

# Status of harbour seals (*Phoca vitulina*) in mainland Norway

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## ABSTRACT

Harbour seals were counted along the entire Norwegian coast at known moulting haulout sites in the period mid-August to early September 2003-2006. In 2003-2005, almost all known moulting areas from Finnmark to Vestfold counties were covered by aerial photo surveys flown at altitudes of approximately 800-900 ft (243-274 m), and at low tide ( $\pm 2$  hours). Surveys in the Østfold County were flown in 2003-2006 at 300 ft (91 m), and the small tidal amplitudes permitted counts to be carried out irrespective of the tidal cycle. In some sub-areas, two or three independent surveys were conducted. Visual counts using binoculars from smaller boats and islands were carried out in some selected areas. The surveys revealed a total minimum population of 6,705 harbour seals in Norwegian waters. Harbour seals were most abundant in the Nordland and Sør-Trøndelag counties with minimum estimates of approximately 2,500 and 1,500 seals, respectively. The presented minimum estimate is approximately 800 seals lower than an estimate obtained in a comparable study carried out during the moult in 1996-1999. Increased anthropogenic removals, and the phocine distemper virus (PDV) epidemic in the Skagerrak region in 2002, may have contributed to the current lower estimate.

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## INTRODUCTION

Northeast Atlantic harbour seals (*Phoca vitulina*) are distributed in coastal areas from northern Portugal to the Barents Sea (including also the British Isles, Iceland, and western Spitsbergen) and in the Baltic Sea (Bigg 1981, Wiig 1989, Henriksen *et al.* 1997). In Norway, the species is resident along the entire coast where they occur in three distinct types of habitats: open rocky coasts, deep fjords and estuarine sandbanks (Bjørge 1991). The northernmost harbour seal population in the world occurs at Prins Karls Forland, Svalbard

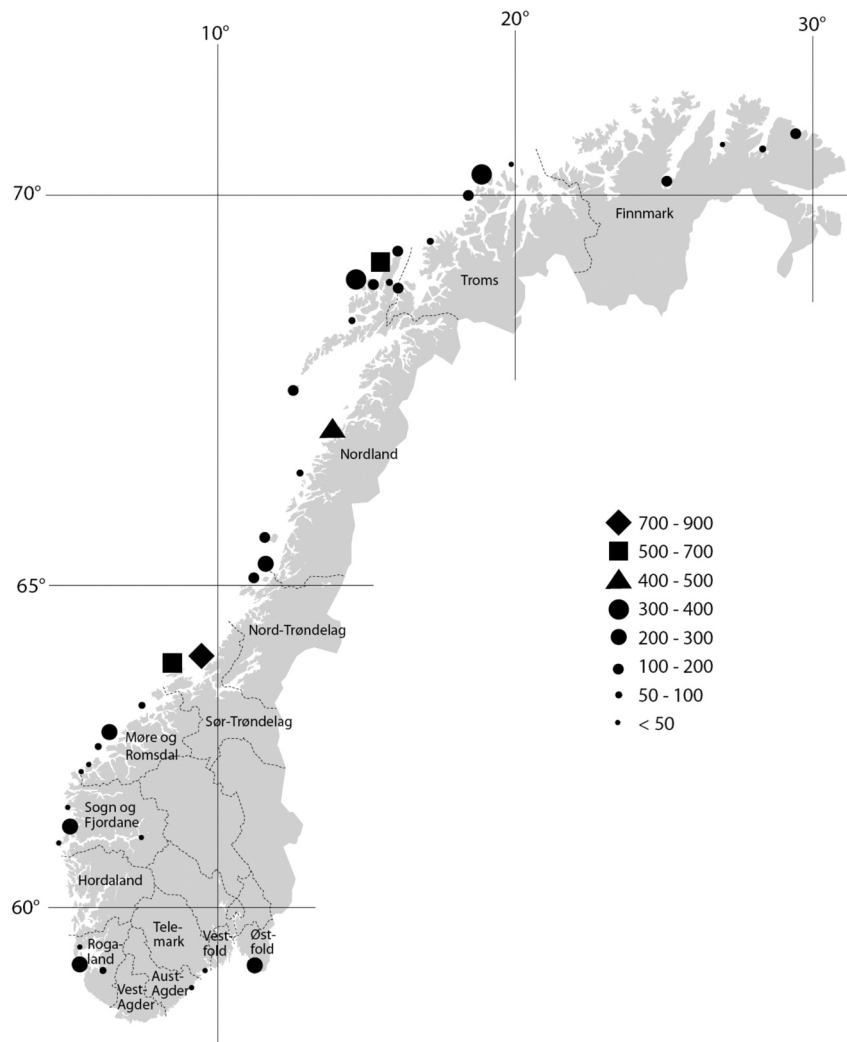
(Lydersen and Kovacs, 2010). Harbour seal hunting has long standing traditions in Norway as an important food and fur resource for the coastal communities. The hunt can be traced back to the Stone Age (Olsen 1976), and the first laws regulating hunting rights dated back as early as 11<sup>th</sup> – 13<sup>th</sup> century (Anon. 1990). In the first part of the 20<sup>th</sup> century harbour seals were regarded more as vermin, with bounty paid in some areas, resulting in local depletion of the species. In order to prevent the species from extermination, local initiatives led to the protection of harbour seals in sub-areas of Nordland (1962) and Møre og Romsdal Counties (1966) (see Fig. 1). Also, during the

1960s, the interest for harbour seal hunting decreased in Norway (Bjørge 1991).

Based on information obtained from fishermen, seal hunters, lighthouse keepers, and others supposed to possess knowledge about local seal populations; Øynes (1964, 1966) suggested that the total harbour seal population in Norway in the early 1960s may have been about 4,000 animals. He also suggested that the species had suffered a severe decline prior to the 1960s and that it was threatened in some areas. To obtain a better basis for management, more extensive studies of harbour seals were carried out by the Institute of Marine Research (IMR) along the Norwegian coast from Østfold to Finnmark (Fig.1) during the period 1977-1989 (see Bjørge 1991, Bjørge and Øien 1999). These studies indicated that the number of har-

bour seals inhabiting Norwegian coastal waters was probably around 3,600 animals. Due to differences in applied methodology (interviews and questionnaires in the 1960s, boat-based counts in the breeding season in 1977-1989), it was assumed that there had been little change in the overall number of harbour seals along the Norwegian coast during the 25 years between the two studies (Bjørge and Øien 1999).

Except for the local protection initiatives in the 1960s, the harbour seal hunt was virtually unregulated prior to 1973 (Anon. 1990, Bjørge 1991). In 1973, regulatory measures were introduced, with a general protection of harbour seals in southern Norway from Østfold county to the Sogn og Fjordane county (Fig 1). Further north, free hunting was allowed in the period late



**Fig. 1.**  
Numbers of harbour seals recorded along the Norwegian coast during 2003-2006.

autumn to spring (Bjørge 1991). A new management regime was implemented for harbour seals in Norway in 1997. The major management objective was to secure viable stocks within their natural distribution areas. However, there was also a requirement that consideration should be given to conflicts between seals and fisheries. In areas where seal numbers were supposed to sustain a harvest, hunting could be used to control population sizes. This objective was defined in a consensus report from a group of experts including scientists and managers from the Ministry of Fisheries and the Ministry of Environment (Anon. 1990). According to the new management regime, restricted quotas were to be allocated and defined hunting periods (between 2 January – 30 April and 1 August – 30 September) were implemented. Although the population structure of harbour seals along the Norwegian coast was unresolved, quotas were given separately for each county.

The introduction of quotas facilitated the need for updated information on abundance, and it was recommended that a monitoring programme should be established, where the populations were surveyed approximately every 5 years (Anon. 1990). Harbour seals are usually counted during pupping and/or moult, when most of the species haul out (Heide-Jørgensen and Härkönen 1988, Thompson and Harwood 1990, Reijnders *et al.* 1997, Huber *et al.* 2001, Gilbert *et al.* 2005). A first harbour seal survey that included the entire Norwegian coast, primarily based on aerial photographic surveys, but supplemented with boat based visual counts in a few areas, was conducted during moult (August-September) in 1996-1999 and resulted in a point estimate of 7,465 harbour seals for the entire Norwegian coast (Bjørge *et al.* 2007). Even though the methodology applied in 1996-1999 differed from previous studies, the new point estimate was taken as an indication of recent growth in the harbour seal population.

According to the recommended interval, new aerial photo surveys, aimed to assess current population size, were performed during the moulting seasons of 2003-2006. The study also included visual counts using smaller boats. This paper summarizes the results from these recent surveys.

## MATERIALS AND METHODS

### Field data collection

Harbour seal abundance was investigated along the entire Norwegian coast at previously known moulting haulout sites (Øynes 1964, 1966, Bjørge 1991, Roen and Bjørge 1995, Bjørge and Øien 1999, Bjørge *et al.* 2007) in August-September 2003-2006. Almost all known moulting areas from Finnmark County in the north to Vestfold County in the south were covered by aerial photographic surveys in 2003-2005. In Østfold county aerial photographic surveys were conducted in 2003-2006 as a part of the Swedish harbour seal monitoring. In some sub-areas two or three independent surveys were conducted on different days within the same year. Due to difficult topography, aerial surveys were replaced by visual counts using binoculars from a smaller boat in the Lysefjord in Rogaland County in 2003. Also, due to low numbers of seals observed in the aerial photo surveys, the Porsangerfjord in Finnmark County and the western Skagerrak coast were covered with additional visual counts from smaller boats and islands in July and August 2005, respectively.

In the areas from Finnmark to Vestfold counties, the aerial photographic surveys were conducted using a PA31 Piper Navajo aircraft fitted with the gyro-mounted Leica RC 30 camera with 15.3 cm lens and Agfa Pan 400 aerographic black-and-white film and Agfa Aviphot colour HX100 PE1 film. The surveys were conducted at altitudes of 800-900 ft (243-274 m). The surveys were flown at low tide ( $\pm 2$  hours) during day time, and as far as possible in good weather conditions without rain and preferably with sun. Surveys in the Østfold County were carried out from a Cessna 172 flying at 300 ft. Photos were taken by digital Canon EOS 20 cameras equipped with 85 mm lenses. GPS positions were given for each photo. The low tidal amplitude permitted counts to be carried out between 0900 and 1500 hours, irrespective of the tidal cycle.

Each photo session started when the aircraft entered the start position of a known haulout site and continued until the aircraft passed the

**Table 1.** Minimum numbers of harbour seals in each county along the Norwegian coast based on aerial photo surveys and visual counts during the moult (August-September) in 2003-2006.

County	Year				Max count
	2003	2004	2005	2006	
Østfold	192	147	229	266	266
Vestfold	0			7 <sup>a</sup>	7
Telemark	0			45 <sup>a</sup>	45
Aust-Agder	0			10 <sup>a</sup>	10
Vest-Agder	0			0 <sup>a</sup>	0
Rogaland	360 <sup>b</sup>				360
Sogn og Fjordane			325		325
Møre og Romsdal	302		477		477
Sør-Trøndelag	1,527				1,527
Nord-Trøndelag	138				138
Nordland		2466			2,466
Troms			727		727
Finnmark			357 <sup>c</sup>		357
Sum Norwegian coast					6,705

<sup>a</sup> Visual counts

<sup>b</sup> Includes visual counts in the Lysefjord

<sup>c</sup> Includes visual counts in July 2005 in the Porsangerfjord

**Table 2.** Numbers of harbour seals observed in aerial photographic counts in sub-areas where 2-3 independent surveys were conducted during the moult within the same year.

Sub-area	County	Year (dates)	Numbers		
Hvaler	Østfold	2003 (18/8; 25/8; 26/8)	192	158	151
		2004 (23/8; 2/9)	67	147	
		2005 (15/8; 17/8; 18/8)	226	229	222
		2006	141	266	217
Onsteinen, Brønnøy	Nordland	2004 (23/8; 24/8)	17	140	
Røst	Nordland	2004 (19/8); 2005 (17/8)	34	147	
Hadseløya	Nordland	2004 (19/8); 2005 (17/8)	7	72	
Stø/Anda	Nordland	2004 (19/8; 25/8; 26/8)	243	125	385
Gisløy	Nordland	2004 (19/8; 25/8; 26/8)	0	116	44
Nordmela	Nordland	2004 (19/8; 25/8; 26/8)	414	133	592
Måsvær	Troms	2005 (17/8; 18/8)	111	351	
Porsanger	Finnmark	2004 (27/8); 2005 (15/7a; 26/8)	54	150 <sup>a</sup>	95
Laksefjord	Finnmark	2004 (27/8); 2005 (26/8)	30	31	

<sup>a</sup> Visual counts

haulout site. Thus, the survey tracks were predetermined and aimed at a complete coverage of the areas used for haulout. In high density sites, areas adjacent to the known haulout sites were also photographed.

### Photographic counts

Two readers with experience from harbour seal fieldwork and two inexperienced readers examined the negative films. One reader with extensive previous experience from the investigations in 1996-1999 (Bjørge *et al.* 2007) examined a common series of photographs and compared seals identified with the other readers. Each frame was examined using a light board in combination with a binocular (type Leica Wild M715) fitted with a lens giving 6.4 - 40X magnification. For each photo with harbour seals observed, the number of seals and the GPS position of the frame were recorded. Digital photos were displayed and magnified on a computer screen and seals were counted by an experienced observer.

## RESULTS

Harbour seals were detected on approximately 5 % (247 photos) of a total of 4,878 photos shot from Finnmark to Vestfold. Harbour seals were most abundant in the Nordland and Sør-Trøndelag counties with minimum estimates of approximately 2,500 and 1,500 harbour seals, respectively (Fig. 1). Including also the Swedish investigations in Østfold, the 2003-2006 surveys revealed a total minimum population of 6,705 harbour seals in Norwegian waters (Table 1). This number is based on the direct maximum counts of harbour seals detected on photos and the number of seals recorded in the visual counts. The results are minimum point estimates, which is well demonstrated by the large variations in multiple counts at various sub-areas in the counties Østfold, Nordland, Troms and Finnmark (Table 2).

Known harbour seal moulting areas along the western Skagerrak coast (the counties Vestfold, Telemark, Aust-Agder and Vest-Agder) were surveyed using aerial photos in August 2003, but no seals were detected on the photos. In August 2006, those areas were surveyed using

an inflatable rubber boat. Only 7 (Vestfold), 45 (Telemark) and 10 (Aust-Agder) harbour seals were recorded. Also, 55 harbour seals were recorded in the Lysefjord and 150 harbour seals in the Porsangerfjord in visual counts in 2003 and 2005, respectively (Tables 1 and 2).

## DISCUSSION

Time of the day, tidal state and meteorological conditions have been shown to be key elements influencing haulout patterns of harbour seals at various sites within their range, including also the coast of Norway (*e.g.* Roen and Bjørge 1995, Reder *et al.* 2003). The present investigations were conducted mainly during the moulting period when the number of seals hauled out was believed to be highest and the weather conditions were likely to be favourable for flying. Nevertheless, the aerial photo method is sensitive to disturbance of the seals due to more unpredictable factors such as boat traffic (*i.e.* seal and bird hunting, seal watching, recreation), which could explain the large variations observed in some counts in the surveyed sub-areas (see Table 2). Also, in some areas the seals seemed to be sensitive to the photo-aircraft itself, as they were occasionally observed to rush into the water when approached by the plane. The impression was that such behaviour mainly occurred in a restricted number of areas, probably where the seals might have been stressed due to known high hunting activity.

Results from the present study are comparable with the results from a similar study carried out during the moult in 1996-1999, which resulted in a minimum estimate of 7,465 harbour seals along the entire Norwegian coast (Bjørge *et al.* 2007). Known harbour seal colonies in the inner part of the Sognefjord in Sogn og Fjordane County were not surveyed, but an earlier study suggests an abundance of approximately 50 seals in that area in 1996 (Sørland and Dale 2003). As in the present survey, harbour seals were most abundant in Nordland and Sør-Trøndelag also in 1996-1999. However, the present uncorrected minimum estimate is approximately 800 seals lower than the corresponding estimate obtained in 1996-1999. Both studies covered the same areas and used the

same methodology. Certainly, increased disturbance due to hunting activities may have changed the seal distribution during moult in the recent surveys. This may have resulted in reduced coverage since the present survey area was based on previous knowledge of haulout sites. However, in addition to the most used moulting haulout sites, adjacent areas were also photographed.

Quotas for the harbour seal hunt are set annually by the Directorate of Fisheries, based on the decisions of the national Marine Mammal Council. This Council's main objective is to provide management advice to Norwegian authorities in all questions regarding marine mammals. The scientifically recommended quotas for harbour seals provided by the IMR to the Council have since 1997 and up to date generally, been set at 5 % of available abundance estimates (*i.e.* the maximum numbers obtained from aerial surveys and visual counting, see Nilssen 2007). Occasionally, the Norwegian management authorities have previously increased the recommended quotas by 20-30 % in restricted areas where there are assumed high conflicts between seals and fisheries. However, contrary to the scientific advice, the quotas were increased substantially in 2003 by the Council and the management authorities, now being set at 13 % of the total population estimates in all areas, except for a few small local colonies. Also, a bounty was paid for each harbour seal documented taken in several regions. Elevated quotas were maintained for the entire period 2004–2008.

Limited quantitative historical data on harbour seal hunting activities in Norway are available prior to 1997, but in a culling programme aimed to reduce the number of coastal seals during the period 1980-1987, 1,236 harbour seals were shot in the areas from Møre og Romsdal to Nordland (Bjørge and Øien 1999). As all licensed coastal seal hunters during the latest decade have been obliged to report their hunting results to the authorities, catch statistics are available since 1997 (see Nilssen 2009). In the period 1997-2002, 26-93 % of the quotas recommended by the IMR were taken annually (catches from 60 to 466 animals). The increased quotas and bounty paid in 2003-2008 did not seem to affect catches in 2003 (457 seals taken),

but an increase was seen in subsequent years when the IMR scientifically recommended quotas were substantially exceeded (by 107–216%, and 549–905 animals taken annually; see Nilssen 2009). Thus, the bounty paid has apparently increased the harbour seal hunting along the Norwegian coast, and it may also have resulted in an increase in the numbers of unreported seals killed (shot seals that sink), since the bounty is paid only for animals where the lower jaw and body measurements have been sampled.

Harbour seals along the Norwegian coast are also subjected to by-catch mortality. In a mark-recapture experiment, where 630 harbour seal pups were tagged during the period 1978-1998, 13 % of the tags were returned (Bjørge *et al.* 2002a). Incidental mortality, mainly in bottom-set nets, accounted for 48% of deaths, and the seals were most vulnerable during their first 3 months after birth, although high incidental mortality prevailed during the first 8-10 months. Interactions with fish farms by harbour seals are known to occur (Bjørge *et al.* 2002b). It is also evident that interactions may occur between harbour seals and salmon (*Salmo salar*) river fisheries (Henriksen and Moen 1996). According to current regulations, it is permitted to shoot seals that interact with fish farms and salmon fisheries, and these removals are supposed to be reported to the authorities. There are indications, however, that not all cases are reported, which may lead to an underestimate of the total number of seals taken.

A great majority of the harbour seals in Østfold County is found in the outer Oslofjord close to the Swedish border. The stock in this area has been counted annually through the period 1999-2007. All sites used by seals have been photographed from air during the two last weeks of August. Three repeated flights have been carried out in most years, except for 2002, when phocine distemper virus (PDV) epidemics resulted in mass mortality of harbour seals in northern Europe (Härkönen *et al.* 2006). Surveys in the Østfold area were postponed to the following year. Data from freeze-branded seals in the adjacent seal colony in the Koster area in Sweden showed that the mean proportion hauled out during surveys was 56%, and the annual maximum count (the highest of three

surveys) represents 65% of the true population (Härkönen *et al.* 1999). The stock was increasing up to 2001 when maximum counted numbers amounted to 548. The 2002 PDV epidemic killed about 65% of the harbour seals in the Østfold area, after which the stock has fluctuated around 200 animals.

Even though the moult is known to be a period when a larger fraction of harbour seals haul out, only a certain proportion of the animals will haul out on shore and be available for photographic counts (see Boveng *et al.* 2003). The size and variation of such proportions can be estimated in telemetric studies (*e.g.* Reder *et al.* 2003, Gilbert *et al.* 2005). Also, in a recent study of harbour seal moulting phenology in North America it was observed that the timing of moulting differed among age-sex classes (Huber *et al.* 2001, Daniel *et al.* 2003). It appears reasonable to assume that this could also be the case for harbour seals in Norway, and population estimates based on aerial counts conducted during a narrow window within the moulting period could then likely be biased toward certain age-sex classes. Successful studies on potential variation between age groups and sex in haulout behaviour during moult are still lacking for Norwegian harbour seals. It is, therefore, difficult to give a corrected estimate of the total current abundance of the species along the Norwegian coast. Nevertheless, in an attempt to estimate the total population from the number of hauled out seals recorded in 1996-1999, Bjørge *et al.* (2007) applied assumed correction factors, based on regional visual observations of harbour seal haulout behaviour in relation to tidal amplitude and diurnal light conditions, and suggested a total population of approximately 10,000 animals based on 7,465 harbour seals counted along the Norwegian coast. Assuming that this estimate reflected the approximate size of the harbour seal population in Norwegian waters when the study was conducted, Bjørge *et al.* (2007) concluded that subsequent anthropogenic removals were most likely above sustainable levels and would reduce the population unless the current management regime was changed.

The observed reduction in total minimum abundance estimate between 1996-1999 and

2003-2006 may support a recent decrease in numbers of harbour seals in Norwegian waters. However, most of the haulout sites were surveyed only once, and no attempt was made to consider the variance associated with the results. For this reason, it is not possible to assess whether the observed change in abundance is significant. The likely magnitude of current anthropogenic removals, combined with the results from the most recent survey, emphasize the need for improved methodology to monitor population trends and effect of current management. Bjørge *et al.* (2007) suggested the use of repetitive flights to improve the reliability of abundance estimation and associated variances with the estimates. Additionally, the proportion of the population hauled out at any time, as well as the age and sex composition of the hauled out seals, changes with area and season (Thompson and Rothery 1987, Kovacs *et al.* 1990, Huber *et al.* 2001, Daniel *et al.* 2003, Jemison and Kelly 2003, Reder *et al.* 2003). Therefore, biases associated with haulout behaviour need to be quantified, and reliable correction factors must be developed in order to obtain abundance estimates that reflect the total size of the Norwegian harbour seal population more realistically than current minimum estimates.

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