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Vulnerability of harbour seals, *Phoca vitulina*, to transient industrial activities in the Strait of Dover

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The abundance of the harbour seal (*Phoca vitulina*) was recorded on a tidal bar in the Dover Strait off Calais, over a six-year period between 1999 and 2004. Despite clear seasonal and interannual variability in the number of individuals hauled out on the bar, underwater activities devoted to the installation of industrial wastewater pipes conducted during seven weeks 1 km away from the bar led to a dramatic decline in the number of seals hauling out. A full 19 months after the end of the operations the harbour seal population had not recovered their initial abundance. The results of this study have critical consequences on the conservation of *P. vitulina* in areas impacted by anthropogenic activities.

Despite an overall abundance estimated up to 47,000 individuals in Great Britain (Burns, 2002) and the subsequent amount of work published on biology and ecology of harbour seals, to our knowledge little has been written about the population dynamics of *Phoca vitulina* along the French coast of the English Channel. In particular, no attention has been given to harbour seal colonies localized in the Strait of Dover where the scarcity of sheltered tide bars, sandy or cobble beaches, the absence of intertidal reef and the intensity of disturbance related to industrial and commercial activities are likely to affect their haul-out behaviour.

This analysis is part of a multiyear study designed to investigate the population dynamics of harbour seals on a newly colonized tidal bar (50°59′40″N 1°54′55″E). The bar is located 700 m from the lowest limit of the intertidal zone, parallel to the coast, 6 km long and 1 km wide at low tide. Observations were conducted at low tide as regularly as weather permitted from 3 February 1999 to 20 December 2004 (383 observations). Harbour seals were observed from the shore using binoculars (magnification ×60) and the number of individuals hauled out on the bar were counted.

In total, 938 harbour seals were seen on the tide bar over the 383 days of observation. The mean number of seals hauled out on the tide bar over the survey period was 2.47 ±0.17 individuals d^{-1} (ind d^{-1}; $\bar{x} \pm SE$), with strong interannual and seasonal variability (Figures 1 & 2). The number of hauled-out individuals was significantly different between years (Kruskal–Wallis test, $P < 0.01$). A subsequent test for ordered alternative (Jonckheere test, $P < 0.01$) showed that the abundances break into four groups of decreasing abundance (Figure 1), including: (i) 1999 ($\bar{x}$=5.20 ±0.44 ind d^{-1}; $\bar{x} \pm SE$) and 2002 ($\bar{x}$=5.73 ±0.56 ind d^{-1}); (ii) 2000 ($\bar{x}$=2.55 ±0.21 ind d^{-1}) and 2001 ($\bar{x}$=3.02 ±0.22 ind d^{-1}); (iii) 2003 ($\bar{x}$=0.84 ±0.26 ind d^{-1}); and (iv) 2004 ($\bar{x}$=0.49 ±0.11 ind d^{-1}). Maximum monthly abundance was always observed during the moulting season (between spring and autumn). However, in 2003 no harbour seals were observed during the seven weeks of industrial underwater activities that started on 14 April from a floating platform located 1 km away from the bar. No haul out was observed in June and September, and only one individual was sighted hauling out in July, August and October (Figure 2).

The mean number of harbour seals on the tidal bar at low tide decreased from a range of 2.39 to 6.33 ind d^{-1} found between April and July from 1999 to 2002 to values of 0.01 and 0.71 in 2003 and 2004, respectively. Similarly, the maximum abundance decreased from a range of 3 to 10 to values bounded between 0 and 1 in 2003, and between 1 and 4 in 2004. The industrial underwater activities that took place from 14 April to 31 May 2003 thus led to a 19 month period where the mean number of seals

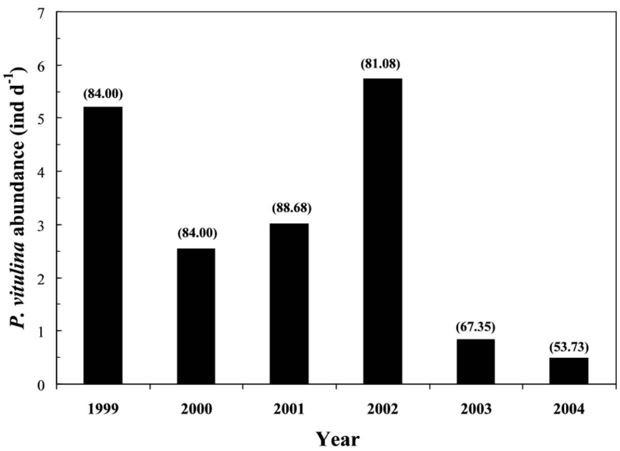

Figure 1. Mean abundance of *Phoca vitulina* in the Strait of Dover study area between 1999 and 2004 as a function of annual observations grouped in low tide periods. The frequency of occurrence of *P. vitulina* is given is parentheses above the corresponding bar for each year.

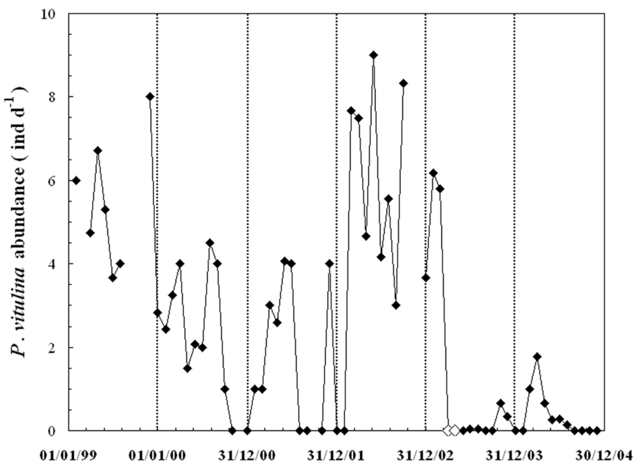

Figure 2. Mean monthly abundance of *Phoca vitulina* in the Strait of Dover study area between 1999 and 2004. The open symbols correspond to the period of underwater industrial activity.

observed on the bar was the lowest of the six-year survey period. Nine hundred harbour seals had been observed hauled out over the 234 days preceding the disturbance (i.e. 3.85 ind d^{-1}), while only 38 harbour seals were observed over the 149 days of observation that followed the beginning of the underwater activities (i.e. 0.26 ind d^{-1}). The industrial disturbance thus led to a 15-fold decrease in the mean abundance of seals observed on the bar. Nineteen months after the end of the industrial disturbance, the population still had not recovered its initial abundance (Figure 2).

The decrease in the abundance of harbour seals observed in the Strait of Dover from April 2003 cannot be directly related to the phocine distemper outbreak that decimated more than 22,000 harbour seals in Europe in 2002 (Jensen et al., 2002). The space–time dynamics of the 2002 epizootic is indeed not consistent with our observations as it originated in April in the Kattegat, spread through the Skagerrak and then into the Dutch Wadden Sea and the North Sea, reaching the UK in August 2002 where harbour seal mortality peaked in mid-September, and finally collapsed in late 2002–early 2003 when harbour seal mortality did not differ from background mortality. In the Strait of Dover, the number of harbour seal strandings as well as harbour seal mortality did not increase during the epizootic nor since the beginning of the observed decrease in harbour seal haul out, has been consistent since the beginning of our survey (1999–2004) and no evidence of morbillivirus infection was found in stranded seals (Seuront & Prinzivalli, unpublished data).

While a few studies have investigated the disturbance of harbour seals by cruise ships (e.g. Suryan & Harvey, 1999), the present work illustrates the strong detrimental effect of a transient industrial activity on the number of harbour seals hauled out. The disturbance related to seven weeks of industrial activities located 1 km from the tidal bar thus led to a dramatic decrease in the number of harbour seals. Our results diverge significantly from previous studies showing very small and/or no impact of anthropogenic activities on seal haul out behaviour (Frost & Lowry, 1988). The disturbance identified in the present work might have been particularly detrimental for the harbour seal population as it occurred at the beginning of the moulting season. The sensitivity of harbour seals to industrial disturbance is indeed likely to differ relative to their breeding or moulting status (Suryan & Harvey, 1999). Harbour seals may also be highly vulnerable to disturbance because of their small size (Rejinders, 1986), restricted range and site fidelity (Thompson et al., 1998; Härkönen & Harding, 2001).

The extreme vulnerability of harbour seals to anthropogenically-driven disturbance illustrated here is likely to be a critical issue for species conservation in many regions of the world where habitats are subjected to increasing pressure from industrial and commercial activities.

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REFERENCES

Burns, J.J., 2002. Harbor seal and spotted seal. In *Encyclopedia of marine mammals* (ed. W.F. Perrin et al.), pp. 552–560. New York: Academic Press.

Frost, K.J. & Lowry, L.F., 1988. Effects of industrial activities on ringed seals in Alaska, as indicated by aerial surveys. In *Ninth International Conference on Port and Ocean Engineering Under Arctic Conditions* (ed. W.M. Sackinger et al.), pp. 15–25. University of Alaska, Fairbanks: The Geophysical Institute.

Härkönen, T. & Harding, K.C., 2001. Spatial structure of harbour seal populations and the implications thereof. *Canadian Journal of Zoology*, **79**, 2115–2127.

Jensen, T., Bildt, M. van de, Dietz, H.H., Andersen, Ths.H., Hammer, A.S., Kuiken, T. & Osterhaus, A., 2002. Another phocine distemper outbreak in Europe. *Science, New York*, **297**, 209.

Reijnders, P., 1986. Reproductive failure in common seals feeding on fish from polluted coastal waters. *Nature, London*, **324**, 456–457.

Suryan, R.M. & Harvey, J.T., 1999. Variability in reactions of Pacific harbor seals, *Phoca vitulina richardsi*, to disturbance. *Fishery Bulletin*, **97**, 332–339.

Thompson, P.M., Mackay, A., Tollit, D.J., Enderby, S. & Hammond, P.S., 1998. The influence of body size and sex on the characteristics of harbour seal foraging trips. *Canadian Journal of Zoology*, **76**, 1044–1053.

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