

# Relationship of minke whales (*Balaenoptera acutorostrata*), harbour porpoises (*Phocoena phocoena*) and feeding groups of seabirds in the Inner Hebrides, Scotland

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## Introduction

Short-term associations between different cetacean species or between cetaceans and seabirds are often linked to foraging. Minke whales, harbour porpoises and multi-species flocks of seabirds in the Inner Hebrides probably feed largely on herring and sprat in autumn. How do the taxa interact? Harbour porpoises and birds might benefit from minke whales driving fish-shoals together at the surface, but minke whales could also profit from seabirds such as auks herding fish, and harbour porpoises and minke whales might compete for the same resource.

## Questions:

Do minke whales, harbour porpoises and birds show a spatial or temporal segregation?

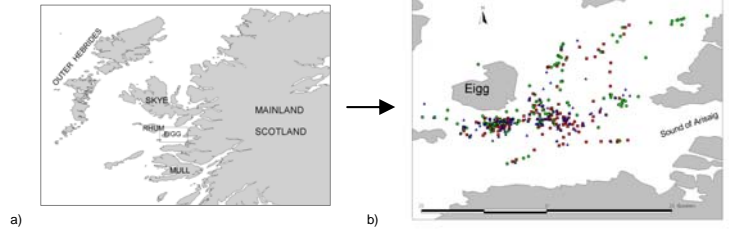
Who associates with whom?

## Methods

Observations were conducted from Sept. 17<sup>th</sup> to 23<sup>rd</sup> 2001 around the Isle of Eigg, West Scotland (see map). We recorded the location, time, group size and composition of a total of 110 seabird aggregations (44 with minke whales, 7 with harbour porpoises, 5 with both cetacean species, and 54 with neither) and compared them with 178 minke whale (54 with, 124 without seabirds) and 156 harbour porpoise sightings (14 with, 142 without seabirds) during the same time period. All observations were made at sea state 3 or less.

Figure 1.

a) Location of the study area and b) Sightings of minke whales (red squares), harbour porpoises (green circles) and feeding groups of seabirds (blue triangles).



## Results

**Spatial Distribution:** Minke whales, harbour porpoises and seabird aggregations all showed the highest concentrations south and south-east of the Isle of Eigg (Fig. 1). A spatial segregation between the taxa was thus not found.

## Temporal Distribution:

The number of birds per hour showed a significant positive correlation with the numbers of both minke whales and harbour porpoises (Tab. 1, Fig. 2a/b). The taxa must therefore show at least some similarities in their diurnal patterns. However, the correlation between numbers of minke whales and harbour porpoises per hour did not reach significance (Tab. 1b/c, Fig. 2c), and only the number of harbour porpoises per hour was correlated with time of day (Tab. 1c).

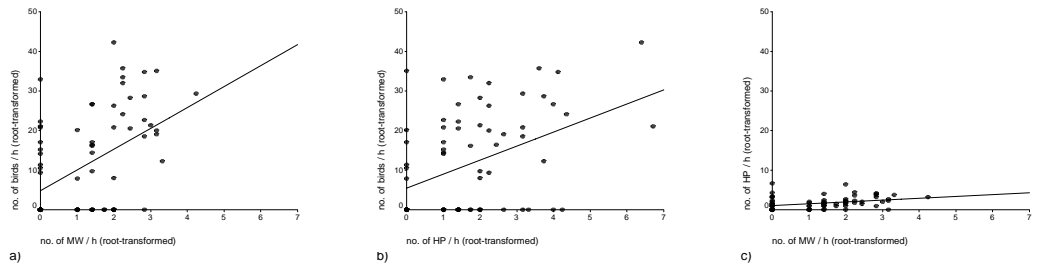


Figure 2. Correlation between numbers of a) birds and minke whales, b) birds and harbour porpoises and c) harbour porpoises and minke whales per hour. MW=minke whales, HP=harbour porpoises.

Table 1. Anova-tables for a) number of birds, b) number of minke whales, and c) number of harbour porpoises per hour, after non-significant variables ("hours before / after high water Dover", "tidal stream", and additionally "time of day" for models a and b) have been eliminated. The variable "day" was left in each model to correct for potential differences between days. All numbers of animals per hour were root-transformed.

a)	Sum of squares	df	Mean square	F	P	B	Std. error
Corrected model	4816.711	8	602.089	5.892	<0.001		
Intercept	137.437	1	137.437			2.935	3.378
Day	1277.918	6	212.986				
No. MW/h	652.382	1	652.382	6.384	0.014	3.211	1.271
No. HP/h	842.655	1	842.655	8.247	0.006	2.716	0.946
Error	6641.853	65	102.182				

b)	Sum of squares	df	Mean square	F	P	B	Std. error
Corrected model	36.880	7	5.269	5.984	<0.001		
Intercept	25.937	1	25.937			0.861	0.29
Day	14.955	6	2.493				
No. birds/h	8.224	1	8.224	9.341	0.003	0.031	0.01
Error	58.111	66	0.880				

c)	Sum of squares	df	Mean square	F	P	B	Std. error
Corrected model	94.583	19	4.978	3.762	<0.001		
Intercept	35.924	1	35.924			-0.455	0.791
Day	32.409	6	5.401				
Time	30.817	12	2.568	1.841	0.049		
No. birds/h	17.753	1	17.753	13.415	0.001	0.049	0.013
Error	71.462	54	1.323				



Minke whale swimming towards a mixed-species feeding aggregation of birds, including kittiwakes and herring gulls

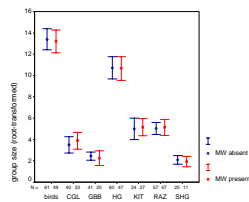


Figure 3. Mean group size (with 95% CI) for overall group size and each bird species in groups where minke whales were present / absent. CGL=common guillemot, GBB=great black-backed gull, HG=herring gull, KIT=kittiwake, RAZ=razorbill, SHG=shag.

**Association patterns:** 40% of the 110 bird groups had a minke whale associated with them, but only 6% had harbour porpoises, and 5% both cetacean species in association. Feeding assemblages of seabirds ranged in size from 40 to 543 individuals. However, the presence of minke whales with a bird group was independent of the overall group size (logistic regression, 1<sup>st</sup> model;  $R^2=0.001$ ,  $P=0.775$ ) and number of each bird species in the aggregation (logistic regression, 2<sup>nd</sup> model;  $R^2=0.08$ ,  $P=0.342$ ), (Fig. 3). All seabird aggregations had already formed and birds were actively feeding before a minke whale arrived. Although the overall species composition of the flocks varied, all feeding aggregations of seabirds contained auks (either razorbills or guillemots or both), which are able to herd fish and could thus have facilitated prey capture for the whales. Associations between minke whales and harbour porpoises were never observed in the absence of bird assemblages.

## Conclusions

Minke whales, harbour porpoises and seabirds are likely to follow the diurnal pattern of their common prey.

The slight discrepancy in the diurnal pattern of minke whales and harbour porpoises may indicate a mechanism to reduce interspecific competition for the same prey. The possibility that harbour porpoises profit from minke whales while foraging can be ruled out, as this would have resulted in the same diurnal pattern of the two species.

Minke whales often took advantage of the tight fish-balls herded by auks, whereas harbour porpoises probably fed on smaller fish shoals or single fish, either on their own or at the periphery of bird aggregations.