Harbour seals *(Phoca vitulina)* and rehabilitation

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ABSTRACT

Throughout the past few decades, rehabilitation of seals has become an activity that is anchored in the present day society of many countries. Seals are primarily rehabilitated to help individual animals in distress. At the same time, the release of seals which would have otherwise died can be considered as a contribution to the population. Most rehabilitated seals are animals under one year of age. They are mainly orphans, weaned seals with complications and seals with a parasitic bronchopneumonia. For the optimal handling of seals and their diseases, centralised operations with quality standards are essential. Rehabilitation provides an instrument to monitor the health of the seal population and its ecosystem. Changes in stranding trends or the appearance of new diseases can be monitored. Moreover, rehabilitation is important to show the general public the state of the marine environment. In the Netherlands there is significant social support for the rehabilitation of seals. Experience obtained with seal care is of importance in countries where urgent help of threatened seal species is required. Here individual seals are also ambassadors to raise support for the protection of this species in general. Given that the anthropogenic impact on the seals and their environment is extensive in the Wadden Sea, rehabilitation centres can compensate the consequences of this impact on individual seals as well as the population as a whole.

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INTRODUCTION

The harbour seal *(Phoca vitulina)* is a species that is rehabilitated on a significant scale. During the 1970s, rehabilitation proved to be an important factor in stopping the decline of the number of common seals in the Dutch Wadden Sea. It also was important to the recovery of the population in the 1980s (Reijnders *et al.* 1996). Rehabilitation is first of all the expression of the need to help individual animals in distress, which is experienced by many. At the same time it can provide support to a population under pressure. These two approaches, animal welfare and population biology, are central to the discourse surrounding this subject. Furthermore, during the two major outbreaks of phocine distemper virus (PDV) in 1988 and 2002, rehabilitation made an important contribution to the identification of the virus (Osterhaus and Vedder 1988, Jensen *et al.* 2002). While the rehabilitation of common

seals will here be discussed in general terms, there will be a focus on the European situation, the Wadden Sea in particular. The situation in North America has been discussed by, amongst others, Reynolds and Odell (1991), St. Aubin *et al.* (1996), Measures (2004) and Moore (2007). The present paper will first describe the historical background of rehabilitation in the Wadden Sea. It will then examine practice and results in the Netherlands, using rehabilitation data from the Seal Rehabilitation and Research Centre (SRRC) in Pieterburen, the Netherlands. Following this, other relevant issues, such as the handling of infectious diseases, the effects of rehabilitation on the harbour seal population and the rehabilitation of other, threatened species, will be addressed. In addition, the position of rehabilitation within society will be discussed. It is argued that rehabilitation should at all times be conducted in a professional way, assuring its quality through strict protocols. Also education and scientific research should be conducted for the benefit of the individual seal and the conservation of the species in general.

REHABILITATION HISTORY

Interactions between seals and humans are age-old. Archaeological excavations (prehistorical and later) have revealed that grey seals *(Halichoerus grypus)* were taken by the inhabitants of the present day Netherlands (Van Giffen 1913, Van Bree 1961, Clason 1988, Koot and Van der Have 2001). Initially seals were hunted for the purposes of subsistence. However, this began to change during the 16th century as seals came to be regarded as competitors for fish. From 1591 until 1942 (with shortinterruptions) incentives to hunt seals were given in the form of bounties ('t Hart 2007). In the 19th century it was sometimes profitable to bring live seals ashore, if they could be sold by fishermen or seal hunters to zoological gardens (Winter 2004, 't Hart 2007). Along the coast of the Netherlands and Germany several North Sea Aquaria took seals from the wild to add to their collections. For Wesermünde, Germany, Junker (1940) describes the rearing of seals and states that in the first decades of the 20th century, 5-10 very young seals of only a few days old, were annually brought to the Aquarium, many of which died. In the period 1922-1931, 3 seals were captured and successfully reared. They were still part of the collection of 12 in 1940; the other 9 were descendants of the 3 captured seals (Junker 1940). Occasionally private individuals who came across seals on the shore kept them in moats or ponds ('t Hart 2007). Keeping seals alive proved to be a difficult task. During the 1950s, a successful feeding formula for rearing young seals was developed in Germany with Dr. K. Ehlers and Dr. M. Reineck as main contributors (Reineck 1961). The use of minced herring instead of cow's milk was an essential ingredient in the new formula. This break-through increased the rate of successful rearing of seals substantially. This method was further developed in the Netherlands and formed the basis for rearing techniques in that country and beyond. In particular, the handling techniques and medical care have evolved over the years.

Rearing a seal in captivity does not automatically imply that it will be returned into its natural habitat. In the early days, release was rarely considered. A list of the possible destinations for seals after rearing illustrates this:

1. Rehabilitation; to be released
2. Display; *e.g.* as part of a zoological collection
3. Research; as part of a scientific programme
4. Reproduction; as part of a breeding stock.

Rearing seals in captivity thus cannot be defined as rehabilitation in all cases. Rehabilitation is the activity which can be defined as: "temporarily keeping a wild animal which would not have survived otherwise, with the intention to rear and/or treat this animal with release back into the wild as the ultimate goal". This definition is in line with the European tradition, but is different to the one generally used in North America where seals that remain in captivity after rearing and/or treatment are also considered as falling under their definition of rehabilitation (Wilkinson and Worthy 1999).

The first rehabilitation in the Netherlands took place in 1960. The seals were taken care of by

Mr. R. Wentzel, a municipal official and a keen hunter. After his retirement, this initiative was continued with the establishment of the SRRC, which was founded in Pieterburen in 1971 by Mrs L. 't Hart. In that same year the *Landesjägerschaft Niedersachsen, Kreis Norden* founded the *Seehundaufzuchtstation Norden-Nordeich,* which aimed to rehabilitate seals.

A few years earlier, initiatives had already been taken in Schleswig-Holstein by the hunting association, the Sea Aquarium and the Lütje family in Büsum. Most of the seals were released after they had been reared (Schumann 1976). Further to this, in Esbjerg, Denmark Mr. S. Tougaard started to rehabilitate seals at the Sealarium which was founded in 1976 and part of the *Fiskeri- og Søfartsmuseet;* a few years later he discontinued this practice. In 1976 the Texel Museum, now Ecomare, started to release seals originating from the wild, which they had reared, as well as seals born in captivity. A few years later, in 1985, the *Landesjagdverband Schleswig-Holstein* founded the *Seehundstation Friedrichskoog* which also rehabilitates seals. Rehabilitation initiatives were not only developed in countries bordering the Wadden Sea, but also in the United Kingdom. In the 1960s, Mr. K. Jones of St. Agnes was one of the first to rehabilitate seals in the United Kingdom (Jones 1970). At present several organisations are involved in this field, including the RSPCA (Royal Society for the Prevention of Cruelty to Animals). More recently initiatives for the rehabilitation of common seals have been started in Belgium and France.

REHABILITATION IN PRACTICE AND FIGURES

The operational aspects of rehabilitation will here be described with reference to the situation in the Netherlands. The SRRC in Pieterburen rehabilitates seals from the entire Dutch coast, with the exception of the island of Texel and a stretch of the mainland adjacent to Texel. The general procedures used at the SRRC to rehabilitate seals are described. Moreover, the data on the seals rehabilitated over the period 1971-2008 are presented in the following sections.

Facility and quality control

When a seal is reported at an unusual location or in distress, a trained member of the stranding network is dispatched to the seal and will start to observe and evaluate the situation, taking into consideration the local circumstances. In consultation with the SRRC a decision is made, and if necessary, the seal will be transferred to the rehabilitation facility at Pieterburen. The EHBZ team *(Eerste Hulp Bij Zeehonden* or First Aid for Seals) is trained to provide first aid to the seal; this usually starts with rehydration of the animal. The seal must be stabilised before transport. Decisions with respect to the follow-up treatment are taken at the centre. Transportation to the facility at Pieterburen is organised in the most efficient way without delay. On arrival the seals embark on a 3-phase process.

Firstly, the newly admitted seals are kept in quarantine. This status continues until it is proved that the new seal poses no risk to the other seals present at the centre. Feeding protocols, which are standardised according to weight and diagnoses, are followed. Seals receive food supplements (vitamins and minerals) and medication when indicated. The therapeutic use of antibiotics at the SRRC is subject to strict protocols and is monitored by regular testing of bacterial resistance patterns.

After the seals are released from quarantine, they enter the second phase and are transferred to enclosures with pools in which they are grouped together but can still be observed and handled easily.

Finally they are transferred to the larger pools from which they will eventually be released. In this final phase they must be able to eat well by themselves and attain the physical condition that will qualify them for release. All of the seals are returned to their natural habitats. The entire rehabilitation process from the beach to release is standardised, adhering to protocols with an ISO 9001-2000 certificate.

Arctic species, such as hooded seals *(Cystophora cristata)*, harp seals *(Pagophilus*

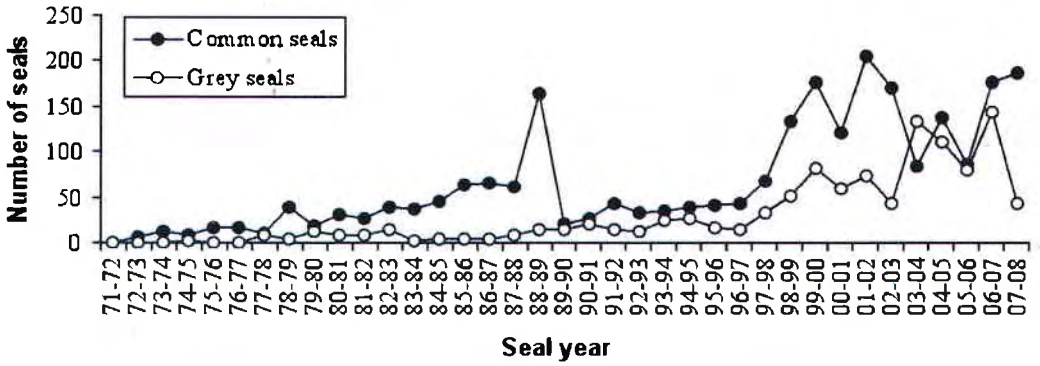

Fig. 1. *Numbers of common seals and grey seals rehabilitated by the SRRC*

groenlandicus) and ringed seals *(Phoca hispida)*, undergo the same process, although they are continuously kept completely separated of other species. This is to ensure that no disease will be transmitted, which is foreign to the species undergoing rehabilitation at the centre.

Seals rehabilitated at the SRRC

Since the start of the operations in 1971, the number of seals admitted to the SRRC facility increased annually (Fig. 1). In total, approximately 2,500 common seals and 1,100 grey seals have been admitted since 1971. Instead of numbers per calendar year, seals were categorised per so-called seal year. For the harbour seal a new seal year starts with the stranding of the first orphan, which is usually in May or June. The new seal year for grey seals starts with the first orphaned or weaned grey seal stranded in autumn, which is often a pup from the English or Scottish coast. Most of the seals admitted are animals younger than one year; older seals are admitted only incidentally. In the analysis, the older animals are included in the seal year of the year of stranding.

The dataset of harbour seals admitted during the period from December 1971 until the first orphan stranding in May 2008, was analysed (N=2,490). Four categories can be distinguished. Orphaned seals comprised the first and largest category (N=1,005, 40.4%). They were categorised as orphans based on their length, weight and the diagnoses recorded in their rehabilitation files. The second category are seals which are weaned but stranded in an emaciated condition with complications (N=304, 12.2%). The third category of seals diagnosed with a parasitic bronchopneumonia proved to be the second largest group (N=947, 38.0%). The remaining seals (category four) stranded due to other causes (N=234, 9.4%). The different categories will be discussed in the following paragraphs.

1. Orphaned seals

Orphaned harbour seal pups are found in the period from May until the beginning of August (Figs 2 and 3). In the Wadden Sea, mothers and their pups always stay in close proximity during the 4-week nursing period (Osinga and 't Hart 2006, De Vries *et al.* 2008). However, disturbances, either natural or anthropogenic, can lead to the separation of mother and pup.

Fig. 2. *Orphaned seal found at the coast*

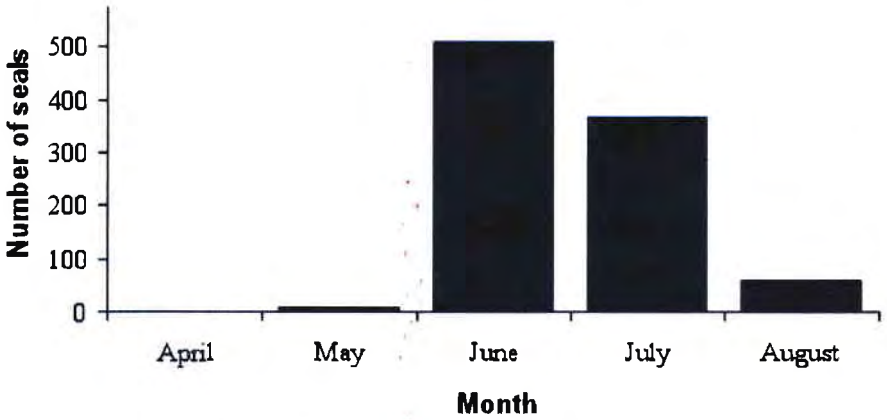

Fig. 3. Admitted orphaned harbour seals per month

These orphans are found in an emaciated and dehydrated condition and would not survive without rehabilitation. Prematurely born seals are sometimes found from April to June and can be identified by their white lanugo. Newborn seals can be recognised by their umbilical cord. Analysis of data from the seals which entered the centre with an umbilical cord, showed a shift in birth season of 0.905 days earlier each year from day 190 in 1974 to day 163 in 2007 (N=322, B= -0.905 ± 0.0598 SE, $p<0.001$) (SRRC, unpublished data).

The number of admitted orphans increased over the years (Fig. 4). However, when compared to the number of common seals in the Wadden Sea, there is no relative increase or decrease in the number of admitted orphans. The number of orphaned seals tends to fluctuate with population size. Orphaned seals are reared and/or treated until they reach a sufficient weight, which is around 35 kg, and are able to forage independently. The rehabilitation process usually takes three and a half months (108 days).

2. Weaned seals with complications

Weaned seals which have got into difficulty start to strand on the coast approximately four weeks after the onset of the birth season. They are usually diagnosed with an emaciated condition as well as wounds and infections (*e.g.* to the mouth and eyes). These problems arise amongst seals, which have completed the 4-week nursing period but may have failed to utilise all necessary periods of suckling, resulting in body weight that is too low at weaning. This occurs, for instance, when seals are frequently disturbed during nursing on the sandbanks at low tide (Drescher 1979). After treatment, these seals can be released when they have gained sufficient weight, that is, on average after almost 4 months (118 days).

3. Seals diagnosed with parasitic bronchopneumonia

Lungworms are the nematodes that cause the majority of problems (Fig. 5). They are *Otostrongylus circumlitus* (Railliet 1899) and/or *Parafilaroides gymnurus* (Railliet 1899). Both

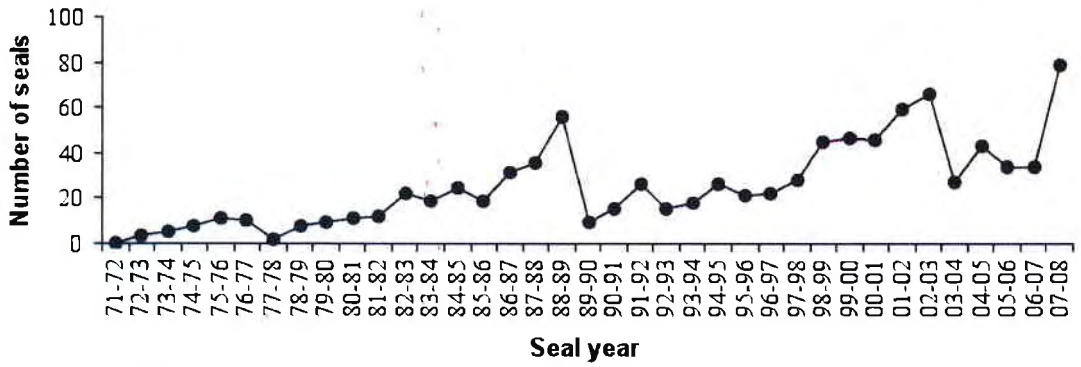

Fig. 4. Admitted orphaned common seals per seal year

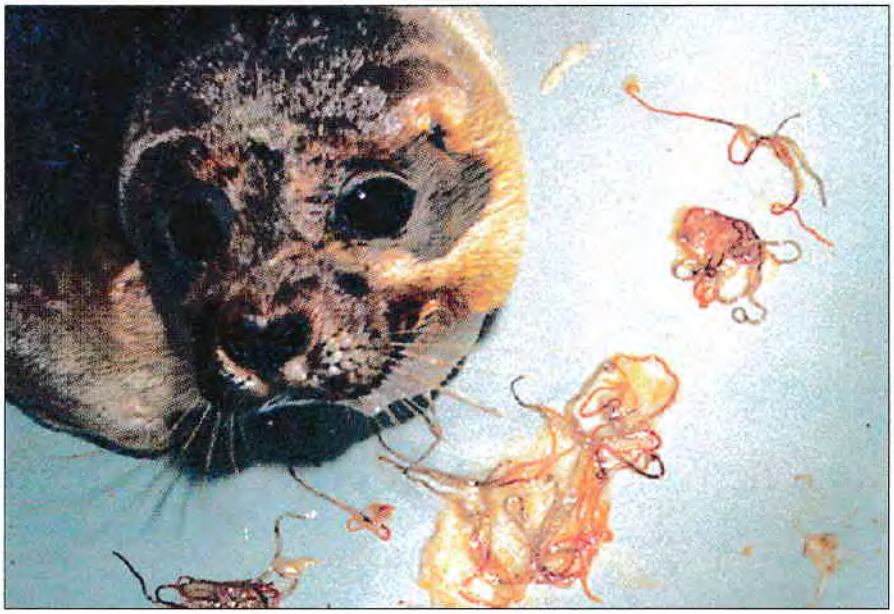

Fig. 5. *Seal with a parasitic infection*

are described in common seals from the Wadden Sea by several authors, *e.g.* Mohr (1952), Van den Broek and Wensvoort (1959), Van den Broek (1963), Van der Kamp (1982), Van Haaften (1982), Borgsteede *et al.* (1991) and Lehnert *et al.* (2007). Parasitic lungworm infections usually occur in seals under a year old. Older animals are rarely found with a significant parasitic infection of the lungs. Seals diagnosed with this infection strand throughout the whole year, but numbers start to increase in November and decrease after January (Fig. 6).

Since seal year 1997-1998 there has been an increase in the number of stranded seals with a parasitic bronchopneumonia (Fig. 7). Moreover, compared to the number of common seals in the Dutch Wadden Sea, there has been a relative increase of seals with a parasitic bronchopneumonia. During necropsy of seals that washed up dead along the coast, parasitic bronchopneumonia was found to be a common cause of death. This indicates that the total morbidity and mortality caused by parasitic bronchopneumonia is higher than the admission figures show. Several factors are thought to potentially influence the scale at which harbour seals are infested with parasites:

1. Pollution - Contaminants can impair physiological functions in the organism, including

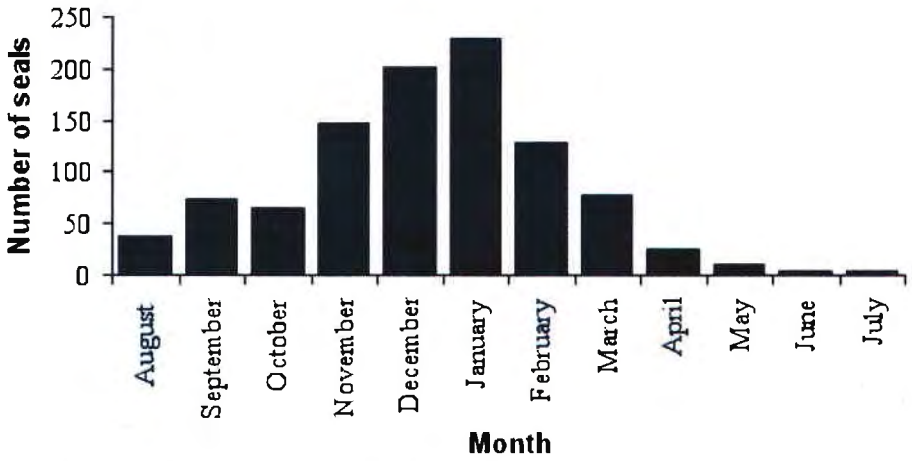

Fig. 6. *Admitted seals diagnosed with a parasitic bronchopneumonia per month*

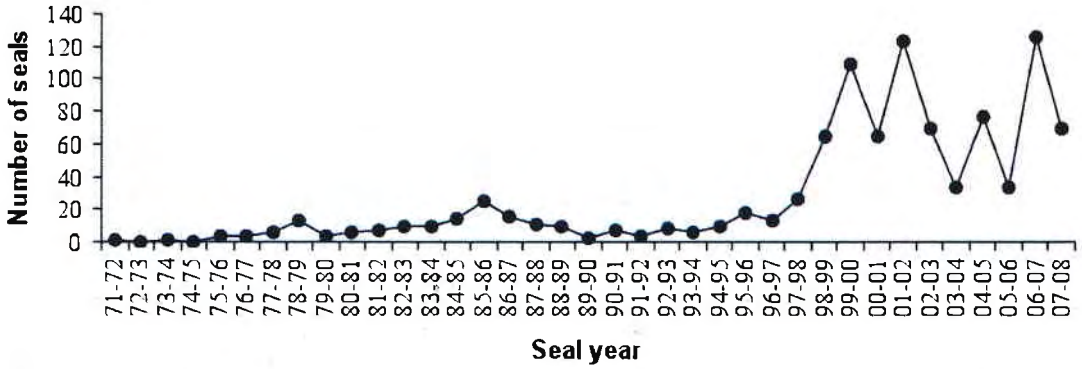

Fig. 7. Admitted harbour seals diagnosed with a parasitic bronchopneumonia per seal year

the immune system. Evidence from a long-term feeding study demonstrates that ambient levels of environmental contaminants are immune-toxic to captive common seals (Ross 1995, De Swart 1995). Several studies have indicated that there is an association between environmental pollution and infectious disease mortality in marine mammals found in the North Sea (Jepson *et al.* 1999, Siebert *et al.* 1999, Jepson *et al.* 2005).

2. Population size - The harbour and grey seal populations in the Wadden Sea have increased; it is possible that the parasitical burden could have increased alongside them too.
3. Changes in the stocks of available prey species can affect the level at which seals are infested with parasites. Food shortages may weaken the condition of seals, making them more vulnerable to parasitic infections. Furthermore, fluctuations in available fish stocks may lead to a shift to foraging on other species, which could be more infested with stages of the parasite's lifecycle.
4. Competition with grey seals for food sources is regarded as a factor affecting harbour seals (Thompsen *et al.* 2001, Bowen *et al.* 2003). Grey seals always visited the Wadden Sea on occasions, but they only began to settle again from the 1980s onward and in 1985 a grey seal pup, which was born in the Dutch Wadden Sea was observed ('t Hart *et al.* 1988). Since then, the colony has been growing continuously. The numbers of grey seal pups admitted to the SRRC, which still had white lanugo, has grown by 11.1% (±1.01SE, $p<0.001$) per year (Fig. 8).

The increase in harbour seals suffering from parasitic bronchopneumonia coincides with the moment the numbers of admitted grey seals started to increase (1997-1998) (Fig. 1).

At this stage, it is not possible to identify the cause of the increased occurrence of parasitic bronchopneumonia. Abt (2002) identified an increasing percentage of harbour seals found

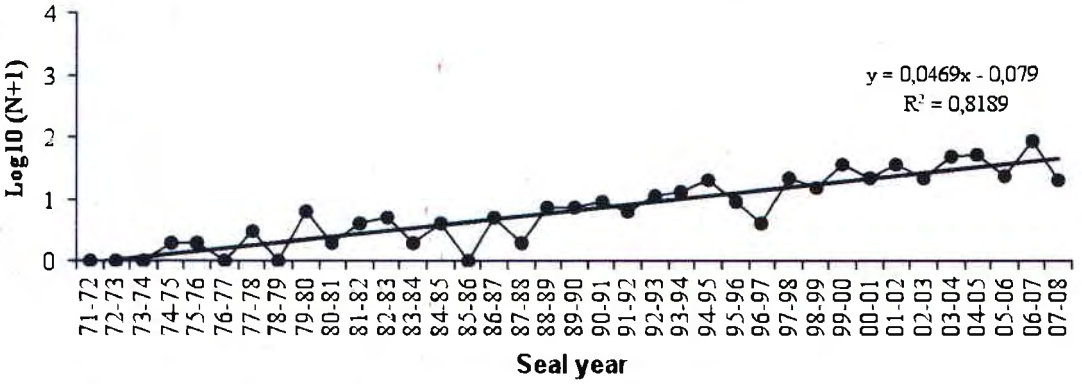

Fig. 8. Logarithmic function of admitted orphaned grey seals per seal year

both dead and alive on the coast of Schleswig-Holstein, Germany, from 1998 onwards. This corresponds with an increase of harbour seals diagnosed with parasitic bronchopneumonia being admitted to the SRRC. Place figure 8 here Seals suffering from parasitic bronchopneumonia require medical treatment. These seals often strand in a severely emaciated condition and have wounds and other infections, which also need to be treated. Seals, which suffered from a bronchopneumonia, are usually released after just over 4 months (128 days).

4. Seals with other complications

The majority of the admitted seals were orphans, weaned pups with complications or animals with parasitic bronchopneumonia. The remaining seals suffer from a whole range of different conditions. In general, a wide range of parasitic, bacterial and viral infections can occur. Seals may also be admitted as a result of injuries or lesions. Entanglement in ghost nets is a frequent cause of injury and occurs multiple times each year. After the net has been removed, the seal must usually be admitted for recovery. Seals are occasionally diagnosed with ingested fishhooks (Osinga and 't Hart 2006). In addition, traumatic lesions or fractures can be inflicted by boat propellers or as a result of collisions with dams or boulders. Skin lesions in, for instance, the abdominal region may be caused by infections. The attachment of transmitters and other foreign objects were also found to cause serious skin lesions.

Survival rate of SRRC rehabilitation

The survival rate of seals rehabilitated by the SRRC improved with growing experience in seal care. The survival rate of both species has been calculated since 1990, excluding the PDV epizootic year 2002 for common seals. The survival rate of the SRRC is 92.0% for common seals and 94.8% for grey seals. The survival rates were lower during the epizootic years 1988 and 2002, even though the survival rate was significantly higher in 2002 (60.3% for common seals) as compared to 1988 (10.5% for common seals).

Adaptation and survival after release

Reijnders *et al.* (1990) concluded that 5 seals, which were tagged and monitored after release, adapted quickly and well to the area in which they were released. With respect to rehabilitated seals Reijnders *et al.* (1996) concluded: "Tag-recoveries and radio-telemetry studies demonstrate that survival of the released animals was similar to that of free-ranging seals of the same species".

Every now and then rehabilitated seals are reported back after release. All seals are released with a tag in their hind flippers and since 1995 a microchip transponder has been implanted in each animal. In total, 155 SRRC tags or microchips of harbour seals were found back and reported, which is 7.9% of all released seals (January 1972 until May 2008, N=1973). The tags or microchips of 148 seals could be linked to individual seals rehabilitated at the SRRC. The other 7 SRRC tags were reported without a notification of the tag number and were therefore excluded from the analysis. Of the 148 seals, 47 were found alive while 101 seals were dead. During the PDV epizootic years 1988 and 2002, a relatively high number of seals was reported back (N=52). Of the 148 seals, 23 seals were reported back in the same year in which the animal was released, 72 seals the next year, 18 seals after 2 years, 12 after 3 years, 14 after 4 years, 5 after 5 years, 2 after 6 years, 1 after 8 years and 1 after 10 years. These 148 seals include animals which were reported from outside the Netherlands, namely in: Germany (N=20), Denmark (N=4), United Kingdom (N=4), France (N=4) and Belgium (N=1).

The original causes of stranding were analysed to see if seals that stranded for particular reasons were more likely to strand again after their release. Of the 148 seals, 65 (43.9%) originally stranded as orphaned pups, 12 seals (8.1%) were weaned seals with complications, 57 seals (38.5%) had been diagnosed with parasitic bronchopneumonia and 14 seals (9.5%) had originally stranded due to another causes. These percentages are similar to the total percentages of these categories, which are rehabilitated by the SRRC (see section 'Seals rehabilitated at the SRRC'). It can, therefore, be concluded that there are no differences between the categories of seals with respect to the likelihood of being reported back after rehabilitation. In January 2006 a harbour seal,

which was rehabilitated by the SRRC in 2000, washed ashore dead on the German coast. Necropsy revealed that the animal had died of a torsion of the intestines and carried a foetus. On numerous occasions individual sightings were reported to the SRRC. Unfortunately, tags cannot be read well from a distance. Sometimes seals have such clear characteristics that they can be identified. For example, a melanistic grey seal is observed regularly, as are seals that had distinctive scars of injuries around their neck due to previous net entanglements. Blind seals can be released without difficulties and have regularly been sighted again in a good general health condition.

Arctic seals are released into the North Sea, far north of the Dutch islands in the waters of the Dutch continental shelf. On 13 March 1997, a hooded seal was released; a few months later on 26 September 1997 it was shot in its home range by a Greenlandic hunter more than 4,900 km away from the release site (Derix and Van Bree 1997). The hunter reported that the seal was in a good condition and had displayed normal behaviour.

HANDLING INFECTIOUS DISEASES DURING REHABILITATION

Infectious diseases in the wild and their management during rehabilitation are an important issue with increased awareness since the PDV epizootic decimated the common seal population of north-western Europe. Quality control on the management of these diseases at the SRRC is assured by standardised protocols. For the optimal handling of seals and their diseases, centralised operations with quality standards are essential. The professional care of seals can reduce mortality during rehabilitation to a minimum, resulting in the successful release of the treated animals.

Zoonotic diseases

Strict protocols have to be in place to prevent contamination of infectious diseases from human to seal and vice versa. It has been shown that influenza is capable of crossing the species barrier from human to seal (Osterhaus *et al.* 2000); personnel treating the seals at the SRRC are therefore vaccinated against influenza. Pox viruses observed amongst seals could also infect humans; the usual precautions in handling infected seals can prevent infection. Seal pox is, however, to humans just a nuisance (Osterhaus 1990, Osterhaus 1994). Seal finger (a bacterial infection which might develop after a seal bite in the hand) has been an occupational hazard as long as people have worked with marine mammals; it also used to be prevalent among Dutch whalers. For staff handling seals it is important to take the usual precautions with seals and fish and immediately treat injuries (Breuker *et al.* 1994). Brucellosis is another bacterial infection that occurs in marine mammals (Jepson *et al.* 1997, Foster *et al.* 2002). It might potentially cause abortion and is one of the reasons why pregnant staff members are not permitted to work with the animals.

Phocine distemper virus (PDV)

Two major outbreaks of PDV in 1988 and 2002 had devastating effects on the seal population. Soon after the virus was identified a vaccine became available (Visser 1993). In the event of a PDV outbreak, vaccination in controlled quarantine surroundings becomes necessary (Philippa 2007). Close monitoring of admitted seals provides valuable information on diseases in the population. Combining rehabilitation with scientific research enables a check of results obtained through different approaches. During both epizootics, close cooperation between rehabilitation and scientific research led to the identification of PDV as the cause of the mass mortalities (Osterhaus and Vedder 1988, Jensen *et al.* 2002). Viral infections require rehabilitators to remain vigilant. Apart from PDV, herpes is another virus that has implications for the rehabilitation process (Harder 1997, Martina 2003).

Anthropogenic influences

Anthropogenic influences on the occurrence of infectious diseases should also be considered. Diseases in terrestrial carnivores can pose a significant threat to seals. Also fresh water runoffs into coastal waters pose a serious risk for marine mammals. For instance, toxoplasmosis, a parasitic infection in the southern

marine otters of California, has been traced back to the runoff from freshwater rivers (Miller *et al.* 2002). Classic canine distemper virus (CDV), which is closely related to PDV, lead to mass mortality among the Caspian seal population in 2000; although its origins have not yet been identified, domestic dogs should not be excluded as a potential source (Kennedy *et al.* 2000, Kuiken *et al.* 2006). The origins of the 1988 PDV epizootic among harbour seals is possibly linked to the invasion of harp seals *(Pagophilus groenlandicus)*, which took place on a large scale in 1987 and 1988 (Harder 1997). The invasion of harp seals was lead by their search for food (Haug *et al.* 1991, Haug and Nilssen 1995, Bogstad *et al.* 2000). The harp seals also reached the Wadden Sea area (Van Bree 1994, Osinga and 't Hart 2007). If the shortage of food was caused by anthropogenic factors, then the introduction of PDV in the common seals can also be considered to have an anthropogenic origin.

REHABILITATION AND POPULATIONS

Rehabilitation centres can serve two principal goals. Firstly, individual animals can be helped from an animal welfare perspective. Secondly, rehabilitation can support the population. The relevance of this second goal can be illustrated by the development of the number of seals in Dutch waters.

Effects on the harbour seal population

When rehabilitation began in the Netherlands in 1960, many years of intensive hunting had caused the seal population in the Wadden Sea to dwindle. The seal hunt in the Netherlands ended in 1963 and the number of seals started to rise again. By the late 1960s and early 1970s the population had declined once again. Koeman and Van Haaften identified the role of pollution (Van Haaften 1974). Later, the low birth rate of seals was linked to pollution (Van Haaften 1978, Reijnders 1980). The seal numbers were lowest in the Netherlands and the population became dependent on rehabilitation and immigration for its survival in Dutch waters. Van Bemmel already realised the importance of migration in 1956 when he concluded that the Dutch seals could only sustain a high hunting pressure through the migration of seals from Germany. During the 1990s suppression of the immune system of seals in the Wadden Sea was also linked to pollution (Ross 1995, De Swart 1995). Rehabilitation proved to be a support to the seal population in the Wadden Sea.

At present, harbour seal populations in, for example, Canada and Scotland are reported to be declining. While this is not the case for the Wadden Sea, careful consideration of the situation in areas of decline is warranted.

Bowen *et al.* (2003) observed a rapid decline of harbour seals on Sable Island, Canada, throughout the 1990s. Although minimum estimates of shark-inflicted mortality can account for much of the decline, evidence suggests that food shortages arising from competition with grey seals may also have played a role in causing the decline of the population.

Significant reductions in the local abundance of harbour seals were also observed in 1998 for an area in Orkney, which was considered to be a stronghold for this species in the 1980s (Thompsen *et al.* 2001). Survey results from 2001 to 2006 showed a general decline in most of the common seal colonies around Great-Britain with the exception of the Inner Hebrides. During this period the population in Orkney and Shetland declined by 40%, indicating that common seals in these areas experienced substantially increased mortality or very low recruitment over this period (Duck *et al.* 2008).

A reduction in recruitment seems to play a role in the areas with a declining abundance (Pitcher 1990, Thompsen *et al.* 2001, Bowen *et al.* 2003, Duck *et al.* 2008). The seals rehabilitated in the Netherlands and Germany are mainly seals of the first year age class. The precise contribution to the population by rehabilitating seals, which would otherwise die, is difficult to establish as there is no consensus with respect to the actual rate of first year mortality. Ries (1999) established a rate of 42.7%, while Abt (2002) established a rate

of 35% and Borchardt (1995) a rate of 25%. In either case the contribution of rehabilitation to the reduction of first year mortality will be significant and have a positive effect on recruitment levels and population growth.

Effects on threatened species

Rehabilitation requires experience, which can only be gained by treating many seals. This is how intimate knowledge of species and problems is built up. This experience is difficult to obtain locally when a species is threatened with extinction like the monk seal (*Monachus monachus*). Protocols must be applied to the needs of the specific species and the individual specimen undergoing rehabilitation; flexible application can only be performed effectively if one is thoroughly familiar with the rehabilitation process. Since 1987, 15 monk seals have been released with the help of the SRRC: Greece (n=7), Mauritania (n=7) and Turkey (n=1). Besides the direct support for the population in numbers, rehabilitation acts as a catalyst for the protection of the population in general. In Turkey, the recently released monk seal (2007) became an excellent ambassador for the species and raised support for its protection in general, which would otherwise have been very difficult (Dijkema 2008).

Genetics

Analysis of microsatellite DNA polymorphisms have demonstrated that there is a complex pattern of genetic differentiation present within European common seal populations, with the Wadden Sea as one of the population units (Goodman 1998, Andersen and Olsen 2010). Different impacts on this population, such as hunting and epizootics, lead several times to a drastic reduction in numbers of seals. It is likely that such declines have affected the level of genetic diversity. Kappe (1998) found a low level of overall genetic diversity in the Wadden Sea common seal population. The rehabilitation of seals results in a reduced first year mortality and contributes to the population growth. It thus may well limit a further loss of genetic diversity of Wadden Sea seals.

REHABILITATION AND SOCIETY

Animal welfare and socio-cultural tradition

The first thing, that usually comes to mind when people encounter orphaned or ill seals, is that they want to help them. It is with this basic animal welfare principle in mind that many people set out to rehabilitate seals and other wildlife species. Rehabilitation is indicative of the way in which society treats animals in a broader sense. Since 1981, it has been official government policy in the Netherlands to take a non-anthropocentric approach towards animal protection. In Germany that approach was introduced more than 50 years earlier ('t Hart 2007). It means that individual animals are protected for their sake and not because people are offended by cruelty to animals. The philosophy of rehabilitation in the Netherlands recognises the welfare of the individual seal.

There are many anthropogenic influences on seals, a few of which have been described, but many more exist. These influences imply that no pristine natural situation exists in the Wadden Sea. It is generally recognised that numerous human activities take place and affect seals. Rehabilitation is a way to take responsibility for this. In the Netherlands, there is at present a good cooperation between fisheries and rehabilitation. The historically negative attitude of fishermen towards seals has changed and fishermen now tend to help seals in distress. Joint research between the Dutch Fisheries Union and the SRRC has developed and aims to reduce the interactions between marine mammals and fisheries. Rehabilitation in the Netherlands is supported by the general public and abandoning rehabilitation would go against the socio-cultural tradition; it would even alienate the general public from wildlife, which is not recommended. The situation differs from country to country and even within national boundaries. Scientists and rehabilitators working with seals should recognise the national traditions and work in harmony within that tradition and the organisations rooted in it. It should be noted that without central rehabilitation facilities available, private initiatives will take place any-

way, but in such a situation quality assurances will not exist.

Economical aspects of rehabilitation

Responsible rehabilitation requires substantial financial input. In the Netherlands, the rehabilitation by the SRRC is paid for by the general public through gifts and regular donations; no governmental funding exists. In Germany, there is the strong backing of the hunting association as well as support from the general public. In every country the situation is different and the socio-cultural tradition is an important factor, which determines whether rehabilitation centres can act as independent charities. Funds which are available for rehabilitation would generally not be available for research since the general public specifically supports the help for individual seals. Rehabilitation has a positive effect on the total research effort, either through research executed at rehabilitation centres or via increased awareness of the importance of seal research. At the same time, one has to realise that marine mammals do represent a commercial value and zoological gardens and marine parks make it their business to earn money with these species. The commercial interest of museums and aquaria along the coast is not new. However, this interest has recently revived and the involvement of commercial organisations in the rehabilitation effort has increased.

Education

Rehabilitation is an important instrument to provide information about the species to the general public. In visitor centres people can see the seals (Fig. 9) and learn about the animals and their environment. In addition to the possibility of seeing rehabilitation in practice, people should be able to observe seals in the wild. Many different possibilities exist for doing so (see for example - DiGiovanni and Sabrosky 2010). The island of Terschelling is one place in the Netherlands where seal watching trips are undertaken on a regular basis and several families derive their main source of income from it. The inhabitants of the Wadden Sea Islands thus have an additional way of generating income, which also contributes to the positive attitude towards seals.

Fig. 9. *Harbour seals in the last stage before release*

CONCLUSIONS

Throughout the past few decades, seal rehabilitation has become an activity which has established a place in many countries. Although the main motive for rehabilitation is often to help individual seals, it also provides support for the population by reducing first year mortality. The rehabilitation process requires centralised operations with certified quality standards from stranding to release. They are necessary for the optimal handling of seals and their diseases. Professional care of seals can reduce mortality amongst seals undergoing rehabilitation to a minimum, resulting in very high survival rates. At all times rehabilitators have not only the responsibility for the individual animal but also the population as a whole when they release seals.

Rehabilitation provides an instrument to monitor the health of the seal population and its ecosystem. The seal is an indicator species for the Wadden Sea and without rehabilitation no direct information on the health of this indicator would be available. With regard to changes in the trends of stranding, such as the increase of parasitic bronchopneumonia or the appearance of new diseases, information on the clinical symptoms is essential to the identification of their causes. These clinical data can only be gathered through rehabilitation. Collaboration between scientists from all of the various disciplines becomes essential for effectively addressing the issues facing the seals.

Rehabilitation can provide an important tool for showing the general public the state of the environment. In the Netherlands, there is broad social support for the rehabilitation of seals. The experience gained in seal care should be applied in countries where urgent help for threatened seal species is required. Here individual seals can act as ambassadors to generate support for the protection of the species in general.

Given that the anthropogenic impact on the seal and its environment is extensive in the Wadden Sea, rehabilitation centres can compensate for the consequences of this impact on the individual seal and the entire population alike.

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