

The harbour seal, *Phoca vitulina*, in the Oosterschelde: decline and possibilities for recovery

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Abstract

Within a timespan of a few decades, the harbour seal almost completely disappeared from the estuaries in the south-west of the Netherlands. In 1960 a population of around 350 animals still lived in the Oosterschelde and Westerschelde area. About a quarter of this population lived in the Oosterschelde. At present less than 17 animals can be regularly observed in the whole area. Human influences are responsible for the rapid decline of the population. Initially a high hunting pressure and later environmental pollution are the main causes. Loss of habitat and disturbance at the resting places are additional important factors. The Oosterschelde still is a suitable habitat for seals. A short term natural development of a viable population in the area is not to be expected. Only with human help through active management, *i.e.* reintroduction of rehabilitated seals (preferably originating from that area) and strict conservation of the extant Oosterschelde seal population, accompanied by environmental sanitation of the neighbouring waters, can the current southern Dutch harbour seal population increase.

Introduction

As top predators seals play a significant indicative role for the quality of the marine ecosystem they live in. The integrity of marine ecosystems is of value to us and so, by implication, is the survival and well-being of marine mammals. This gives them a value for society which is hard to quantify but is nonetheless real (Holt, 1986). In most parts of their range European seal species are in need of active conservation to prevent their numbers diminishing (Summers *et al.*, 1978). This is certainly the case for the southern Dutch harbour seal population (Reijnders, 1985a, Reijnders *et al.*, 1990). In a management policy statement of the Dutch government for the Oosterschelde in

1982, it is clearly stated that the natural values of the system should be kept intact and, if necessary, improved. One of the elements important in this context is the restoration of a viable harbour seal population in the area.

The time period under consideration in this study is 1960 till present: from 1960 onwards, regular aerial surveys of the seal population in the Delta area have been carried out. This period coincides with the start of the major construction works aimed at safeguarding SW Netherlands from disastrous storm surges. A review of the changes in population size is presented. The causes for the decline and the possibilities for recovery are discussed.

General ecology of the harbour seal

The harbour seal occurring in the Oosterschelde belongs to the subspecies *P. vitulina vitulina*, which inhabits the northeastern part of the Atlantic Ocean from Iceland and Finland to the North Sea, the Irish Sea and the Baltic Sea. The most important populations are found around Iceland, in the Wash (UK), around the Orkney Islands, in the Wadden Sea and in the Kattegat-Skagerrak/southern Norway area (Bonner, 1972, Reijnders & Lankester, 1990). Except some small colonies in France, the Dutch Delta area can be considered as the southern limit of its former geographical distribution. It is the only breeding marine mammal in these waters in recent times.

The animals are known to frequent estuaries and coasts where offshore sandbanks or rocks are regularly exposed at low tide. In areas with no tidal rhythm, a different regime more related to daylight can be observed. Common seals haul out on these spots to give birth and suckle their young,

to rest and to moult. In most areas they are seen at the haul-out sites throughout the year, but their abundance varies in relation to factors such as season, time of day, tidal cycle and weather conditions (e.g. Godsell, 1988; Boulva & McLaren, 1979; Thompson, 1989). Numbers are generally highest in summer.

It is difficult to obtain population estimates and other parameters necessary for accurate population dynamical studies (Thompson & Harwood, 1990). Even aerial counts seem to be too blunt an instrument as was shown by the recent seal plague when more animals died in the German Wadden Sea than the best estimates of the size of the local population size (Reijnders, 1988a, Harwood, 1989). Therefore all published figures have to be interpreted as minimum estimates of the total population size and can only indicate a trend in population size.

Seals are carnivorous mammals which subsist largely on fish though, at times, molluscs and crustaceans may form a significant part of their

Table 1. Prey species found in stomach and colon of 63 seals shot in the Delta area. Calculations from the data of Havinga (1933).

Species		Numbers	Weight (g)	Weight (%)
<i>Platichthys flesus</i>	< 14 cm	307	4605	15.6
	14–18 cm	62	2480	8.4
	> 18 cm	53	4505	15.2
<i>Pleuronectes platessa</i>	< 10 cm	145	722	2.4
	10–15 cm	24	480	1.6
<i>Solea solea</i>		13	569	1.9
<i>Limanda limanda</i>		28	1167	3.9
<i>Myoxocephalus scorpius</i> + <i>Agonus cataphractus</i>	< 15 cm	103	2066	7.0
	> 15 cm	57	3990	13.5
<i>Zoarces viviparus</i>	< 13 cm	148	444	2.3
	> 13 cm	62	930	3.1
<i>Clupea harengus</i>	< 16 cm	38	190	> 1
	> 16 cm	7	87	< 1
<i>Merlangius merlangus</i>		17	1105	3.7
<i>Gadus morhua</i>		46	2658	9.0
<i>Osmerus eperlanus</i>		29	725	2.8
<i>Pomatoschistus minutus</i>		1567	1668	5.6
<i>Belone belone</i>		6	620	< 1
<i>Engraulis encrasicolus</i>		2	620	< 1
<i>Ammodytes tobianus</i>		53	620	< 1
<i>Alosa fallax</i>		4	620	< 1
<i>Crangon crangon</i>		512	540	1.8

diet. They are opportunistic feeders, eating a wide variety of fish species (Havinga, 1933, Sergeant, 1951; Rae, 1968; Harkonen, 1987; Sievers, 1989; Pierce *et al.*, 1990). No recent data on food preference of seals in the Oosterschelde are available. Havinga (1933) examined stomach contents of 63 seals shot in the Delta area throughout the year (Table 1). The main prey species of the harbour seal in the Delta area was flounder *Platichthys flesus* Linnaeus 1758 (39% on a weight basis). Other important species in their diet are bull rout *Myoxocephalus scorpius* Linnaeus 1758, and hook-nose *Agonus cataphractus* Linnaeus 1758 (20%), cod *Gadus morhua* Linnaeus 1758 (9%), and gobies *Pomatoschistus species* (6%). Further, small quantities of whiting *Merlangius merlangus* Linnaeus 1758, plaice *Pleuronectes platessa* Linnaeus 1758, dab *Limanda limanda* Linnaeus 1758, sole *Solea solea* Linnaeus 1758, and a variety of other fish were found.

History of the common seal in the Oosterschelde

The estuaries in the south of the Netherlands are traditionally used by seals. Around 1900, approxi-

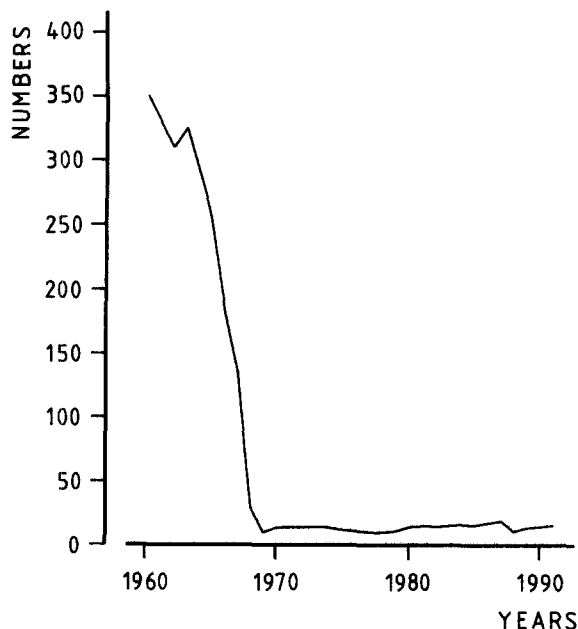


Fig. 1. The decline of the number of seals in the Delta area.

mately 11 500 seals lived in the Delta area, some 25% of this population in the Oosterschelde (Reijnders, 1992a). Van Bommel (1956a) estimated the population at about 1000 animals in 1954, 25–30% of which lived in the Oosterschelde. He already noted that the numbers were decreasing (Van Bommel, 1956b). Reijnders (1985a), reviewing Van Bommels figures, agrees that during his research the population was already on the decline. However, in a later study it was concluded that Van Bommels figures have to be upgraded to assess the actual numbers present (Reijnders, 1992a). From 1959 onwards, aerial surveys (van Haften, 1974) showed a rapid decline in numbers of seals in the Delta area. Based on those actual surveys Reijnders (1985a) estimated the population size on 350 in 1959, down to 40 in 1969 and to less than 25 animals since 1974 (Fig. 1). In 1991 only 17 seals were counted in the Delta area, 7 of which in the Oosterschelde.

Possible causes of changes in the size of the population

Interactions with fisheries

Seals are regularly drowned after becoming entangled in fishing nets (drift nets, ghost nets). Nets made of synthetic fibre are more resistant than natural fibre nets (Bonner, 1972). Avoiding to discard old nets in the sea will help to reduce the incidence of these deaths.

Van Bommel (1956b) already concluded that weir-fishery prevents the seals from reaching habitual resting places in the Oosterschelde. Especially fyke nets (also used in the Oosterschelde) seem to present a problem. In 1987 six seals drowned in the Ems estuary (De Boer, 1989). A simple solution like placing a large meshed 'keerwant' (allowing the fish to pass but preventing seals to enter) in the mouth of the fykes seems to reduce the risks for the seals significantly (Reijnders, 1985b).

Hunting pressure

Seals have been persecuted by man for centuries, and also in the Delta area hunting was carried out on a large scale. It has been widely accepted that marine mammals, if they are exploited anyway, should be treated as renewable resources, and that only sustainable yields should be taken from their populations. Practice has usually been far from this ideal. The southern Dutch harbour seal population has clearly been over-exploited. This was stimulated by payment of bounties on the grounds of fisheries protection. In the early 1900s, when the number of common seals in the Delta was estimated at about 11 500 (Reijnders, 1994), the annual hunt was very high (*ca* 1000 animals). This slowly dropped to approximately 400 animals from 1920 till 1950. Then an increase took place to 700 animals in the mid 1950s, whereafter it declined again (Reijnders, 1994). After 1949 the bounty system was abolished and the demand for train-oil had ended. The result was that the interest in adults diminished and only pups were killed for the fur industry (Reijnders, 1976). This led to an increased population decline as was also noted by Van Bommel who thought that if the population of about 1000 animals in the area was stable, the existing breeding stock could cope with an annual killing of 15% of the total population. In 1954 and 1955 the annual killing rate became much higher (up to 50%) and a sudden decrease in numbers became apparent (Van Bommel, 1956b). In 1954 seals were included in the provisions of the hunting law and could only be taken under licence. The harbour seal became totally protected in 1962. The high hunting pressure caused a collapse of the population from 11 500 animals in 1900 to 350 in 1960 (Reijnders, 1994).

Environmental pollution

It is well established that environmental contaminants accumulate in marine mammals. For reviews of pollutants in seals we refer to Holden (1978) and Reijnders (1988b). Seals are particularly vulnerable to pollution because they are at

the top of the marine food chain and therefore accumulate toxins. Furthermore, organochlorine compounds like the persistent polychlorinated biphenyls (PCBs) and DDT tend to accumulate extra in lipid tissue. Therefore concentrations of organochlorines are highest in organs or tissues with the highest lipid content. Muscle tissue and livers of the most important prey species of seals (fish) and the blubber and liver of seals itself are proven to act as storage sites of a wide variety of contaminants (Holden & Marsden, 1967; Ten Berge & Hillebrand, 1974; Reijnders 1980; Van Haren & Marquenie, 1988). Since aquatic mammals have a relatively high proportion of their body weight in the form of subcutaneous fat (blubber) they carry relatively high burdens of organochlorines. In the mid seventies high concentrations have been found in ringed seals *Phoca hispida* Schreber 1775, grey seals *Halichoerus grypus* Nilsson 1820, and harbour seals *Phoca vitulina* Linnaeus 1758 from the Baltic area and the Swedish west coast (Helle *et al.*, 1976a, b). In seals from the North Sea high concentrations have been detected in specimens from the Dutch coast (e.g. Koeman *et al.*, 1975), the east coast of Britain (e.g. Holden, 1978), and the German Wadden Sea (Drescher *et al.*, 1977). Organochlorine residues in male seals increase with the age of the animals (Addison & Brodie, 1977; Reijnders, 1980). This relationship is not established for female seals in low to medium polluted areas, suggesting that these can excrete the residues by some route(s) closed to the male (Addison & Brodie, 1977; Boon *et al.*, 1987). The most obvious mechanisms are parturition and lactation.

The contaminants are released when the animals mobilise their lipid reserves at times of stress, such as the pupping and lactation season or during the moult (Harwood & Reijnders, 1988). The recorded concentrations may be sufficient to result in some additional stress to the animals in case of fat mobilisation during illness or starvation (Law *et al.*, 1989).

High concentrations of certain organochlorines and metals have since long been associated with reproductive failure and increased juvenile mor-

tality in marine mammals (De Long *et al.*, 1973; Helle *et al.*, 1976a, b). The most extensive study of these effects was carried out by Reijnders in the Dutch Wadden Sea. The harbour seal population in the Dutch part of the Wadden Sea has declined from about 17000 in 1900 to about 900 animals in 1959 (Reijnders, 1976, 1992). Like in the Delta area, this decline was only caused by overhunting. However, after hunting was restricted and finally banned the population continued to decrease after an initial rise from 1959 to 1964. This decline was predominantly caused by a very low reproductive rate of seals from this part of the Wadden Sea (Reijnders, 1978, 1980). Reijnders (1978) showed that in the Dutch Wadden Sea population pup production was lower and juvenile mortality was higher than for the stable populations of Schleswig-Holstein and Denmark. The observed decrease in reproductive success correlated strongly with the high concentrations of PCBs in the tissues. Thus these environmental pollutants, mainly originating from the heavily polluted rivers Rhine and Meuse, have been implicated as possible causative agents of the drastic reduction in the harbour seal population in the Dutch Wadden Sea (Reijnders, 1980, 1981a; Reijnders *et al.*, 1981). Later Reijnders (1986) was able to demonstrate a causal relationship between naturally occurring levels of PCBs and a physiological response of the seals. He showed that harbour seals fed on PCB-contaminated fish from the polluted part of the Wadden Sea had significantly lower reproductive success than seals fed 'clean' fish. In a cooperative study an important role of vitamin A in PCB-induced reproductive failure in common seals was found. Vitamin A plays an important role in resistance to infections. PCB effects may thus be accompanied by a weakened condition and increased susceptibility to viral infections (Brouwer *et al.*, 1989).

Since the closing of some upstream tributaries there is no direct input of polluted fresh water in the Oosterschelde. Consequently water quality is relatively good. Yet, in the period 1980–1987 concentrations of PCB-153 in Oosterschelde mussels were so high that the reproduction of seals could be expected to be disturbed (Vonk, 1990). Since

then the situation is improving. It should be noted here that the neighbouring Westerschelde estuary is still heavily polluted (Van Eck *et al.*, 1991). A clean Oosterschelde seems to be of limited value to the seals without an equally clean Westerschelde. Since both systems are very close together and since some traditional resting places of the Southern Dutch harbour seal population are (were) located in the Westerschelde, important migrations of animals from Ooster- to Westerschelde are to be expected once an Oosterschelde population is established.

Disturbance and loss of habitat

After the total protection of the harbour seal in 1962 no increase was found in the Delta area, similar to what happened in the Wadden Sea (Reijnders, 1976). Besides the effects of pollution, an additional factor could be the start of the engineering works within the frame of the Delta plan, which destroyed much of the habitat and caused great disturbance. However, the impact of these activities and the recreational disturbances are presumably only important for the last phase in the decline (1965 and onwards) because a major part of the population had already disappeared before the works started. A more important aspect of disturbance is probably the negative influence on recolonization possibilities. Many of the traditional resting places disappeared. In the mouth of the Grevelingen resting seals were often observed before the start of the construction works in 1965. Soon thereafter they disappeared. They might have moved to the heavily polluted Westerschelde that year, as numbers increased there (Benschop & Van Haperen, 1988).

The influence of disturbance from the construction works has decreased since 1986, but disturbance due to recreational activities has increased significantly during the last decade (Reijnders, 1985a). Besides this, there is also disturbance from professional traffic such as fisheries, shipping and research vessels. Marine mammals are also tourist attractions. There is some fear that

increasing tourism will interfere with the vital activities of the animals. The critical period for the seals is mid June to the end of August. During the whelping and nursing period seals are highly dependent on the sandbanks during low tide. Seals are often forced to leave the tidal flats when disturbed by boats. This results in less time for nursing and resting and possibly in increased pup mortality. Disturbance also plays a significant role in the occurrence of skin lesions. Mechanical injury to the nearly healed umbilicus with consequent infection of the wound may also occur (Reijnders, 1981b).

Chances for recovery

Effects of the seal plague

In the summer of 1988 more than 17 000 common seals died around the northwest coasts of Europe (Dietz *et al.*, 1989). Some 60% of the Wadden Sea population is believed to have died. In 1991, approximately 6100 seals were counted in the Wadden Sea, 750 in the Dutch part (Reijnders, 1992). The primary cause of the seal plague has been identified as infection with a previously undescribed virus from the morbilli genus, the phocine distemper virus (Cosby *et al.*, 1988; Kennedy *et al.*, 1988; Mahy *et al.*, 1988; Osterhaus 1988; Osterhaus & Vedder, 1988; Osterhaus *et al.*, 1988). These and several other authors have related the severity of the outbreak to pollution in the North Sea (Holt, 1989). As mentioned above, there is strong evidence that the high levels of organochlorines which have been recorded in the blubber of seals in the Dutch Wadden Sea and the Baltic Sea have contributed to the low fertility which has been observed in these areas. In the recent disease outbreak attention has again focused on PCBs. PCB effects may be accompanied by a weakened condition and increased susceptibility to viral infections (Brouwer *et al.*, 1989). These compounds have been demonstrated to have an immunosuppressive effect and thus to increase vulnerability to infection (Wasserman *et al.*, 1979). Whatever the proximate or ul-

timate causes of the epidemic were, any positive trends in the population developments of the common seal have been abruptly interrupted. The plague not only was a catastrophe for the entire Wadden Sea population itself, but especially for areas with lower birth rates, *i.e.* the Dutch Wadden Sea and the Delta area. The chances for a short term natural recolonization of the Oosterschelde are seriously reduced, since the establishment of a breeding stock of seals in the Oosterschelde is highly dependent on the immigration of young animals from the Dutch Wadden Sea. In the next few years there will also be fewer animals available from the nursery stations, limiting possibilities for large scale reintroduction programs (Reijnders *et al.*, 1990).

Furthermore the Delta area itself was not isolated from the virus. The effects were not massive because of the very low population density, but still some animals were found in that region which died because of virus infection. The well-being of a possible future Oosterschelde population will largely depend on the evolution of the disease-cycle. If the plague is recurrent, the influx will be limited and only a marginal recovery will occur, if at all.

Management and conservation

In the period 1980 to 1988 there was a clear recovery of the seal population in the Dutch Wadden Sea. This was mediated by an increased immigration from the German and Danish parts where hunting ceased in the mid seventies (Reijnders, 1983, 1988a) and where pup production was higher than in the Dutch part. The protection of resting areas, the release of rehabilitated seals by nursery stations and the release of animals born in captivity contributed significantly to population growth by improving recruitment. The slight increase in the number of seals in the Delta area observed in these years is believed to be predominantly connected with increased numbers in the Wadden Sea. Because of the already mentioned dependency on dispersal of young animals from the Wadden Sea, the fate of

the Oosterschelde population is closely related to the condition of Wadden Sea population.

The perspective of a natural recovery to a viable population is temporarily ruined by the epidemic in 1988. A short term natural development of this population is not to be expected because of the seal plague in the North sea in 1988 and consequent massive death (Reijnders *et al.*, 1990). Long term perspectives for natural recovery are good providing the Wadden Sea population increases and water quality of the North sea, the Rhine, the Meuse and the Westerschelde improves. PCB levels in the Delta area are not dramatically high. The situation is not worse than in the Wadden Sea but still they are high enough to hamper reproduction.

The release of rehabilitated animals into the Oosterschelde seems to be a feasible way for a recovery on the short term. Eventually, a growing seal population in the Oosterschelde could be a centre for dispersion to other parts of the Delta area. A first experiment has been conducted (Reijnders *et al.*, 1990). The introduction was successful but the authors conclude that disturbance by boats, airplanes and other professional and recreational activities in the Oosterschelde are of such a level that the quality of the habitat is too low to continue without accompanying additional conservational measures. Rest for the animals has to be guaranteed. Management of the seal population should include undisturbed rearing areas for the pups and reserves where the animals can rest at all times. Measures like increasing minimal flying height may also prove beneficial (De Vlas, 1988). Reijnders *et al.* (1990) also stress the importance of a 'keerwant' in all fykes to prevent drowning of seals.

Conclusions

The Oosterschelde still is a potentially suitable habitat for the harbour seal. Water quality is not poor. Although some of the traditional resting places disappeared due to the engineering works, numerous large sandbanks are still present and there is a rich food supply. The deep gullies on the

seaward side of the storm surge barrier will not disappear. The barrier itself seems not to be a physical problem for the seals (Reijnders *et al.*, 1990). In the Oosterschelde and the adjoining part of the Voordelta there is in principle room for 2000–2500 seals. Negative prospects for a successful recolonisation are the increasing recreation pressure and the ongoing heavy pollution in the Westerschelde. If the environmental conditions of neighboring waters improve and resting places in the Oosterschelde and parts of the Voordelta would be safeguarded, there is little doubt that a breeding population in the Delta area can develop. A short term natural colonization leading up to a viable seal population is, in view of the recent seal plague, not to be expected. A well planned reintroduction of rehabilitated seals in the area (preferably originating from there) can be a good strategy providing the conditions mentioned above are fulfilled and the introduction is accompanied by appropriate conservation measures.

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