Introduction: the harbour seal (*Phoca vitulina*) - a global perspective

Harbour seal abundance has fluctuated widely in the Northeast Atlantic in recent years, among others due to local outbreaks of viral distemper. In some areas, harbour seals are harvested and/or taken incidentally by fisheries and aquaculture operations (*e.g.* Greenland, Norway and Iceland among NAMMCO areas). They also have significant direct and indirect interactions with fisheries in many places. Although the NAMMCO Scientific Committee has provided information on the role of harbour seals as a source of nematodal infestations in fish (NAMMCO 1998, Desportes and MacClelland 2001) and the HELCOM/ICES/EU Seal Expert Workshop reviewed the status of seal populations, including harbour seals, in the Baltic Sea (Anonym. 2005), there has never been a full assessment of the status of harbour seals in the North Atlantic. Therefore the Council of NAMMCO felt that an assessment of the species was warranted (NAMMCO 2005). As a result the Scientific Committee convened a Working Group to review the status of harbour seals throughout the North Atlantic.

The general terms of reference for this working group was to a) Review and assess the status of harbour seals throughout the North Atlantic; b) Review and evaluate the applied survey methods; c) Assess stock delineation using available data on genetics, spatial and temporal distribution and other sources; d) Review available information about harbour seal ecology; e) Identify interactions with fisheries and aquaculture. The working group also developed a set of research recommendations on *inter alia:* genetic sampling and analyses, improvement of survey methods, population and ecology studies. The report (NAMMCO 2007) is available from the NAMMCO Secretariat.

The present volume is based on updated documents originally submitted to this NAMMCO working group meeting, held on 3-6 October 2006 in Copenhagen, Denmark, and on documents subsequently solicited by the editors. These documents made it possible among other things to provide an updated population estimate of the harbour seal in the entire North Atlantic area, and to underline that harbour seal – human interactions are broader than just conflicts with fisheries and aquaculture. The editors have therefore solicited manuscripts to provide a more global perspective on harbour seal and human interactions. In some areas, harbour seals are the basis for ecotourism (see Di Giovanni and Sabrosky 2010), a growing industry that supplements incomes in coastal communities. A particular interaction between harbour seals and humans is the rehabilitation of stranded or orphaned seals and subsequent release to the environment. This activity is widespread in Europe and North America, and includes release of significant numbers of rehabilitated seals each year. Rehabilitation and release is widely supported in areas were populations are at the verge of extirpation, but is a highly controversial activity in some other areas, *e.g.* where populations are robust and resilient (see discussion in Reijnders *et al.* 2010). The editors believe this discussion will be of interest to the scientific community, managers and the wider public. In this view they solicited a manuscript on seal rehabilitation (see Osinga and 't Hart 2010). Furthermore, as rapid declines of harbour seal abundance with unknown causal relations are observed in some areas (see Thompson *et al.* 2010), but the role of anthropogenic factors in these rapid population changes is not known, some hypotheses are discussed towards the end of this chapter.

In this introduction to the NAMMCO Scientific Publications, Volume 8: Harbour Seals in the North Atlantic and the Baltic, the editors attempt to discuss North Atlantic harbour seals in a global perspective, including taxonomy of the species and distribution and abundance of the respective subspecies throughout the species range. We hope this will be useful reading for the scientific community, managers, and other stakeholders with interest in harbour seals.

TAXONOMY AND DISTRIBUTION

Harbour seals are coastal, non-migratory and distributed from temperate to sub-Arctic waters along the eastern and western coasts of the North Atlantic and the North Pacific Oceans. The ocean basins act as barriers for the coastal harbour seals and the species has evolved into 4 recognised marine subspecies:

1. The eastern North Atlantic harbour seal *P. v. vitulina* (Linnaeus 1758) is distributed throughout Svalbard, Norway, Russian Federation, Iceland, Denmark, Sweden, Germany, Poland, United Kingdom, Ireland, Netherlands, Belgium, France, and there are vagrants in Spain and Portugal.
2. The western North Atlantic harbour seal *P. v. concolor* (DeKay 1842) is distributed from Labrador in Canada to Virginia in USA and in Greenland.
3. The eastern North Pacific harbour seal *P. v. richardii* (Gray 1864) is distributed through Alaska, some Russian islands, Canada, USA and there are some vagrants in northwest Mexico.
4. The western North Pacific harbour seal *P. v. stejnegeri* (Allen 1902) is distributed from eastern Siberia in the Russian Federation to northern Japan. This subspecies is sometimes treated as a separate species, *Phoca kurilensis* or *Phoca insularis.*

The exact borders between the eastern and western subspecies in both the Pacific and in the Atlantic are not well described.

In addition to the 4 marine subspecies there are some landlocked harbour seals in lakes and connecting rivers that flow into south eastern Hudson Bay in Canada. These seals are recognized as a fifth sub-species: the Ungava seal *P.v. mellonae* (Doutt 1942). Their distribution is restricted to Ungava Peninsula, Northern Quebec, Canada.

The spotted seal *Phoca largha* is closest relative to the harbour seal. A study based on mtDNA showed complete genetic isolation between the two species (O'Corry-Crowe and Westlake 1997), although viable hybrids have been produced in captivity (Duffield 1990 cited in Rice 1998). The spotted seals are distributed along the pack ice in the Bering and Chuckchi Seas and breed on ice floes in the spring.

CHARACTERISTICS

The harbour seal is a small Phocid seal averaging about 150 cm body length and 70-100 kg in weight. The females are slightly smaller than males. The biggest seals are described from the western Pacific (*P. v. stejnegeri*) and the smallest from the Gulf of Alaska (*P. v. richardii*) (Markussen *et al.* 1989, Burns 2009). The spotted seals are of the same body size as harbour seals (Burns 2009).

Both the harbour and spotted seals are darker on the dorsal side and lighter on the ventral side. The dorsal colour pattern of harbour seals varies from dark with light grey spots (dark phase) to light grey with darker spots (light phase). The spotted seal pelage is similar to the light phase in harbour seals. Spotted seal pups are born with a whitish woolly lanugo which they shed after about 4 weeks. Harbour seal pups shed their lanugo before birth and are born with the same colour pattern as the older seals. However, a small percentage of harbour seal pups are born with white lanugo, which is shed shortly after birth. On the Norwegian coast, about 4% of harbour seal pups are born with white lanugo (Bjørge unpublished data). These can be prematurely born pups.

ABUNDANCE

The variation in abundance among subspecies is large. The *P. v. stejnegeri* in the western Pacific possibly does not exceed 10,000 seals (Table 1). In contrast, the *P. v. richardii* in the eastern Pacific numbers about 376,000 seals. This difference may possibly partly reflect different carrying capacity levels for the harbour seals in the western and eastern Pacific coastal ecosystems. However, it certainly also reflects differences in the level of protective measures taken in these areas. In the western Atlantic the *P. v. concolor* exceeds 38,000 seals, but recent survey coverage may be missing in parts of the range. In the eastern Atlantic the *P. v. vitulina* exceeds 83,000, a minimum figure based mostly on actual counts of hauled out seals during moult. Applying a correction factor of 1.43-1.82 used by the ICES working group on Marine Mammal Ecology (ICES 2007), the

Table 1. Summary of recent information on abundance of harbour seals globally. Observed numbers are actual counts of hauled out moulting seals and represent a minimum estimate of abundance. The estimated number for Norway is from Bjørge *et al.* 2007. For other areas where observed numbers are available from the cited literature, estimated abundance is derived from conversions factors of 1.43 – 1.82 (ICES 2007).

Subspecies	Area	Observed numbers	Estimated abundance	Year	Reference
P. v. stejnegeri	Hokkaido		350	1980s	Wada *et al.* 1991
P. v. stejnegeri	Kuril Islands		1,900	Early 1990s	In Reijnders *et al.* 1993
P. v. stejnegeri	Commander Isl.		1,500	Early 1990s	In Reijnders *et al.* 1993
P. v. stejnegeri	Kamchatka		200	Early 1990s	In Reijnders *et al.* 1993
P. v. stejnegeri	Aleutian Isl.		3,400	1994	Withrow and Loughlin 1995
P. v. richardii	SE Alaska		112,391	2001-2005	Angliss and Outlaw 2006
P. v. richardii	Gulf of Alaska		45,975	1996-1999	Angliss and Outlaw 2007a
P. v. richardii	Bering Sea		21,651	2000	Angliss and Outlaw 2007b
P. v. richardii	British Col.		108,000	1996-1998	Olesiuk 1999
P. v. richardii	Wash. inshore		15,440	1993	Huber *et al.* 2001
P. v. richardii	Wash. & Oregon		28,094	1993	Huber *et al.* 2001
P. v. richardii	Oregon		10,087	2002	Brown *et al.* 2005
P. v. richardii	California		34,283	2005	Burns 2009
P. v. mellonae	Canada		120-600	Early 1990s	In Reijnders *et al.* 1993
P. v. concolor	Canada		10,000 – 14,000		Hammill *et al.* this volume
P. v. concolor	USA	38,000	99,340	2001	Waring *et al.* this volume
P. v. concolor	Greenland		< 1,000	2007	Rosing-Asvid, this volume
P. v. vitulina	Iceland		12,000	2006	Hauksson and Einarsson, this vol.
P. v. vitulina	Svalbard		1,000	2008	Lydersen and Kovacs, this vol.
P. v. vitulina	Norway	6,705	10,000		Nilssen *et al.* this volume
P. v. vitulina	Sweden, Baltic	588	850-1050	2008	Härkönen and Isakson, this vol.
P. v. vitulina	S. Scandinavia	17,826	25,500-32,400	2007-2008	Olsen *et al.* this volume
P. v. vitulina	Wadden Sea	17,500	25,000-31,800	2007-2008	Reijnders *et al.* this vol.
P. v. vitulina	UK and N. Ireland	24,250	34,600-44,100	2003-2008	Thompson *et al.* this volume
P. v. vitulina	Ireland	2,905	4,100-5,300	2003	Cronin *et al.* this volume
P. v. vitulina	France	295	400-550	2008	Hassani *et al.* this volume
World population of harbour seals			~610,000-640,000	Recent-2009	Bjørge *et al.* this volume

estimated total population of *P. v. vitulina* ranges from 113,450 to 134,200. Thus the figures given in Table 1 account for an estimated world population of approximately 610,000 – 640,000 harbour seals.

Large regional changes in abundance are observed in recent decennia. The causal relations behind some of these changes are well understood, others are yet to be described. In 1988, the PDV epizootic killed about 50% of the harbour seals in Skagerrak-Kattegat, the Wadden Sea and the Wash in the United Kingdom (Dietz *et al.* 1989a, b, Härkönen *et al.* 2006) with the subsequent very rapid recovery of about 13% increase per year, and even higher growth rates were observed regionally (Olsen *et al.* 2010, Reijnders *et al.* 1997). These high observed growth rates were in part caused by high survival of mature females relative to other age and gender groups during the 1988 epizootic.

A new PDV epizootic struck the same populations in 2002 with mortality similar to, or in some areas less than, in 1988. A number of animals gaining immunity during the first epizootic may still be part of the population in 2002, and thus contributed to less mortality during the second epizootic. In the Wash, the 1988 epizootic resulted in 52% drop in the population followed by a rapid recovery, until the 2002 epizootic resulted in 22% drop in the population. In contrast to the recovery after the first epizootic, and different to most other areas affected by the 2002 epizootic, the population in the Wash has continued to decline (Thompson *et al.* 2010). A decline in harbour seal abundance since the late 1990`s is also observed in Orkney, Shetland, and, but to a lesser extent, in the Outer Hebrides and east Scotland. The abundance in West Highlands has continued to increase (Thompson *et al.* 2010).

In the Orkneys the observed abundance declined from about 8,500 in 1997 to less than 3,000 in 2008 (SCOS 2009), resulting in a 65% reduction over a 10-year period. The dynamics behind this observed decline are not known, but the mechanism may involve, *inter alia*, a shift in spatial distribution and/or timing of the moult, mass mortality and/or reduced fertility caused by an as yet unidentified pathogen, illegal and unreported anthropogenic removals, predation *e.g.* by killer whales *(Orcinus orca),* and severe competition with the increasing grey seal *(Halichoerus grypus)* population. The rapid changes in observed abundance involve thousands of harbour seals, and it is likely that a shift in geographic distribution or in the timing of their annual cycle would have been detected. Similarly, mass mortality caused by a pathogen would likely have been detected by diseased or dead animals on beaches. It is hard to assume that illegal removal of thousands of harbour seals can occur without being detected and reported. Predation by killer whales may have contributed to the decline, but killer whales are very visible cetaceans and massive attacks on harbour seals would likely have been observed.

The competition hypothesis is more difficult to counter-argue. The United Kingdom grey seal pup production increased from about 7,000 in the 1960s to more than 41,000 in 2008, representing a total number of about 183,000 grey seals (95% CI 85,600-359,300) (SCOS 2009). The increase in pup production has levelled off since 2000, indicating that the grey seal population is approaching the current carrying capacity level, K. The level of K may vary over time and it is determined by a number of factors, including food availability. Sand eel, *Ammodytes* spp., is a primary prey for North Sea grey seals and also an important prey for North Sea harbour seals (SCOS 2009). The North Sea sand eel spawning biomass stock dropped from a peak of 1.7 million tonnes in 1998 to a level of about 200,000 in the period 2004-2006 (Johannessen 2009). Did the depletion of the sand eel abundance enhance the competition between grey and harbour seals, a competition the smaller harbour seals are losing? Ecological mechanisms involving trophic interactions are often very complex. Even if the competition hypotheses may be correct, there may be several reasons for the decline in harbour seal abundance.

A dramatic decline in abundance by 85% was also observed in Gulf of Alaska harbour

seals from 1976 to 1988. This was in contrast to harbour seal abundance further south, from southeast Alaska to California, where abundance increased over several years until it recently levelled off. Major shifts in climate are believed to have caused or contributed to these opposite trends in abundance (Burns 2009) but involved ecological mechanisms not yet fully described.

Harbour seals show strong site fidelity. They haul out, give birth and nurse their young on beaches, sandbanks and rocks in the intertidal zone along the coasts of Europe and North America. Their coastal habits and site fidelity make the harbour seals vulnerable to disturbance and habitat degradation. They forage in close proximity to the coast. Their near-shore feeding grounds expose harbour seals to contaminants originating from land in run-off from agriculture, industrial and urban areas. They are often seen as competitors to coastal fisheries and regarded as vermin when entering salmon rivers. Therefore, legal and illegal anthropogenic removals do occur. Rapid declines in abundance for unknown reasons demonstrate the vulnerability of the species. However, the rapid recovery after the massive PDV-mortality in the Wadden Sea demonstrates strong resilience when the species and habitat is well managed. We hope that new information made available in this volume will contribute to sound management of the harbour seals and the coastal environment they are dependent upon.

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