971, Schleswig-Holstein in 1973, and finally the Danish Wadden Sea in 1976 (Reijnders 1981, Reijnders 1983). Despite the ban, numbers continued to drop and by 1974, total counts in the international Wadden Sea were down to less than 4000 animals (Reijnders 1980). Up to the 1980's, recovery was hindered by the low reproduction especially in the Netherlands, as a result of pollution by polychlorinated biphenyls (PCBs) at that time (Reijnders 1986). Yet, a slow recovery could be observed throughout the Wadden Sea. Then in 1988, an outbreak of Phocine Distemper Virus (PDV) killed over 50% of the Wadden Sea population (Reijnders et al. 1997) and, as the population, now less hindered by pollution, had recovered, a second outbreak of PDV struck in 2002, killing approximately the same proportion of the population (Harding et al. 2002, Härkönen et al. 2006). Even with these set-backs, the population continued to grow, and in 2017 8427 harbour seals were counted in the Dutch Wadden Sea. The population size in the international Wadden Sea was estimated at 38,000 animals, with about 12,000 animals in the Dutch Wadden Sea (Galatius *et al.* 2017), almost the same amount that were thought to be present in 1900 (Reijnders 1992).

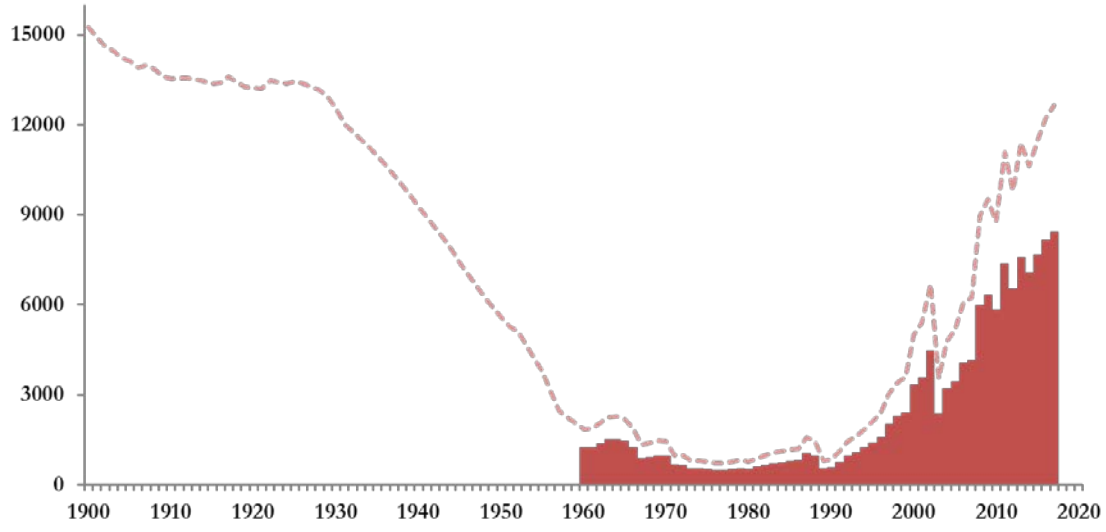


Figure 1. *Estimated (dashed line) and counted numbers (bars) of harbour seals in the Dutch Wadden sea. Numbers before 1960 were estimated based on hunt statistics (Reijnders 1992); after 1960 total numbers were estimated based on the correction of aerial counts (Ries et al. 1998).*

Historically, it seems there were slightly less harbour seals in the Delta region, south of Rotterdam, than in the Wadden Sea (Figure 2). As a result of overhunting in this area, seal numbers almost disappeared and only approximately 350 animals were counted when the hunt was closed in 1960. Possibly, recovery was more hampered than in the Wadden Sea, due to more severe pollution but also to the intensive construction of dikes and dams for the "Delta Works" 1960-1990's. The Delta Works is a series of construction projects in the southwest of the Netherlands to protect a large area of land

around the Rhine-Meuse-Scheldt Delta from the sea, to prevent a dramatic flood which took place in 1953 to reoccur. Since the 1990's the numbers of harbour seals are slowly growing, reaching almost 685 animals in 2016 (Figure 2). However the general intensive use of the area especially by fisheries and tourism impedes a recovery to former levels.

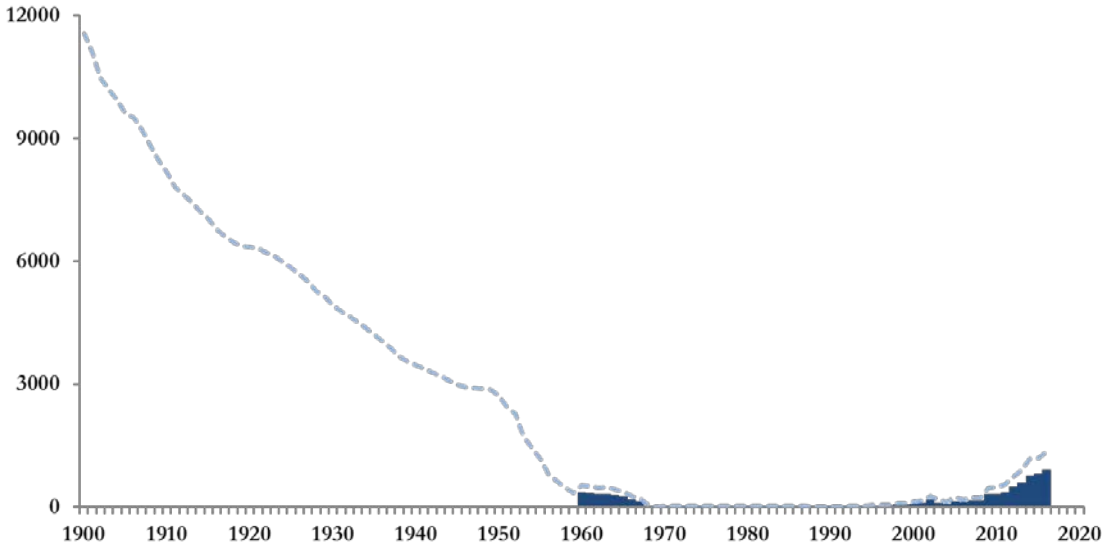


Figure 2. *Estimated (dashed line) and counted numbers (bars) of harbour seals in the Dutch Delta region. Numbers before 1960 were estimated based on hunt statistics (Reijnders 1992); after 1960 total numbers were estimated based on the correction of aerial counts (Ries et al. 1998).*

Pup production

A recent study (Brasseur *et al.* 2018), showed that compared to the German regions in the Wadden Sea, the pup production in the Dutch Wadden Sea is relatively low, with a pup to moult count ratio of 20% in average since 1990 (Figure 3). There, the high growth rate in the counts was explained by the additional influx of pups from the German waters. In the Delta region, pup production is even lower, with a pup to moult count ratio averaging 6% since 1990. This low pup production could impossibly explain the growth in numbers in the area, so there must be a continuous influx, most likely from the Wadden Sea.

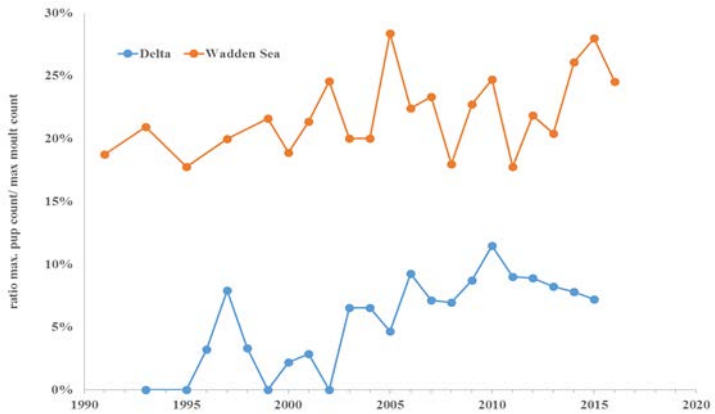


Figure 3. *Ratio pup to moult count for the Dutch Delta and Wadden Sea.*

2.2 Grey seals

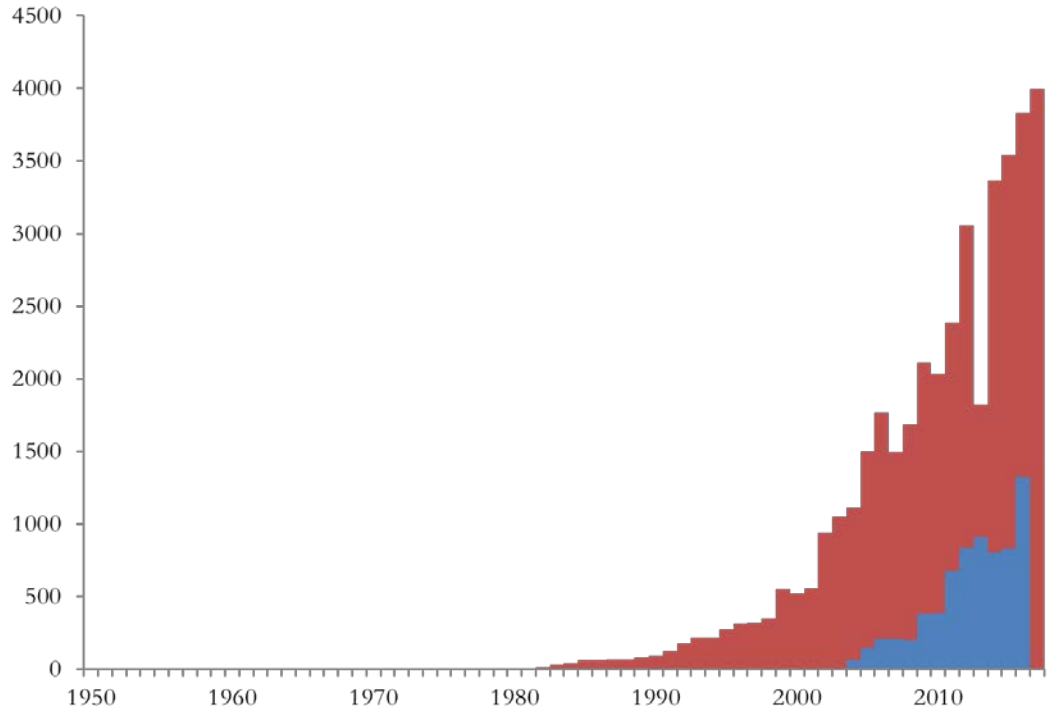


Figure 4. *Counted numbers of grey seals in the Dutch Wadden sea (red) and Delta region (blue).*

Grey seals had almost completely disappeared from the Dutch coast in the Middle Ages, assumingly as a result of the hunt by humans that recently had colonised the area (Reijnders *et al.* 1995, Härkönen *et al.* 2007, Brasseur *et al.* 2015). As opposed to harbour seals, grey seals remain on land for over a month during breeding and are as such a relatively easy prey for hunters. The grey seals had also almost completely disappeared from the UK, when hunting restrictions were introduced in the UK in 1914 under the Grey Seals Protection Act (Lambert 2002). From the mid-1950s onwards, grey seals were occasionally reported as vagrants (Van Haaften 1975), but it was not until 1980 that the first colony was established, and the first pup born was observed in 1985 (Reijnders et al. 1995). In 2017 over 4000 grey seals were counted in the Wadden Sea region during the moult (Figure 4) and almost 800 pups were born in the breeding season of 2016-2017 (Brasseur *et al.* 2017). The numbers have grown at such a high rate that this could only be explained by a continuous influx of young animals from the UK into the Dutch breeding population (Brasseur *et al*. 2015). Additionally, there is continuous exchange of animals between the Dutch coasts, and other North Sea haul outs in France, Germany and Denmark, but most importantly the UK. This makes it clear, even more than with the harbour seals, that the grey seal population should be considered, monitored and managed as a whole North Sea population.

Grey seals were initially also absent from the Delta region. However, from the beginning of this century onwards, the numbers of grey seals have also grown impressively to more than 1300 animals counted during the moult in 2016 (Arts *et al.* 2016). Interestingly, there are no breeding sites in this region. Consequently the region is for the grey seals only an area to haul out between foraging trips, and growth in numbers is a result of increasing movements to and from regions where breeding does occur.

2.3 Phenology and Breeding biology

In the Netherlands harbour and grey seals have a practically mirrored annual cycle: while the harbour seal pups are born in summer (June and July), grey pups are born in winter (November, December) (Figure 5). For both species the peak of the moult occurs approximately one month after the pups were weaned.
After a gestation of almost 11 months, including the delayed implantation, seal females give birth on land to a single pup. Harbour seal pups, which thanks to their “adult” fur can swim almost directly after birth, are then suckled for approximately 21 days (between 15 and 28 days (Cordes & Thompson 2013, Thompson & Wheeler 2008, Wieren 1981) before weaning. From then onwards the pup is left alone and they undergo a post weaning fast period which may take up to one month before it may start to feed independently. Harbour seals reach adulthood as they become sexually mature at 3 to 4 years of age (females), and in average a year later (males) (Härkönen & Heide-Jørgensen 1990).

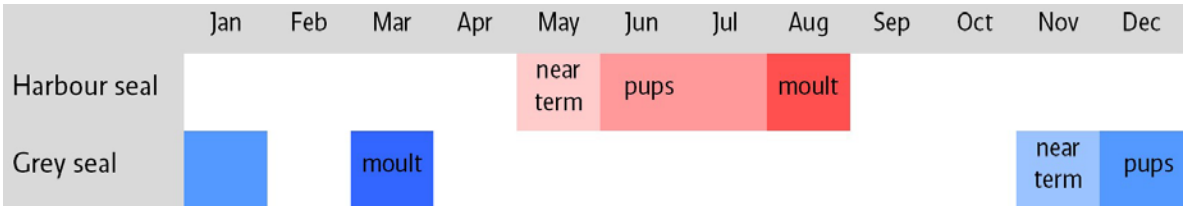


Figure 5. *Timing of the breeding and moulting season for the harbour (red) and grey seals (blue) in the Netherlands.*

Grey seal pups are born with a thick white lanugo fur and do not commonly swim, therefore breeding occurs on higher grounds that generally do not submerge at high tides. There the male grey seals hold territories on which they may defend several females during the breeding season. The males become sexually mature at 5 – 6 years, however they may not be socially mature until the age of 8 or older. Females are sexually mature at 3 - 5 years of age and produce a pup annually. Grey seals have an even shorter suckling period (16-21 days) than harbour seals. But like the harbour seal, the mother–pup bond is broken abruptly after this period and the grey seal pup may remain for up to another month fasting, and in some cases finalising its moult, shedding the white fur, before entering the water.

3 Survey and Stranding data

3.1 Data

Two sets of data were used to procure an overview of seals stranding in the Netherlands: results of aerial surveys in the Wadden Sea and Delta region and data from a public database Waarneming.nl (https://waarneming.nl/).

3.1.1 Aerial surveys

Results of aerial surveys carried out in the framework of the annual seal monitoring were used to compare the stranding trends. There are essentially two monitoring sets:

a) In the Wadden Sea aerial surveys have been carried out since the 1960's (Brasseur et al. 2018, Reijnders *et al.* 2003, Van Haaften 1975, Cremer *et al.* 2017). The surveys were initially aimed at surveying the harbour seals, but from 2001 onwards, grey seals which had been surveyed by boat were included (Brasseur et al. 2015). Aerial surveys were carried out from a fixed-wing aircraft, flying at elevations of 500-1000 ft. (150-300 m) and speeds of 160 to 220 km/h. Surveys were conducted within a 4-h window between 2 h before and 2 h after low tide, on days when low tides occurred between 12:00 and 16:00 local time (Reijnders et al. 2003). Surveys were performed on days with no or little rainfall (<10 mm precipitation, measured between 08:00 UTC the preceding day and 08:00 UTC of the flight day), and winds generally were below 25 knots. Prior to the mid 1990's, seals were counted directly by the observers during the flight in all regions, but from then onwards seals were photographed using camera with slide film (until 2000) or digital camera (from 2000 onwards). The animals were counted from the pictures. The objective was to survey the Dutch Wadden Sea region at least five times per year: at least three times during the pupping period (Jun./Jul. for harbour seals; Nov./Dec. for grey seals) and at least twice during the moult period (Aug. for harbour seals; Mar./Apr. for grey seals).

Figure 6. *Areas defined in both aerial surveys and stranding data. Wadden Sea: areas 1 to 11 and 1.3; Delta: area -1.5 to -5. Areas -2, -4 and -5 include the estuaries to the east as these are open to the sea. Areas 0, 1 and the lake IJssel are not surveyed.*

b) In the Delta region counts are carried out and reported by Delta project Management commissioned by RWS. Surveys are carried out during low tide from a plane except for the Grevelingen area (area -3.5 in Figure 6) where seals are counted by boat. Initially, until 1995 the flights were irregular, but from then on monthly flights were carried out (see (Arts *et al.* 2017) for complete overview of flights). Between 1987 and 2004 aerial surveys were carried out in the framework of several different projects. From 2004 onwards, the ministry of public works (Rijkswaterstaat) included the surveys in their standard monitoring program. Since 2014 the surveys are carried out in cooperation with the province of Zeeland, and there are no flights in the months September and October, while in November only the outer waters (Voordelta; in areas -5, -4, -3 and -2 in Figure 6) are surveyed (Arts et al. 2017). Counts for the Delta area in 2017 were not available yet at the time of the writing of this report.

3.1.2 Stranding data

Waarneming.nl is a public database on which all wildlife observations can be placed by any member of the public. Data is authenticated by a controller before being published. Recently, the seal rescue centres Ecomare and Pieterburen have updated their observations including the stranding (dead and alive) of all seals, going back to the 1970's. Also for the Delta region, Jaap van der Hiele has added all his data. Together with the occasional observations and reports and the more recent stranding services reporting on waarneming.nl, an impressive database of over 15000 records on seal strandings is now available.

3.2 Data selection and Error handling

Aerial survey data
For each year and each area maximum moult count was selected as an index for the total number of seals in the area and maximum pup count during the pup surveys, as an index for the total number of pups born in the area. Areas were defined as in Figure 6 (12 in the Wadden Sea, 7 in the Southern Delta region and 2 along the western coast of the Netherlands)**.** Up to 1990 in the Wadden Sea for even years (i.e. 1990,1992 etc.) only total numbers were counted, therefore in these years there are no area counts available in the Database.

Stranding data
All casual encounters with seals were omitted from the data base (i.e. observations of seals feeding swimming or hauling out) in order to retain only the stranded animals. Stranded animals were split in two categories: **dead** and **rescued**. Only four animals were added to the category dead that had been categorised as either "local" (*ter plaatse* in Dutch) - two animals, and two were reported as "traffic casualty" (*verkeersslachtoffer*). A total of 5477 animals were reported dead after these corrections. Though this first category is quite unambiguous, the second may be object of dispute as it is not clear if all animals reported sick were actually sick or injured and taken in for rehabilitation, or if animals reported otherwise were taken in for rehabilitation. Based on the attached comment, it was clear that 61 seals that were reported as "other" (*overige* in Dutch), 1 animal categorised as "overflying" (overvliegend) and 36 reported as "local" (*ter plaatse* in Dutch) but were then reported to be taken to rehabilitation centres. In all, a total of 9090 animals were reported to have been taken to rehabilitation centres.

Based on the comments were length or weight of the seals were mentioned, age was corrected for 241 animals. For 10 of these, ages had been estimated but did not seem realistic based on length or weight. For 16 others that were categories as "deviant" (*afwijkend*) the ages could be estimated based on the comment. This also holds for 215 animals classified as "unknown". Finally 4 categories were created: **young**: 9935 animals (these would be young of the year; assumed to be recognised by their small size up to several months after birth), **subadult**; 1354 animals (this category is unclear, and could include young adults as well as larger young of the year), **adult** 1396 animals and finally, **unknown**; 1883 animals. Not all animals were sexed: 5852 seals had been identified as **male**, 4586 as **female** and 4129 as **unknown**.

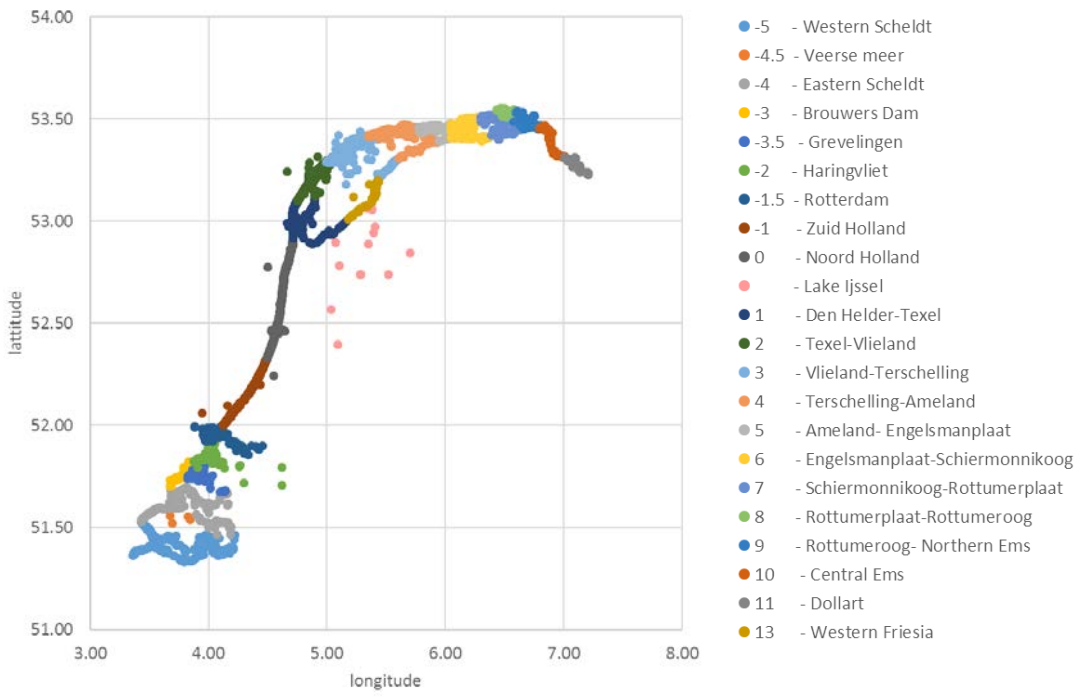


Figure 7. *Distribution of the seals stranding along the Dutch coasts.*

Based on the given coordinates, seals were appointed to areas that correspond to those used in the aerial surveys (Figure 6). Seals that stranded on the outer coast of the islands were attributed to the area to which it was most adjacent to.

4 Results

4.1 Harbour seal aerial surveys

The results of the aerial surveys show a clear growth in harbour seal numbers in both the Wadden Sea region and the Delta region during the study period. In the harbour seals (Figure 8 **and appendix 3**) the mass mortality in 2002 due to a virus epidemic and the following recovery are clearly visible. In the later years however growth seems to slow down. Total number counted during the moult was 8427 in the Wadden Sea in 2017 and 685 in the Delta in 2016. The data is split up into areas showing the difference in usage: for example in areas 1 and 2 (south and north of the Island of Texel) large numbers of seals are counted during the moult whereas relatively few pups are born there. On the contrary, area 9 is much less used during the moult while it is the most important pupping area.

In the Delta region almost all pups are counted in areas -4 and -5 (the eastern and western Scheldt), while during the moult large numbers are also seen in the outer Delta, area -3. The pup numbers are generally much lower than in the Wadden Sea.

In areas 0 and -1 along the west coast of the provinces of North and South Holland, there are no surveys, though occasionally small groups (1-20) are observed to haul out there on the beach. However, these are not fixed haul out sites as the beaches are continuously visited by humans, much more intensively in summer than in winter.

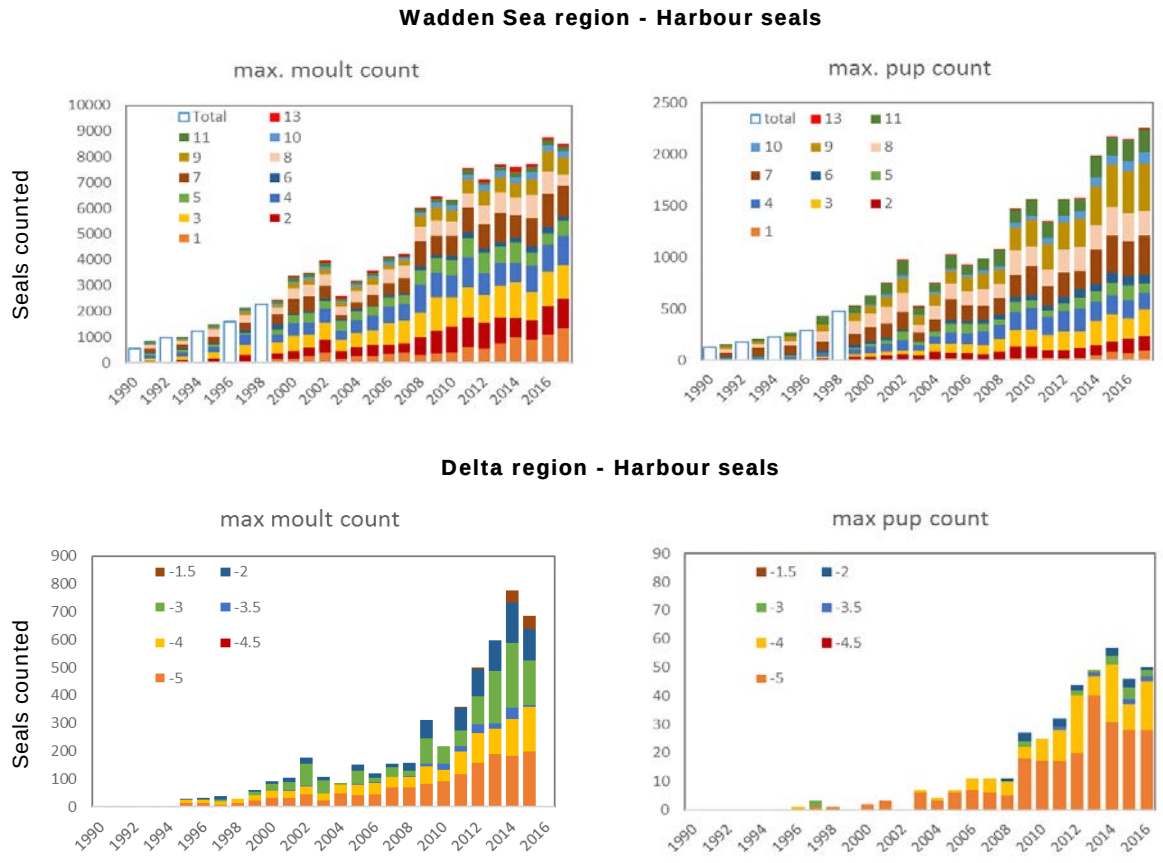


Figure 8. *Annual maximum moult and pup counts of harbour seals for the different areas (Figure 6). Top: counts in the Wadden Sea region; Bottom: counts in the Delta region.*

4.2 Grey seal aerial surveys

The grey seal counts show the strong exponential grow in the study period. In the Wadden Sea region there were no counts in 2001, and in 2013 there was a cold spell that might have affected the survey results, explaining the “dip” in numbers. Area 3 between the Islands of Vlieland and Terschelling, is clearly the most important, though grey seal numbers during the moult in areas 1 and 2 are also quit significant. Pups are clearly more numerous in area 3, where the first breeding colony was observed in the late 1980’s. In the Delta region, despite the impressive growth in numbers, there are no breeding areas. Almost all grey seals are observed in area -3, the outer Delta west of the Brouwersdam.

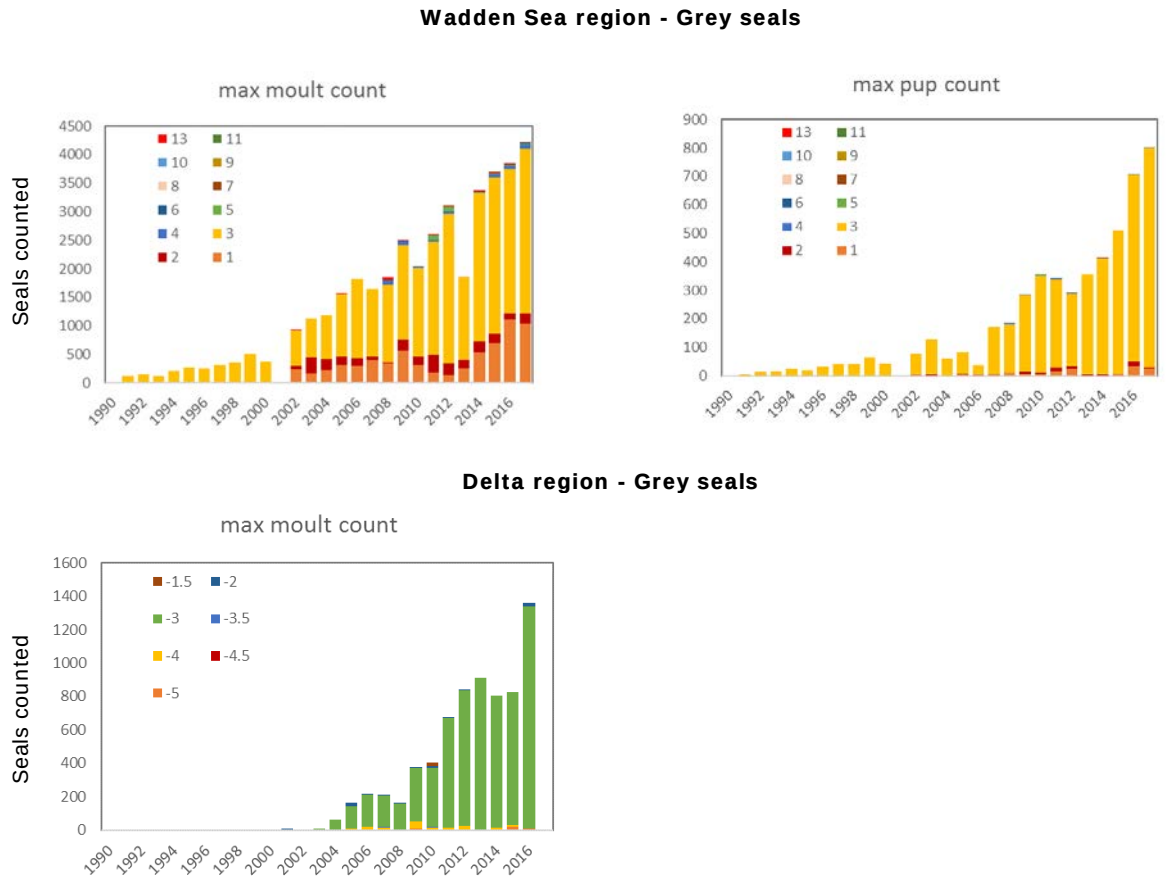
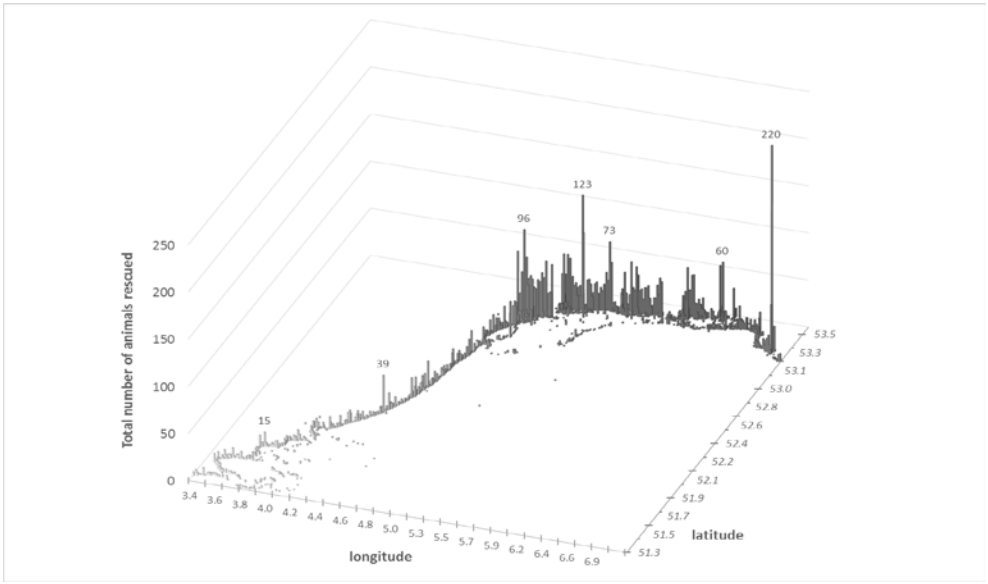


Figure 9. *Annual maximum moult and pup counts of grey seals for the different areas (Figure 6). Top: counts in the Wadden Sea region; Bottom: counts in the Delta region, here there are no grey seal breeding grounds.*

4.3 Stranding data: spatial overview

As the stranding data is collected with geographical coordinates, it is possible to plot the stranding data showing the total number of seals retrieved per km^2 between 1990 and 2016, creating an overview of the live and dead strandings (Figure 10 **&** Figure 11). In 2002 there was a virus epidemic, which killed ~50% of the harbour seals, this year was left out.

Harbour seals in rehabilitation



Harbour seals dead

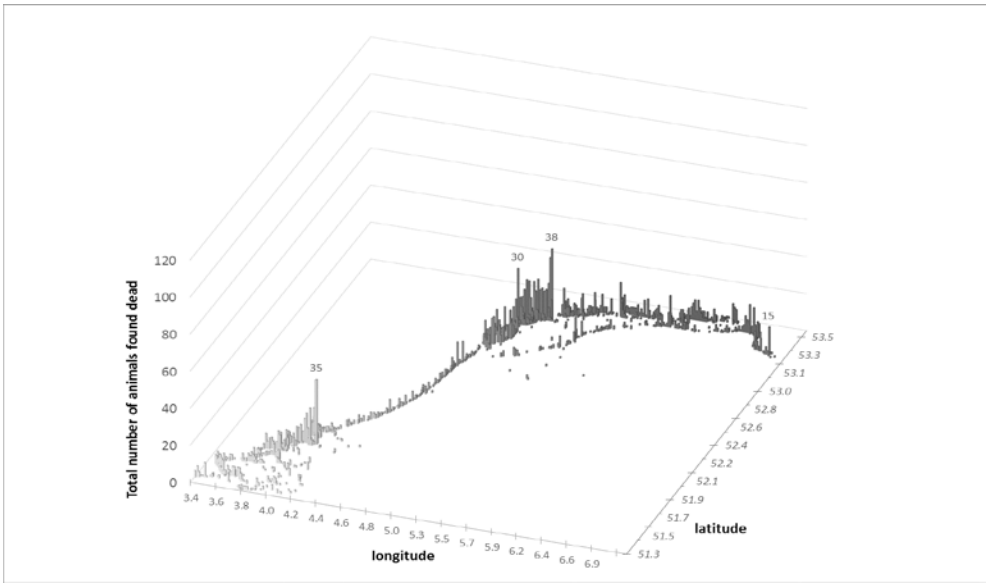


Figure 10. *Total numbers of harbour seals brought to rescue centres (top) or found dead (bottom) per km2 between 1990 and 2016.*

Generally, there are more live strandings in the Wadden Sea than in the Delta region, coinciding with higher numbers of seals observed. The average total number of harbour seals stranded alive from 1990 to 2016, but excluding 2002, along the Dutch coast is 6.9 animals per km^2. In the Delta region the average is lower (2.6 animals per km^2) as the seals were initially almost absent in this area (Figure 8). There are a few locations where we see slightly elevated numbers, just west of the Brouwersdam (with a peak of 15 animals in a km^2 indicated in Figure 10). In the Wadden Sea the average number of live stranded harbour seals is 8.9 per km^2. In this region however there are a few very high peaks: namely on the islands of Vlieland, Terschelling and Ameland where in total 96, 123 and 73 animals were collected on one km^2. The most extreme however is in the Dollard area, near Termuntenzijl where on a single area of 1 km^2 a total of 220 live animals were taken into rescue centres throughout the study period. Interestingly, quite a few seals were collected from the areas where there are no true haul outs (areas 0, -1) with a peak in area -1 of 39 animals km^2.

For harbour seals which were found dead along the Dutch coasts the distribution is quite different. For the total Dutch coast, the average number of dead harbour seals found from 1990 to 2016 (leaving

out 2002) was 3.4 per km^2. In the Wadden Sea region there were considerably less animals found dead than the live strandings: 3.8 per km^2 and the highest numbers were seen around Vlieland where peaks were seen of 30 and 38 animals in a km^2. Conversely, despite the lower numbers there were relatively more dead harbour seals found in the Delta region, 3.2 dead seals per km^2 were found there with a peak as high as in the Wadden Sea of 35 dead seals per km^2.

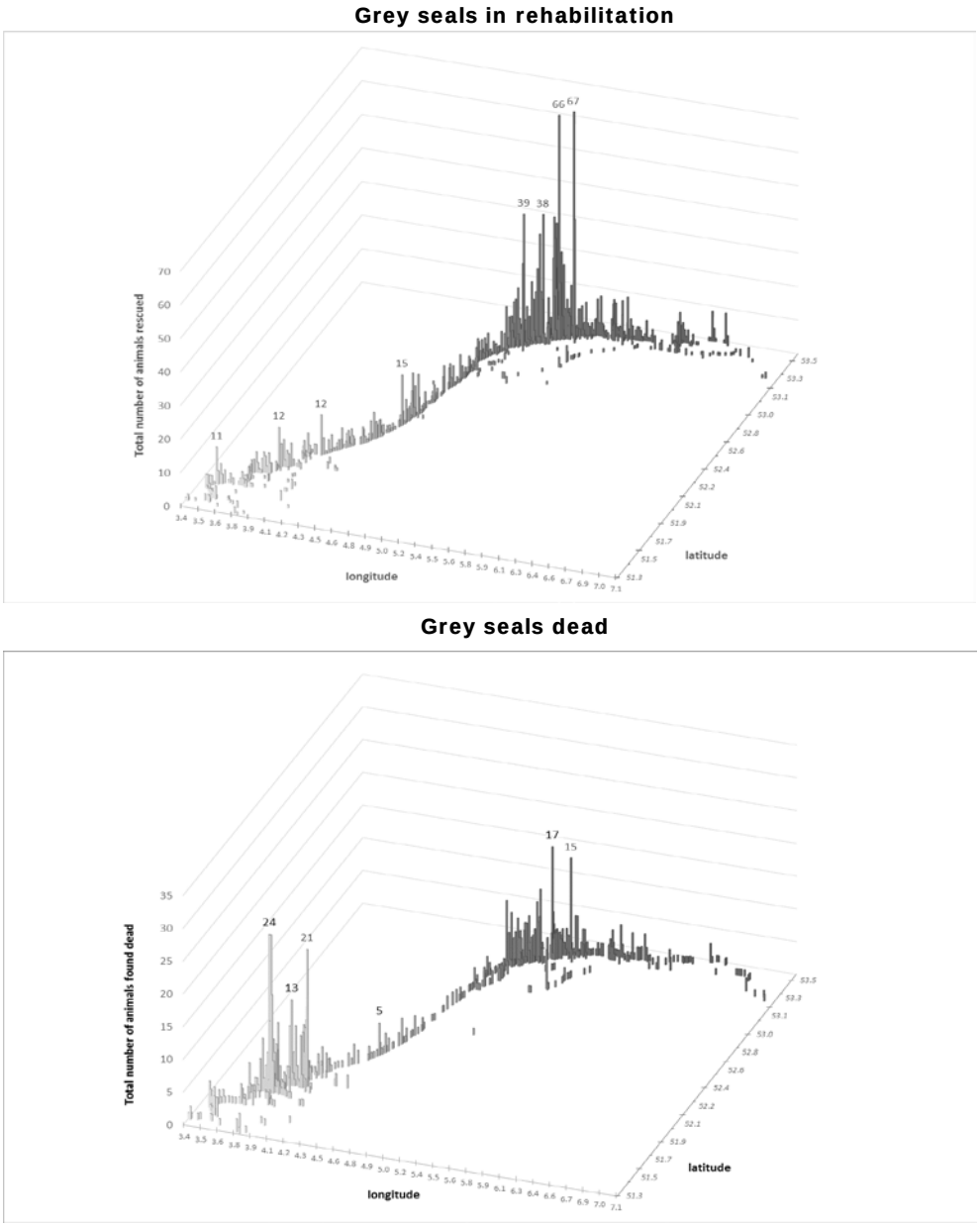


Figure 11. *Total numbers of grey seals brought to rescue centres (top) or found dead (bottom) per km2 between 1990 and 2016.*

Compared to the harbour seals, the number of grey seals stranded per km^2 is slightly lower (Figure 11); for the live strandings average numbers were 3.9 per km^2 coast in total; where in the Wadden Sea alone there were 4.9 seals rescued per km^2, though numbers were quite skewed towards Vlieland and Terschelling where grey seals occur in higher numbers. Peaks of over 65 animals per km2 were seen on Terschelling and of almost 40 animals per km2 on Vlieland. For the Delta region numbers of rescued grey seals are relatively low (2.3/km^2) though still on some locations peaks occur of more than 10 animal per km2 in the study period between 1990 and 2016. Surprisingly, on the coasts of North and South Holland, where seals are rarely seen to haul out, relatively more animals were reported stranded and brought into rescue centres than in the Delta region: 3,1 animal km^2.

Most interesting is that, despite the lower absolute numbers in the Delta and grey seals only have been in the region there for a little over 10 years, the numbers of animals found dead is higher per km^2 than in the Wadden Sea (2.9 dead seal/km^2 vs 2.2/km^2 in the Wadden Sea). Also, on some

locations over 20 animals were found dead, while in the Wadden Sea the peaks are below 20/km^2, even around Vlieland and Terschelling.

4.4 Annual stranding data

For the individual survey areas a comparison of the surveys and the stranding data is given in the appendix (1 and 2). Below, the data are summarised for the different regions.

4.4.1 Harbour seals

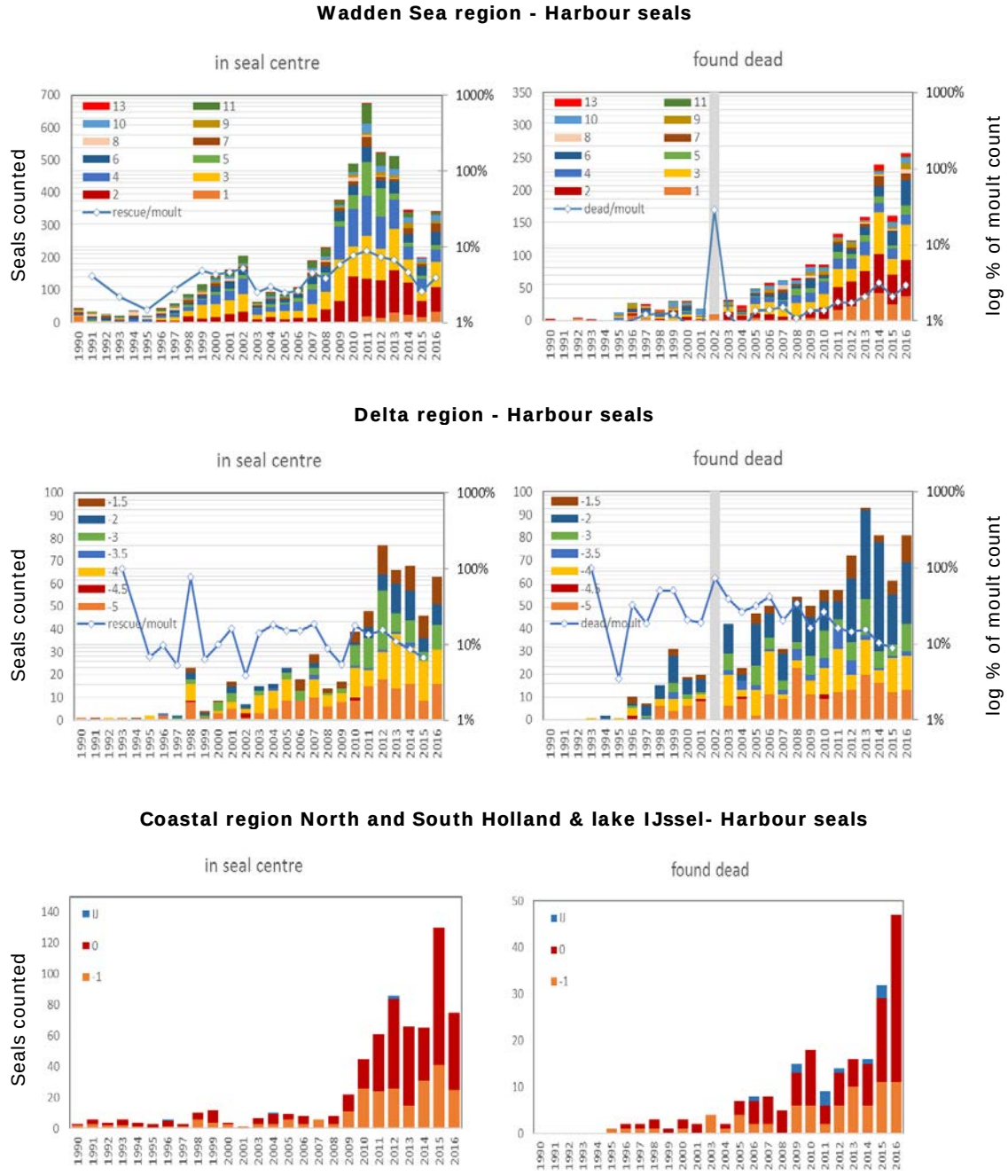


Figure 12. *Annual numbers of harbour seals stranded alive and taken into seal centres (left) or found dead (right) in stacked bars for the different areas (Figure 6). The total numbers stranded relative to the total moult counts are shown as a line (right axis; log scale) Top: counts in the Wadden Sea region; Centre: counts in the Delta region Bottom: Coastal region of North and South Holland and the lake IJssel.*

In Figure 12 harbour seal stranding data is summarised per area. In this data there are interesting discrepancies: first of all in the general pattern. The total number of animals rescued does not seem to follow the population development shown in Figure 8. There is, especially in the Wadden Sea, a clear rise in numbers of seals taken into rescue in the years 2009-2013 (up to almost 700 animals in 2011 and an average of 7% rescued compared to the moult counts). This corresponds to ~5% of the population when correcting for animals not seen during a survey. This rise is not mirrored in the total counts or the numbers found dead. In the Wadden Sea there is a clear peak of dead animals in 2002 related to the PDV outbreak (a total of 1130). From around 2011 onwards there seems to be a rise in numbers found dead; from approximately 1.1% to 2.3% per year, compared to the numbers counted during the moult.

In the Delta region both mortality and numbers of seals taken into rescue are relatively much higher than in the Wadden Sea; in early years this could be a result of underestimation of the true numbers as the numbers were low. However, after 2002 harbour seal numbers grew and the average numbers rescued represented ~13% of the counts or 9% of the estimated population. Most striking is the mortality in this region: in average the numbers found dead annually represent almost 23% of the moult counts or 16% of the estimated population.

Finally in the areas where there are no haul out sites (0,-1 and the lake Ijssel),a relatively large number of seals are rescued (generally ~80 per year in the years >2010) and ~20 per year are found dead, only in 2015 and 2016 these numbers grew to twice this amount.

4.4.2 Grey seals

In the Wadden Sea up to 130 grey seals were taken into rescue in one year, and an average of 5% compared to the total numbers counted during the moult is taken in every year. The numbers found dead, are comparable to the harbour seals: slightly higher than 1% compared to the numbers counted.

In the Delta region a much higher percentage was rescued initially, when numbers counted were low. After 2005 however stranded numbers are similar to the Wadden Sea ~4% per year on average. Interesting is again the numbers of grey seals found dead in this region, though not as high as the numbers of harbour seals, but twice as much as the numbers rescued:~8% compared to the numbers counted.

In the areas where very few animals are seen (areas 0,-1 and the lake IJssel), a relatively large number of grey seals were taken into seal centres (~25 annually from 2010 onwards) and only few were found dead.

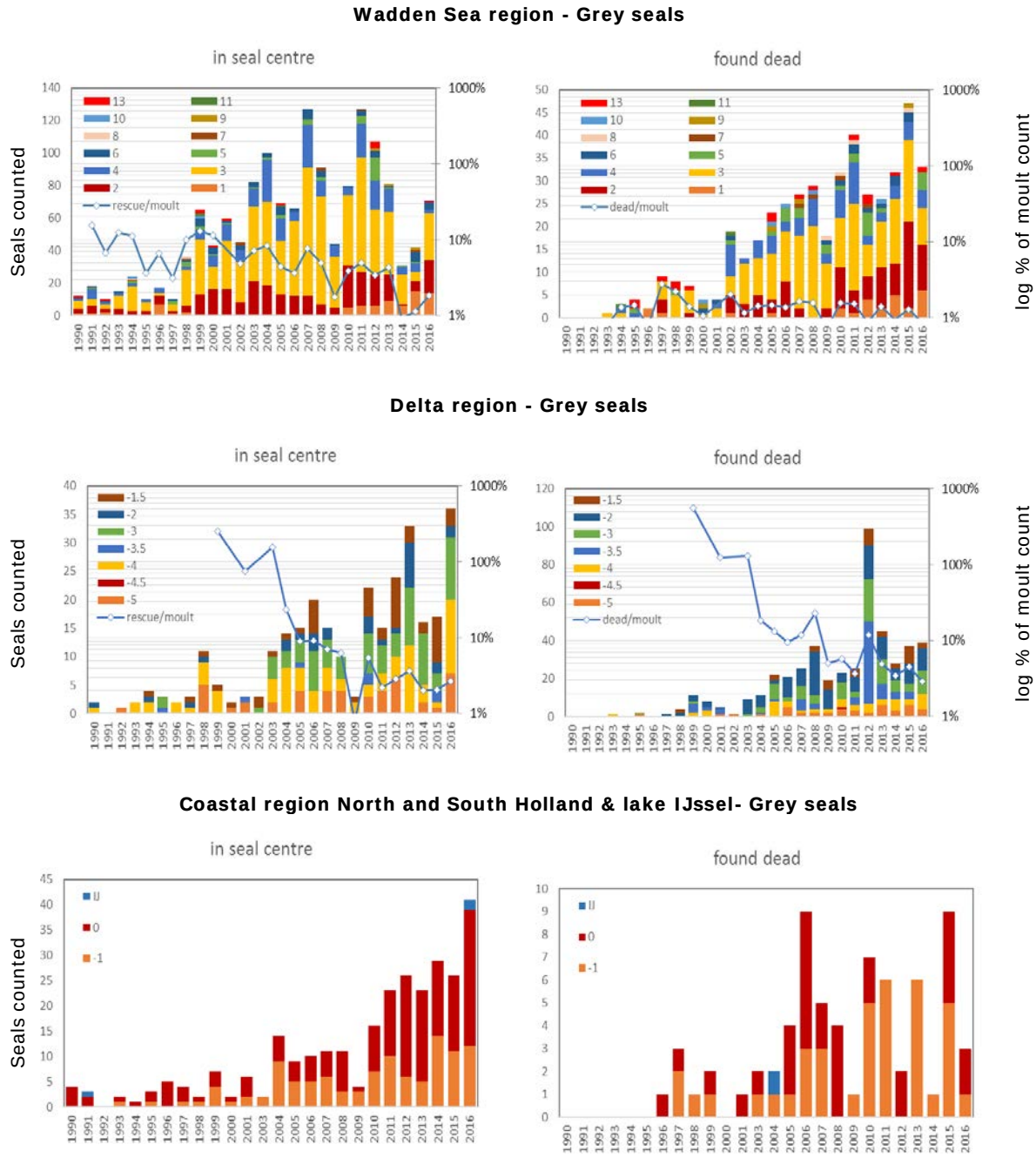


Figure 13. *Annual numbers of grey seals stranded alive and taken into seal centres (left) or found dead (right) for the different areas (Figure 6). Top: counts in the Wadden Sea region; Centre: counts in the Delta region Bottom: Coastal region of North and South Holland and the lake IJssel.*

4.5 Age structure and seasonal variation in stranded seals

The stranding of dead seals in the Netherlands occur throughout the year, with for the harbour seals a slight peak in summer (May-August) when there is a rise in mortality of young animals (Figure 14). There is little variation in the percentage of adults found dead. For grey seals, the breeding season in winter is also a period of more dead pups, while interestingly between March and November mostly adult animals and hardly any pups are found dead.

Figure 14. *Seasonal and age distribution of harbour (left) and grey seals (right) stranded dead along the Dutch coasts (1990-2016). 100% represents respectively all harbour and grey seals found on the Dutch coasts.*

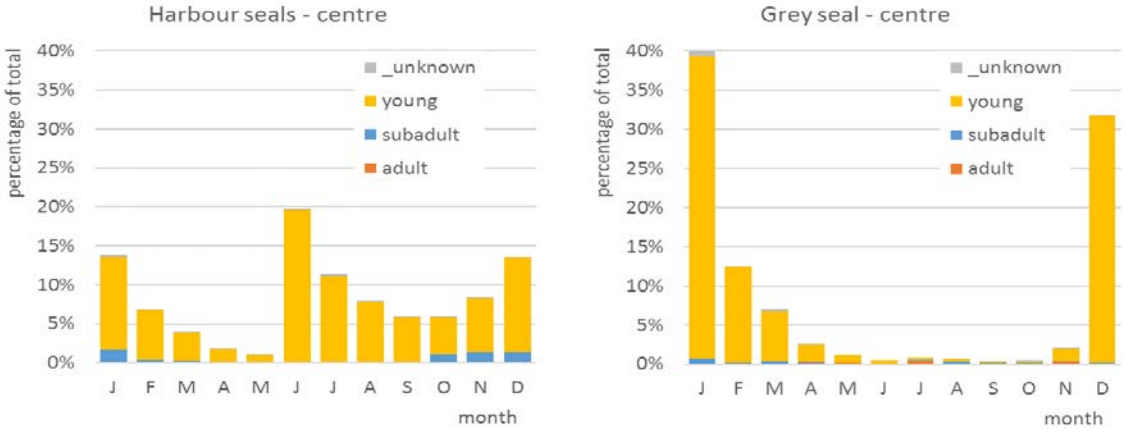


Figure 15. *Seasonal and age distribution of harbour (left) and grey seals (right) taken into seal centres from Dutch coasts (1990-2016). 100% represents respectively all harbour and grey seals found on the Dutch coasts.*

The animals taken into seal centres provide a completely different picture: for both species hardly any adults are taken into care and over 90% are young animals (92% harbour seals, 95% grey seals). For both species, many pups are taken in during or shortly after the breeding season, while for harbour seals there seems to be a second peak in winter (figure 15).

As almost all animals taken into rescue are young it would be better to compare the numbers of animals taken into care to the numbers of seals born that year, this is represented in Figure 16. From these figures it is clear that a high percentage of the pups born in the Netherlands are taken into care every year. In the Wadden Sea up to 50% of the pups that were seen were rescued, though in average 20% of the pups counted are taken into rescue. For grey seals in the Wadden Sea often as many (100%) or even more pups counted in the wild were taken into rescue especially in earlier years. Recently this has dropped to 10%.

In the Delta region the number of harbour seals rescued exceeds the total numbers of young seals counted: in average 180% compared to the pups counted.

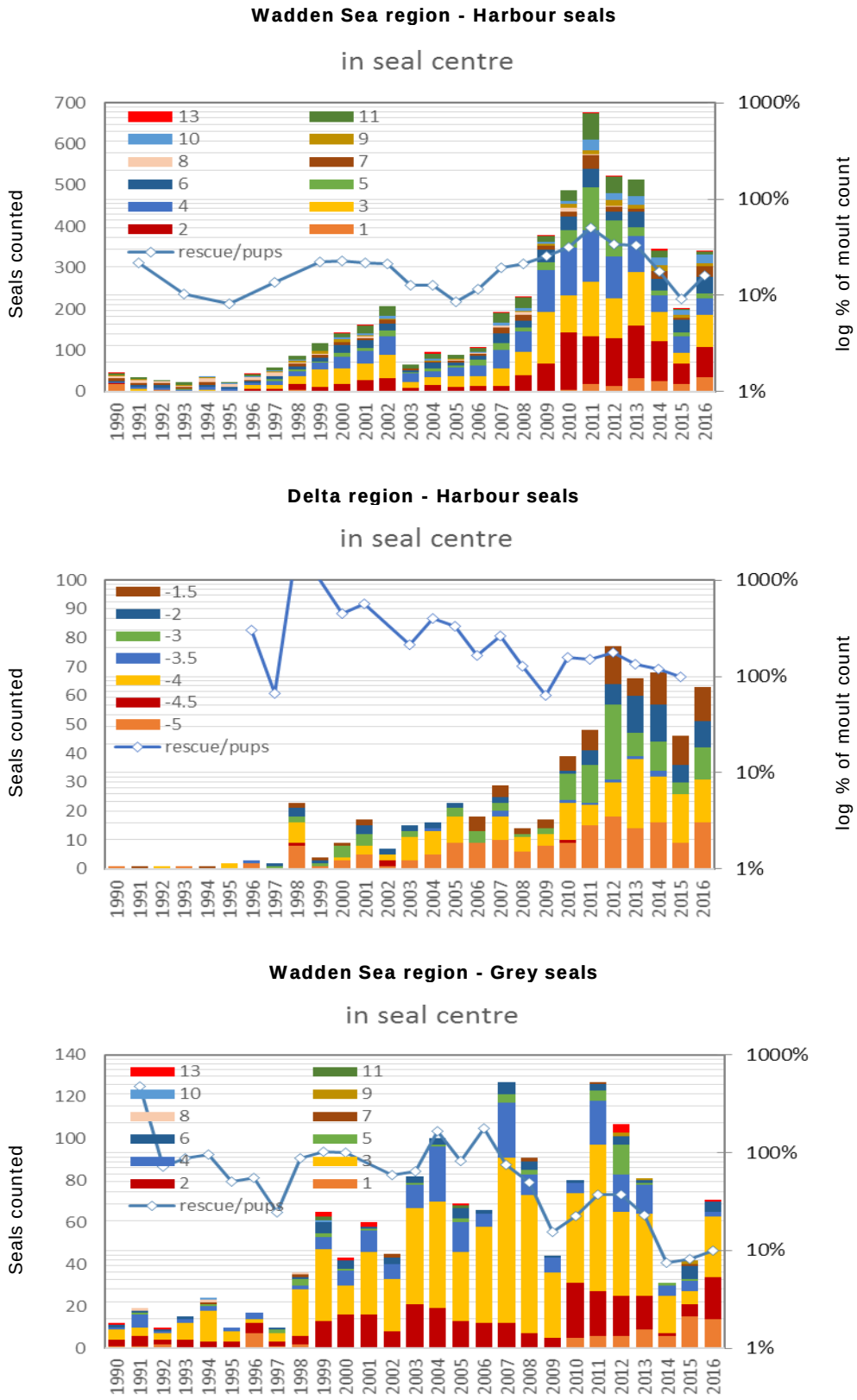


Figure 16. *Annual numbers of seals stranded alive and taken into seal centres per area in stacked bars for the different areas (Figure 6). The total numbers stranded relative to the total pup counts in the region are shown as a line (right axis; log scale) Top: harbour seals in the Wadden Sea Region; Centre: harbour seals in the Delta region; Bottom: grey seals in the Wadden Sea region.*

5 Discussion of the data used

This study is the first to link stranding data to population estimates in the Netherlands as the data was not collected for this purpose directly some remarks should be taken into account.

Aerial surveys seem to be the best way to monitor the long term trends of pinnipeds in general. However, at any time some seals are not seen as they might be at sea during the survey. For harbour seals a correction factor has been determined, enabling us to tentatively estimate true population size (Ries et al. 1998), at least during the summer months. For grey seals the estimate for true population size is more complicated as there is a continuous exchange of seals within the North sea, and thus true numbers of seals present in a region could fluctuate much more. One of the indications that this is the case is for example the fact that in some areas more animals strand than were estimated in the counts (appendix 1 &2). In the Delta area this is most probably also the case for harbour seals as there must be a continuous influx from other areas. Still, even though they might underestimate the total numbers, the surveys are indicative of the changes in numbers of seals in the area.

A next issue relating to the link between counts and stranding data could be that seals might strand near areas where they would not necessarily haul out. There are for example several tracks of tagged seals foraging close to the Delta area while only hauling out in the Wadden Sea area. Again, this would cause an underestimate of the true numbers of seals using the area.

Up until recently, there were only sparse data on the stranding of seals in the Netherlands, therefore waarneming.nl as a new source of information provides a very welcome first overview. There are however potential biases that might affect the results. These are different for live and dead stranded animals.

1. The diagnosis of an animal seen on the coast, is not straight forward. For a dead animal, the diagnosis is quite unambiguous. However for animals to be clearly diseased or simply resting is much more complicated. As an example, seal pups are weaned and left without parental care at a very young age. As they are naive they would not necessarily flee at a human approach. This can easily be misinterpreted especially by those who are driven to save animals in need. It could be that pups are brought that are not in need of help.
2. Search effort: Depending on the proximity to human habitation or the regular monitoring of beaches the chance of finding a stranded animal could differ widely. Even in the Netherlands, which is very densely populated, some coastal areas are rarely visited. Such is the case for the more easterly parts of the Wadden Sea region (especially parts of areas 7-9), where there are extensive sandbanks and uninhabited islands. Also on salt marshes, which are more difficult to access, some seals could be missed. Many of these areas are however regularly patrolled by wardens that would report most findings on waarneming.nl. Accept for these more remote areas, the remaining largest part of the coast is visited almost daily and, certainly in comparison to other less densely populated countries, we expect the stranding data to be quite complete. This could however be ameliorated, by establishing a standard monitoring scheme of stranded animals.
3. Misidentification: not everyone is knowledgeable about the difference between harbour and grey seals and clearly animals could be misidentified. This would certainly be the case of observations in the wild which are difficult to control. Here however we have used data of animals that were brought into care or in the case of dead animals, animals were removed from the beach, thus it is more likely that these seals were correctly identified. Most often, but not always, the handling of the seals is carried out by trained personnel. Much effort has been put in informing the persons that might have misidentified the species and sheets helping to identify have been distributed to those who are likely to report seals. In the future this should be made more public limiting the chance of misidentification in this public data base.

4. Double counts/ missed animals: there could be a slight overestimation of the number of seals in the database as in theory different people could report the same animal. However we have chosen only to use the data on seals actually sent to the rescue centres limiting this for the live strandings. For dead animals this could be more of a problem though most often seals are reported to be taken off the beach and thus not prone to double counting. On the other hand, there is little control on how complete the data is, not all animals that were discarded were reported, and possibly not all privately organised clandestine rescue operations were discovered- both might have led to an underestimate of the numbers. More control i.e. a specific stranding database, could limit these issues and make these stranding reports more useful for monitoring of the status of the population.

Though the public database proves quite valuable, most of these issues could be resolved by creating a specific marine mammal stranding database where every entry is controlled and administrated centrally. In such a database more details on the condition, size, sex and age could be included providing for a better monitoring of possible problems in the seal populations.

It is clear that both species recovered throughout the study period. In the Wadden Sea both harbour and grey seal populations grew in absence of the hunt, and partially fuelled by the influx from seals in other North Sea countries (Brasseur *et al.* submitted 2017, Brasseur et al. 2015). In the Delta region recovery was initially slower and clearly, as for both species births are too low to explain the recent growth, immigration is most probably the underlying drive. Seals partially come from the Wadden Sea but in the case of the grey seals also from UK breeding sites (for example Blakeney point, Donna Nook and even the Farne Islands). This could explain why more pups are rescued in this region than numbers born.

The cumulative numbers of animals stranding between 1990 and 2016 give an indication of areas where generally higher numbers of seals strand (Figure 9 & Figure 10). It is clear that the distribution of standings is far from homogenous; with peaks in areas where many animals occur, for example around Terschelling and Vlieland, but also extreme peaks on less logical sites. For example, in the rescued seals, there is a large peak in the Dollard that could only be explained by the fact that the breeding site is accessible from land and people can easily go out and collect a pup. Other peaks in rescue of both harbour and grey seals along the coasts of North and South Holland are quite difficult to explain as they are far from known haul out sites and would need more thorough analysis.

A striking finding is the large amount of dead animals in some areas, mainly in the Delta region. From descriptions of those finding the animals and occasional pathology studies, there is no indication of specific disease, trauma, or malnutrition occurring in these areas more than elsewhere. It should therefore be considered a possibility that the deaths are human related, and in lack of other likelihoods possibly a result of fishery activities. Research concentrated on these areas might elucidate the cause of death of these animals and help determine if the problem occurs locally or further at large and due to current cause these localised standings.

6 Conclusions

Despite the possible inaccuracies in the data, it is clear that in the Netherlands between 1990 and 2016 the number of rescued animals are much higher than the number of seals found dead. For example in 2011 a total of 970 grey and harbour seals were taken into rehabilitation centres in the Netherlands, while 255 were found dead. As 90 % of the rescued animals are pups, the analysis shows that the numbers of pups rescued often exceeded 50% of the total number of pups counted in the wild. In areas where immigration from other areas play an important role, i.e. for grey seals in the Wadden Sea and harbour seals in the Delta numbers of pups rescued even regularly exceeded 100% of the numbers counted. This was the case for example, for the grey seals in the Wadden Sea region, in 2004 and 2006.

Thanks to the different of individuals that have added the numerous stranding data into the public site of waarneming.nl, we now have an overview of the magnitude of the stranding of seals along the Dutch coast and the number of animals brought into seal centres. However this represents a first analysis and data still needs to be checked with the individual records to ascertain that all animals were reported correctly as discussed above. Given the high numbers reported, it would be advisable to establish an official monitoring program for seal stranding events, similar to the one that exists for cetaceans, instead of depending on public data.

Even though numbers of rescued animals have dropped significantly in the Wadden Sea in the last three years (2014-2016) to approximately 10% of the pup counts, this still represents a large group of animals, for example 628 animals reported in 2016, which can hardly be defined as “the lowest level possible” agreed upon in the Trilateral Agreement.

In the Netherlands, the animals that were released after being taken into care and their possible effect on the wild population as they are released after several months in the centres have not been studied. However, the large amount of released seals could affect the natural selection (Jensen *et al.* 2017), known and unknown diseases could be redistributed in the population (Stamper *et al.* 1998, Goldstein *et al.* 2004) and seals deprived of their youth in the wild could show unknown social defects affecting the population. Regardless of these issues discussed in many earlier debates, the current status of the populations in the Netherlands might give rise to new issues regarding seal rescue: As the populations approach carrying capacity (thus being limited in resources) the rescued animals will cause an increase in demand of resources, resulting in unnaturally high exhaustion of available resources and for example accelerated rise in mortality.

Especially the rescue of pups could be a problem in a density dependant population, as the natural mortality is expected to fluctuate responding to environmental drivers. Influencing pup survival might shift mortality to other animals (including adults), that would otherwise have survived.

In the Netherlands, the concept of wild animals being diseased or dying in the wild is foreign to some, leading to a strong drive to actively seek out any animal, perceived to be in need, and to bring them in. If the aim would be to reduce the number of seals being rescued, the public should be made more aware of the natural processes and how this might be affected by interfering at such a high level.

In the future efforts should be aimed at collecting more detailed stranding information and understanding the underlying mechanisms of disease and mortality. Cause of death (but also rescue) should be included in such a monitoring system and possible findings should be followed up with measures to prevent the events causing local discrepancies. This would include detecting possible problem areas, conducting specific localised research to identify the possible causes and suggesting measures to prevent further problems Such is for example the case for the large amount of dead seals of both species in the Delta region.

7 Acknowledgements

This study could not have been carried out without the undelaying data: thanks to Delta Project management and my current and former colleagues the survey results for the Delta and the Wadden Sea. Thanks to the Waaneming.nl team and the recent efforts of the seal rescue centres Ecomare and Pieterburen but also Jaap van der Hiele and several others who recently added all their data a first overview of the stranding of seals in the Netherlands could be given. Finally, I would like thank Jenny Cremer and Tammo Bult for reviewing this rapport, and providing for excellent comments.

8 Quality Assurance

Wageningen Marine Research utilises an ISO 9001:2008 certified quality management system (certificate number: 187378-2015-AQ-NLD-RvA). This certificate is valid until 15 September 2018. The organisation has been certified since 27 February 2001. The certification was issued by DNV Certification B.V.

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Justification

Report C108/17
Project Number: 4318200016

The scientific quality of this report has been peer reviewed by the a colleague scientist and the head of the department of Wageningen Marine Research.

Approved: Jenny Cremer
researcher

Signature:

Date: 5 February 2018

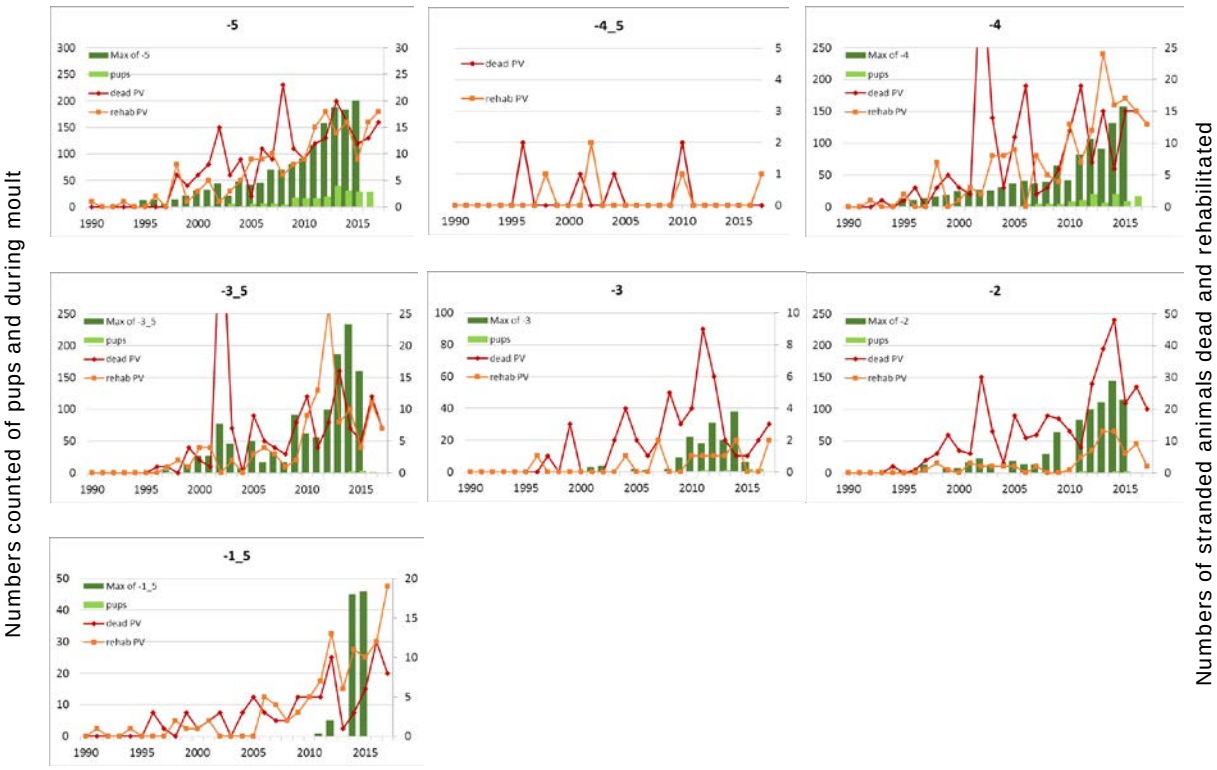
Approved: Tammo Bult
Director

Signature:

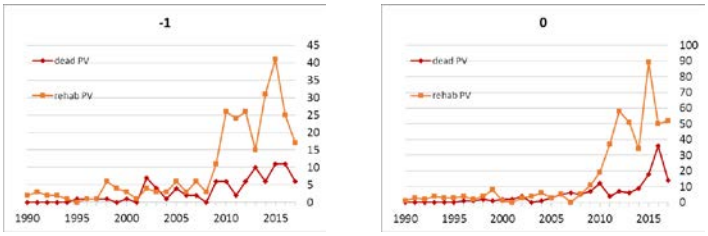
Date: 5 February 2018

Annex 1 counts per area harbour seals

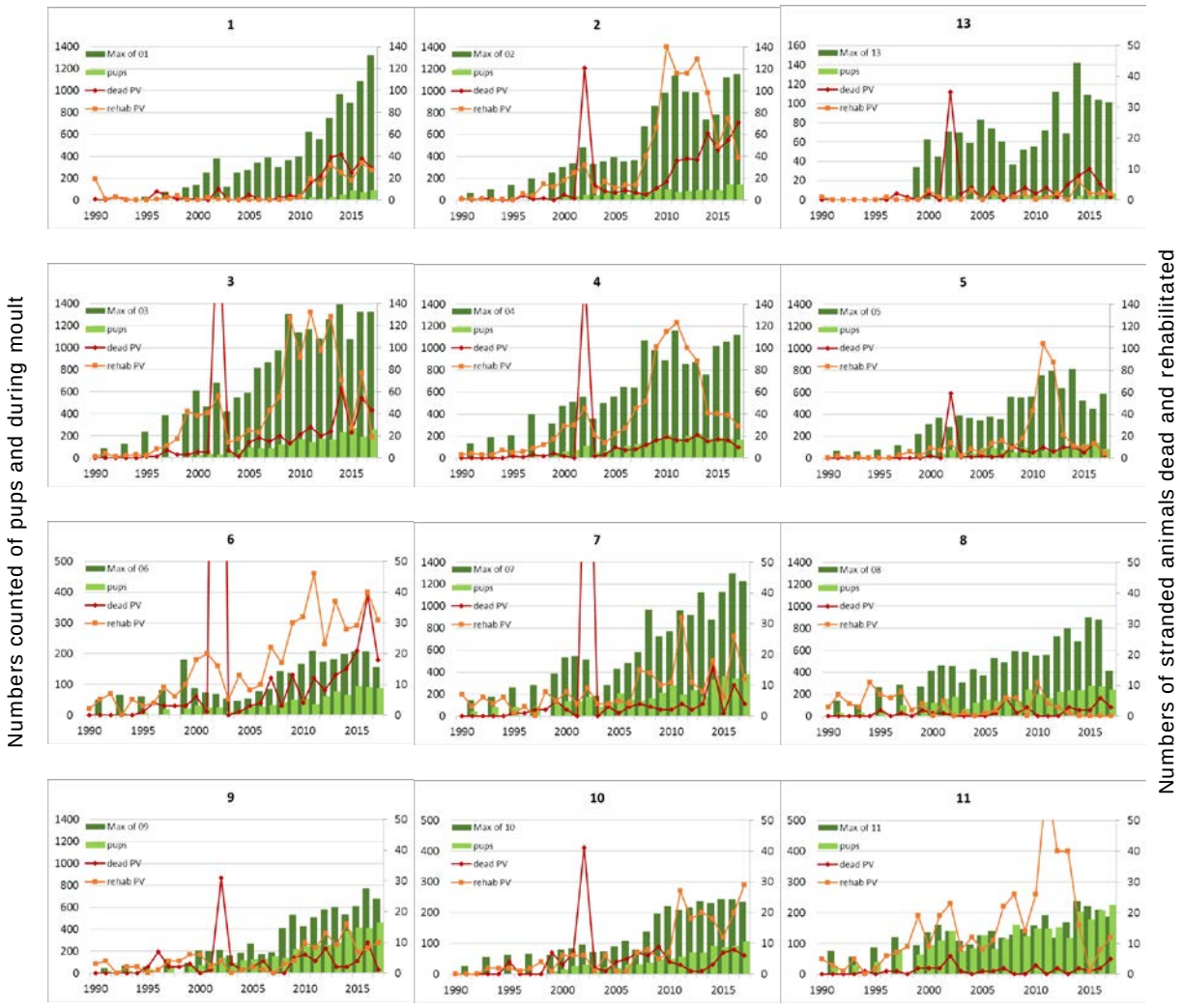
Delta region



Coastal region North and South Holland

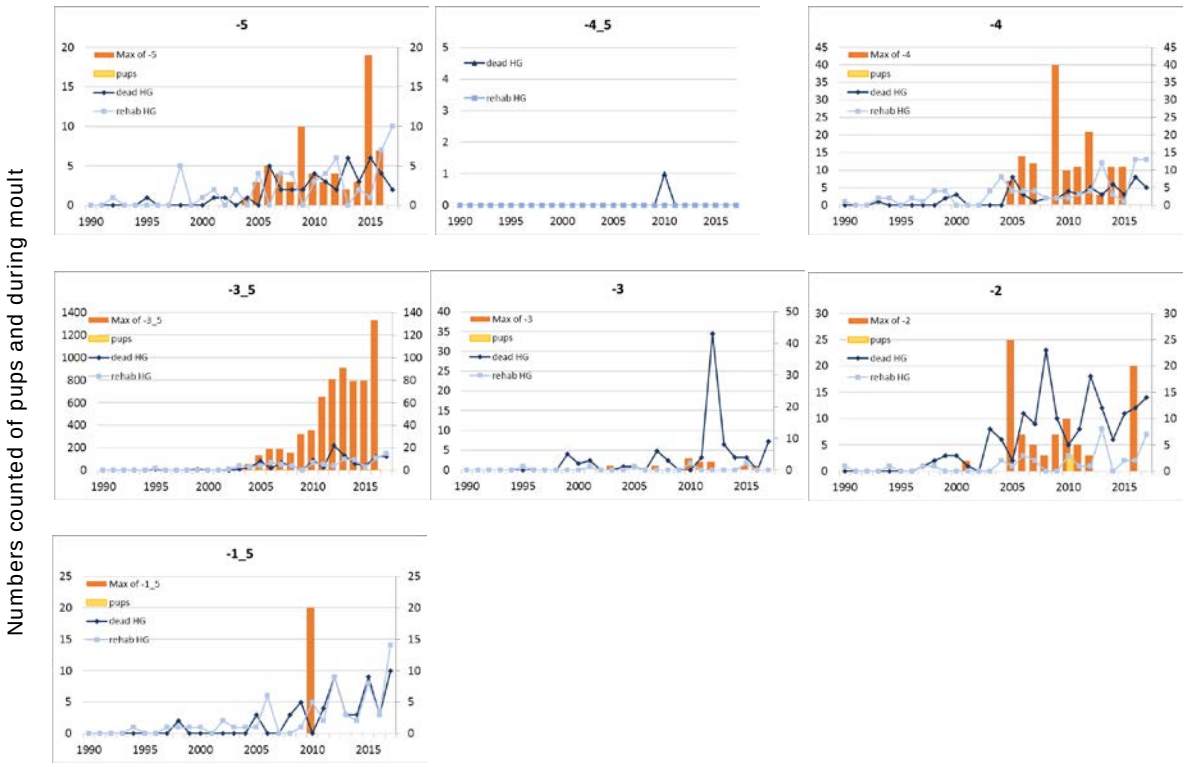


Wadden Sea region

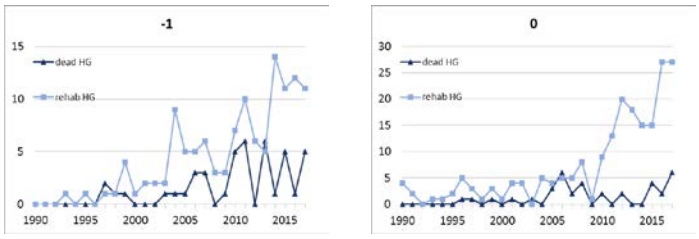


Annex 2 counts per area grey seals

Delta region

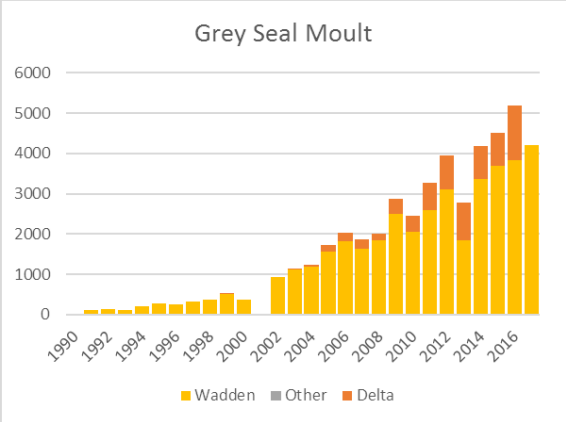


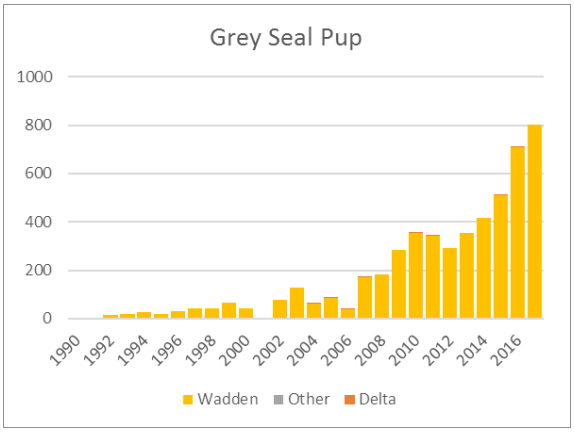
Coastal region North and South Holland

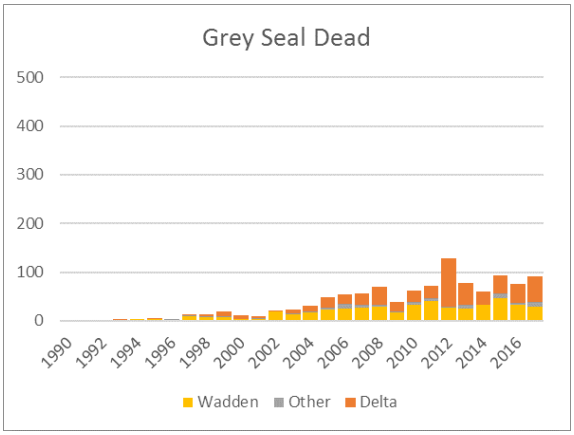


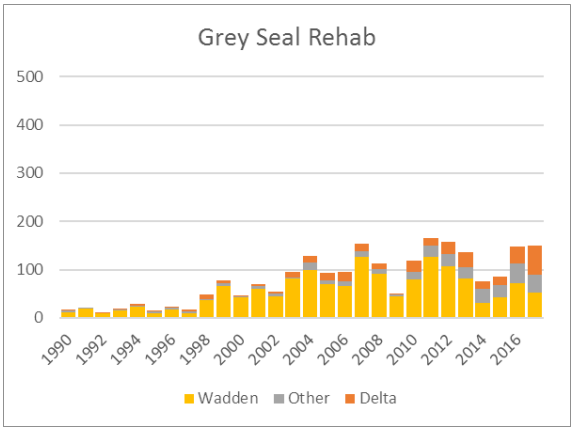
Wadden Sea region

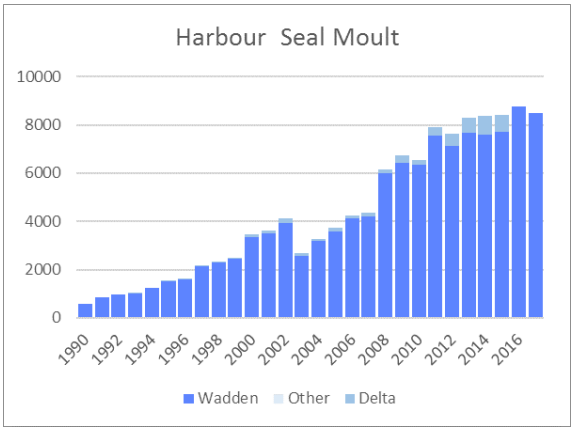
Annex 3 summarised figures of counts and stranding data

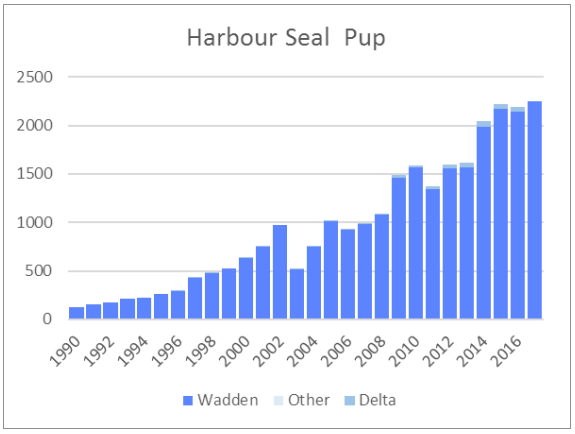


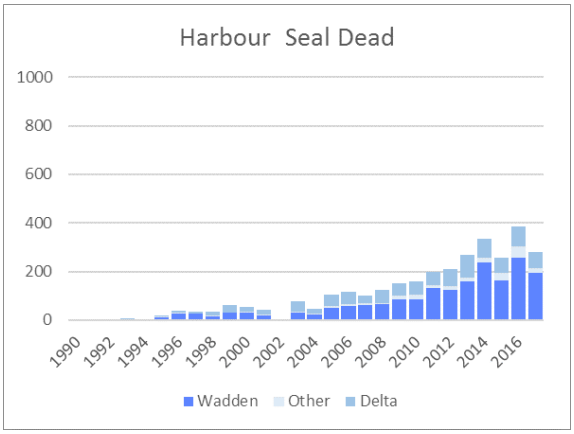







Harbour Seal Moult
10000
8000
6000
4000
2000
0
1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016
Wadden Other Delta


Harbour Seal Pup
2500
2000
1500
1000
500
0
1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016
Wadden Other Delta


Harbour Seal Dead
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800
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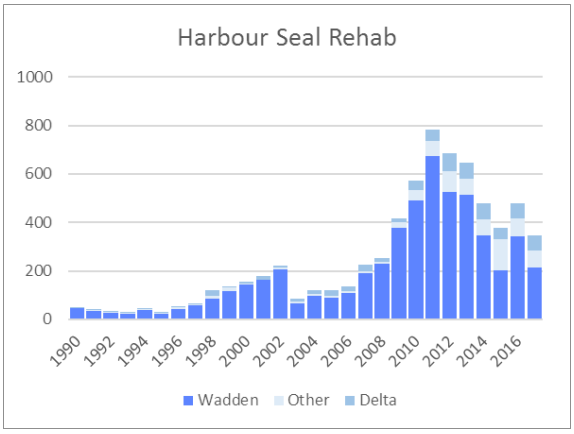
1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016
Wadden Other Delta


Harbour Seal Rehab
1000
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1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016
Wadden Other Delta

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Wageningen Marine Research is the Netherlands research institute established to provide the scientific support that is essential for developing policies and innovation in respect of the marine environment, fishery activities, aquaculture and the maritime sector.

Wageningen University & Research:
is specialised in the domain of healthy food and living environment.

The Wageningen Marine Research vision
'To explore the potential of marine nature to improve the quality of life'

The Wageningen Marine Research mission
- To conduct research with the aim of acquiring knowledge and offering advice on the sustainable management and use of marine and coastal areas.
- Wageningen Marine Research is an independent, leading scientific research institute

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