

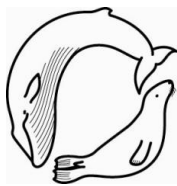
Marine Mammal Scientific Support Research Programme MMSS/001/11

Tasks CSD1 & CSD2:

Workshop report on decline in abundance of harbour seals around the coast of Scotland and discussion of mitigation and management measures

Sea Mammal Research Unit
Report to
Scottish Government

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**Sea Mammal
Research
Unit**

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Harbour Seal Declines Workshop Report

28th August, 2012

Hosted by Sea Mammal Research Unit, University of St Andrews

A list of the participants and their affiliations is given in Appendix 1. A working paper submitted by Harkonen et al. is given in Appendix 2 and copies of the workshop presentations are attached as a pdf document (Harbour Seal Declines Presentations.pdf).

Summary

The workshop participants were firstly asked to consider six aspects relating to the causes of the observed decline in the abundance of harbour seals around Scotland over the past 10 years or so.

1. What additional causes should be considered that are not currently listed? This was in order to ensure there were no major omissions in the list being highlighted so that the second question relating to the most likely causes was as complete as possible.

The major causes currently under consideration include:

- Nutritional stress – as a result of decreased quality or quantity of prey
- Increased competition with grey seals – although the nature of the competition still to be determined
- Increased competition with other marine animals – as above
- Disease
 - Infectious (i.e. viral, bacterial, fungal, parasitic, protozoal)
 - Non-infectious (e.g. persistent organic pollutants)
 - Toxins (biotoxins from harmful algae, e.g. domoic acid, saxitoxin, okadaic acid, yessotoxins)
- Deliberate killing – shooting is known to have been an issue in the Moray Firth
- Trauma (accidental killing) – increased traumatic interactions with vessels have been demonstrated in certain regions but the true extent of this impact is not known.
- Bycatch – in fisheries
- Pollution – this related back to non-infectious diseases as a potential causal factor
- Predation – certainly an increase in killer whale sightings in Shetland and Orkney especially over the last few years has raised this as a potential problem for harbour seal population abundance, particularly in the summer.

Additional causes that were recognised by the workshop break-out groups were:

- Loss of habitat – either foraging, moulting or breeding

- Anthropogenic disturbance – including increased ocean noise, boat traffic, disturbance from haulout sites
- Direct competition with fisheries – also depleting the prey base
- Dispersal and emigration – the permanent movement of animals into other, European populations or perhaps into the stable populations on the west coast
- Climate change
- Natural variation – unidentified reductions in survival and fecundity
- Entanglement in marine debris

2. What are your top 6 most likely factors and how might they interact?

3. What regional and temporal differences are anticipated?

4. What are the priority areas for future research?

The outcome of the breakout group discussions on these three questions is summarised in Table 1. Each group was asked to consider the most likely factors, whether these were acting globally or locally and what the priority areas for future research were. In general there was good agreement that the most likely explanations were involved with prey issues; quality or quantity. Of all those factors considered the top three explanations to emerge were (a) increased competition with grey seals and other top predators (b) natural variation (c) biotoxin exposure.

Post-workshop note: Some further consideration needs to be given to the issues underlying the hypothesis that grey seals are competing with harbour seals and how this might be further explored. The mechanisms for this were not discussed in any detail at the workshop although exploitation competition seemed to be the most popular theory (this is indirect competition where a common limiting resource is acting as an intermediate). Clearly the contemporary harbour and grey seal diet studies currently being carried out are of central importance to this explanation. Evidence of dietary overlap (both prey type and size) needs to be integrated with information on the extent to which foraging areas overlap and finally how much prey is available to both species in these regions. If the first two criteria are met but the shared prey is sufficiently abundant and not limiting, then animals will not necessarily be competing directly. An analysis of the data available for the Moray Firth population suggests that juvenile survival is a major driver here (Matthiopoulos et al. in review) and this may suggest intra as well as inter specific competition. It is not clear whether this is also the case in other regions. For example, an analysis of the decline from the counts of harbour seals in Orkney (Lonergan et al. 2011) and the Tay and Eden Estuaries (Lonergan et al. 2012) concluded that adult as well as juvenile survival has probably also decreased.

Other types of competition that might be relevant here include interference competition where individuals aggressively exclude others from for example foraging or breeding.

The evidence for competition is based mainly on the differences between the population trends (grey seal numbers are increasing in regions where harbour seals are declining). However, it may be that this is because environmental and ecosystem conditions have changed which favours grey seals and is detrimental to harbour seals. Thus, removing grey seals from the region may not improve the habitat and prey availability for the harbour seals.

In the southern North Sea and SE England grey seal numbers are increasing. If inter-specific competition is a or the major driver then we should expected harbour seal numbers there to decline in the not too distant future.

And what is meant by 'natural variation'? There are clearly drivers behind these fluctuations so this theory does require further clarification. This is perhaps better described as environmental variation.

5. What other, related data (e.g. prey base, prey quality and availability, food chain impacts, environmental covariates etc.) are required to assist in determining likely cause(s)?

The priority related data need was clearly identified by the breakout groups as information on the prey base.

In particular sandeel and whiting stocks have declined in recent years. If these are preferred prey that are a limited resource now being shared between many different top predators then harbour seals are potentially being out competed.

The priority research areas identified for **immediate** consideration were:-

- An investigation of the spatial (moult counts and at-sea distribution estimates) overlap between grey seals and harbour seals. There is a clear need to carry out a comparison study. The data are available both at SMRU and from elsewhere. Whatever is happening is **not operating** in the Southern North Sea so these data could potentially be very helpful in directing research priorities and providing information on 'control' or comparative regions where trends and population trajectories are different.
- How do the foraging areas for harbour seals change during the grey seal breeding season (September to December) to when a large proportion of the population of the grey seal population are on land?
- What is the condition of harbour seal pups at weaning and the early survival of pups? A limited study was carried out by SMRU in 2007 at two regions but this has not been repeated.
- The groups emphasised the importance of strandings data – especially samples that could provide information on diet (e.g. stomach contents), causes of death, condition, teeth and whiskers for isotope and blubber for nutritional analyses.
- Key study sites should be identified for which there are diet, harbour and grey seal population data and fish prey data. These sites could then become a key focus for integrated studies investigating the relationship between these species. – **Post-workshop Note:** These regions need to be carefully chosen as it seems quite likely that factors affecting harbour seals may not be consistent among regions.
- A quantitative analysis of direct and indirect effects of shooting should enable this hypothesis to be tested and ruled in or out. – **Post-workshop Note:** an analysis of the harbour seal population dynamics and the impact of shooting in the Moray Firth population has been carried out by Matthiopoulos et al. and a paper is currently in review in Journal of Applied Ecology. Using a state space modelling approach they found that at its maximum

shooting accounted for 13% of the observed mortality and that with the low levels now in place due to the Moray Firth Seal Management Plan and Marine (Scotland) 2010 Act, slow recovery of this population is predicted. It may be difficult to determine the impact of shooting in areas where similar estimates of the numbers killed are not available.

Other discussion points

Other points that were highlighted included

1. For many of these hypotheses (particularly those driven by prey quantity and quality issues) the observed response variable (for example decreased nutritional health) may be the same and therefore many studies will have no discriminatory power to distinguish between competing hypotheses.
2. It is important to mine all the data that is available from different sources –e.g. investigate the dive data from the telemetry tags to see how the patterns may change towards the end of the life of each tag. In this way we may be able to determine if the animal appeared to ‘die’ because its dive behaviour changed towards the end of the tracking period or not.
3. It is also critical to emphasise that the declines are mostly likely to be driven by multiple causes acting together and that the mixture likely differs regionally and over time.

Mitigation

Various mitigation options were discussed but detailed issues were not highlighted as the groups felt unable to comment beyond the general statement that

1. If the cause is anthropogenic AND impact on population can be demonstrated then intervention would be acceptable
2. If it was found to be interspecific competition or other natural drivers then intervention would not be recommended
3. A cost-benefit analysis would have to be carried out
4. A major point for action could be to suspend **all** licences to shoot seals
5. If investigations into the “corkscrew” seal deaths were able to determine the boat type and gear type then intervention may be possible here
6. If fisheries were seen to be involved then again mitigation may be possible
7. Threat of disease - if PDV were to return to Scottish waters then the vaccination issue might be raised again. However, in discussions with the rehabilitation centres and in consultation with other groups faced with the same issue (such as the Hawaiian monk seals) it may only be useful to vaccinate the few seals that are taken into rescue centres. SMRU produced a guide to vaccinating wildlife after the first PDV outbreak which suggested that only under a very few, specific circumstances would this be an option on a population-wide basis.

Other issues raised during General Discussion

How do we account for 'new' impacts (such as the effects of pile driving)? – it was concluded that this is somewhat outside the remit of the workshop and is being covered by many other initiatives facing the expansion of the marine renewable energy sector in Scotland.

However, it was generally agreed that a precautionary approach should be taken.

As scientists it is our job to provide advice. For example if the issues in the Tay and Eden population appear to be driven by a specific cause (such as interactions with vessels causing “corkscrew” deaths) then we can advise the SG but if the population has all but disappeared then there is nothing that can be done. **Post-workshop Note:** An analysis carried out by SMRU for the population of harbour seals in the Tay and Eden estuaries suggests that “the continuation of current trends would result in the species effectively disappearing from this area within the next 20 years. While the cause of the decline is unknown, it must be reducing adult survival. Recovery of the population to the abundance when the SAC was designated is likely to take at least 40 years, even if its cause is immediately identified and rectified”.

But can we really say what the historic populations were doing?

Natural systems are apparent in a variety of steady states not forgetting that multiple factors can and are likely to be operating in different regions.

References

Lonergan M, Duck C, Moss S, Morris C & Thompson D (2011) Harbour seal (*Phoca vitulina*) abundance has declined in Orkney: an assessment based on using ARGOS flipper tags to estimate the proportion of animals ashore during aerial surveys in the moult. SCOS Briefing paper BP 11/08 available at <http://www.smru.st-and.ac.uk/documents/678.pdf>

Lonergan M & Thompson D (2012) Harbour seal (*Phoca vitulina*) abundance within the Firth of Tay and Eden Estuary Special Area of Conservation: recent trends and extrapolation to extinction. SCOS Briefing paper BP 12/05

Matthiopoulos J., Cordes L., Mackey B., Thompson D., Duck C and Thompson P. (in review) State-space modeling reveals proximate causes of harbour seal population declines J. Appl. Ecol.

Table 1. Summary of most likely causes of the decline in Scottish harbour seals; regional variations and priorities for future research.

Major Cause	Secondary causes or associated issues	Impacts on	Regional or global?	Research Priority	Other Research Issues
Lack of available prey	Habitat changes Reduced prey quality Inter-specific or intra-specific competition	Reproduction / condition / health; Pup resilience; Pup dispersal; Immunity; Survival	Scotland wide West coast vs East/North coast	High	<ul style="list-style-type: none"> • Prey distribution and abundance – but scale issue and need to obtain fish abundance and distribution data for appropriate non-commercial species in areas of interest • Consider identifying key areas and sites for medium to long term research into diet and prey abundance / availability • Regime shifts – does this account for the observed southern movement of predators in the North Sea? • Lack of fishery and fish stock information on west coast • Nutritional stress – Is timing of pupping in different colonies a signal? • Nutritional stress - Sizes of seals from aerial photos • Thorough quantitative analysis of available data to assess impact of e.g. fisheries or shooting • Use of fisheries data is problematic as sampling method may not mimic seal foraging strategies • Instigate relevant studies on fish populations and work with fish and fisheries biologists

Environmental Variability		Survival	Scotland wide	High	<ul style="list-style-type: none"> • Pup and juvenile survival • Post weaning pup mass and freeze branding – use data from rehabilitation centres to assist • Pup production • Sex ratios • Model using empirical data to investigate most likely demographic changes to account for observations
Competition with grey seals	<p>Direct - prey (see also lack of available prey)</p> <ul style="list-style-type: none"> - Habitat exclusion <p>Indirect – parasite mediated (prey)</p>	<p>Fitness</p> <p>Foraging</p> <p>Survival</p>	Scotland wide	High	<ul style="list-style-type: none"> • Investigations into dietary overlap underway • Investigate association between trends in grey seal abundance and distribution compare to harbour seal – spatial and temporal changes • Determine scale on which changes in two species are varying • Comparison studies using Southern/ North sea as potential ‘control’ area • Need to know what prey resource is doing, even in overlap in diet and foraging area – may be enough for both?
Competition with other marine mammals	<p>Direct - prey</p> <ul style="list-style-type: none"> - habitat exclusion 	<p>Fitness</p> <p>Foraging</p> <p>Survival</p>	Scotland wide	Medium	<ul style="list-style-type: none"> • Trends in other top predators

	Indirect – parasite mediated (prey)				
Trauma (corkscrew)		Survival	E Scotland	High	Investigations underway
Biotoxins	prey quality low level chronic exposure	Health Reproduction Survival	N and East coast	Medium	Investigations underway
Deliberate killing		Survival	Scotland wide	Medium	<ul style="list-style-type: none"> • Lack of historic data for regions outside Moray Firth • Current analysis indicates shooting may have accounted for up to 13% of observed mortality in Moray Firth population
Predation		Survival	N. Isles	Medium	<ul style="list-style-type: none"> • Killer whale studies in Orkney and Shetland suggest this may be a contributory factor, particular during summer

Appendix 1 – Workshop participants and their affiliations.

Participant	Affiliation
Ailsa Hall	Sea Mammal Research Unit
Dave Thompson	Sea Mammal Research Unit
Jason Matthiopoulos	Sea Mammal Research Unit
Stuart Middlemas	Marine Scotland Science
Georg Englehardt	Department for Environment and Rural Affairs
Steve Bexton	Royal Society for Prevention of Cruelty to Animals
Ian Walker	Marine Scotland Science
Callan Duck	Sea Mammal Research Unit
Sophie Smout	Sea Mammal Research Unit
Ben Wilson	Scottish Marine Institute, SAMS
Paul Jepson	Institute of Zoology
Elaine Tait	Marine Scotland Science
Tero Harkonen	Swedish Museum of natural History
Chris Morris	Sea Mammal Research Unit
Debbie Russell	Sea Mammal Research Unit
Paul Thompson	university of Aberdeen
Stuart Piertney	university of Aberdeen
Andrew Brownlow	Scottish Agricultural College
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Mike Lonergan	Sea Mammal Research Unit
Esther Jones	Sea Mammal Research Unit
Lindsay Wilson	Sea Mammal Research Unit
Isla Graham	University of Aberdeen
John Baxter	Scottish Natural Heritage
Andrew Kent	Marine Scotland Science
Eunice Pinn	Joint Nature Conservation Committee
Beth Mackey	Royal Haskoning
Bernie McConnell	Sea Mammal Research Unit
Silje Jensen	Sea Mammal Research Unit
Don Bowen	Dept Fisheries and Oceans, Canada
Wullie Paterson	Sea Mammal Research Unit
Rob Harris	Sea Mammal Research Unit
Paddy Pomeroy	Sea Mammal Research Unit
Phil Hammond	Sea Mammal Research Unit
Sarah Wanless	University of Glasgow
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Peter Boveng	National Oceanographic and Atmospheric Administration
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