Supplementary material

Mark H. Hancock*, Hannah J. Robson, Trevor D. Smith & Andrew Douse 2019: Spatial and temporal patterns of foraging activity by breeding Common Scoters (*Melanitta nigra*) in Scotland. — Ornis Fennica 96: 124–141.

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Appendix 1. Supplementary Results: **Observations of scoters disturbed by predators**

Foraging scoters were occasionally disturbed by potential predators: 16 such incidents were observed during watches, seven and nine during the pre-incubation and brood periods respectively (approximately one per 13 hours of observation).

The species involved most often, and the only one seen actually attacking scoters, was Black-throated Diver *Gavia arctica*. Five incidents involving this species were observed, at two of the three study lakes holding diver breeding territories. During three incidents, scoters appeared alarmed by divers and moved away from them. The other two incidents were non-fatal attacks on broods, during which the diver surfaced suddenly within the brood, on one occasion grabbing one of the ducklings by the breast; the ducklings scattered while the adult female rushed back and forth across the water's surface. Afterwards the brood re-assembled on the shore with the female.

Other species that scoters reacted to were Grey Heron *Ardea cinerea* (two incidents), Osprey *Pandion haliaetus*, Short-eared Owl *Asio flameus* and Common Raven *Corvus corax* (one incident each). For the remaining six incidents, scoter behaviour suggested a predator was present but no predator was observed; during two incidents, scoters appeared to react to alarm-calling Greylag Geese *Anser anser*.

Table S1 Overview of the variables and units of analysis used in statistical models. Ticks indicate which variables or units were used in each analysis.

	Model of spatial pattern in foraging behaviour	Model of temporal pattern in foraging behaviour
Unit of analysis		
Lake-sector x scoter life stage (female pre-incubation, or brood)	✓	
Lake-year x scoter life stage (female pre-incubation, or brood)		✓
y-variable		
Mean no. underwater foraging scans per watch for this sector and life-stage	✓	
Slope of foraging effort vs. date relationship, for this lake-year and life-stage		✓
Fixed effects		
Intercept	✓	✓
Scoter life stage (female pre-incubation, or brood)	✓	✓
Mean number of scans per watch, all activities	✓	
Proportion of the lake covered by this lake sector	✓	
Water depth	✓	
Large invertebrate abundance	✓	
Water depth x large invertebrate abundance	✓	
Year		✓
Scoter life stage x Year		✓
Random effects		
Lake	✓	✓
Lake-sector	✓	
Year		✓
Over-dispersion parameter	✓	
Scoter life stage x Year[a]		✓

a. This random effect had to be included in order to account for heterogeneous variance between different Scoter life stage x Year groups (Stroup 2013).

Fig. S1 A schematic map of a fictitious study lake with four sampling points (black circles) showing the lake area (grey) and the four lake sectors (bounded by dotted lines).

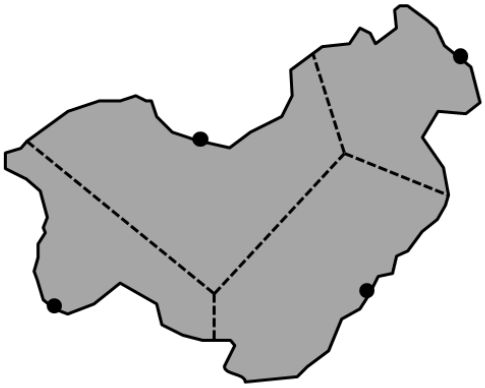


Fig. S2 The abundance of large invertebrates in the early and late parts of the breeding season. The proportions of different groups changed seasonally, but overall abundance changed relatively little. The *y*-axis gives the mean contribution per sample of each taxon, to seasonal totals based on the largest invertebrate per sample. The early and late seasonal periods relate to pre- and post-hatch periods respectively (see text). Data include both adults and younger stages (larvae, nymphs). Malacostraca mainly comprised *Gammarus*.

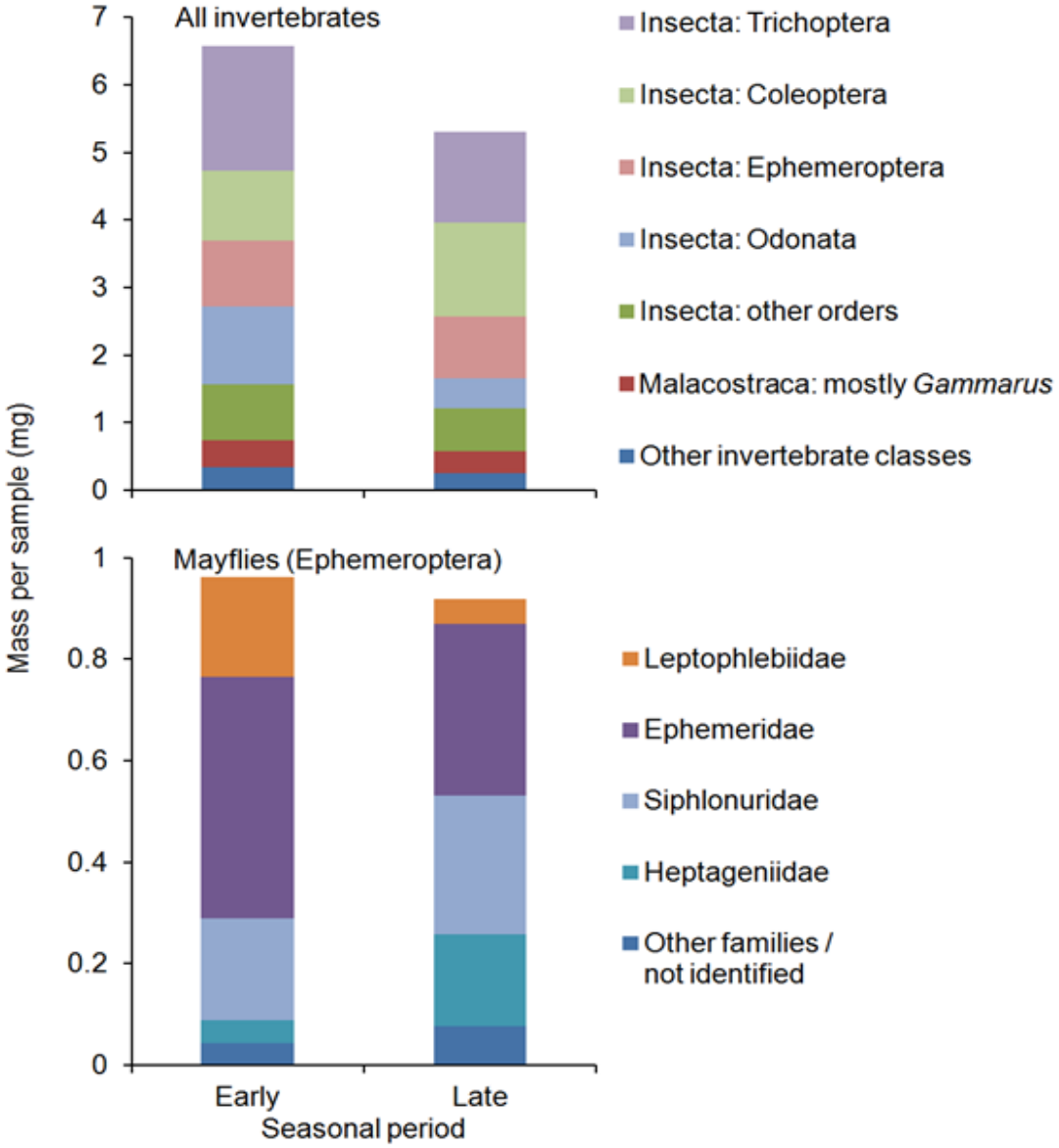
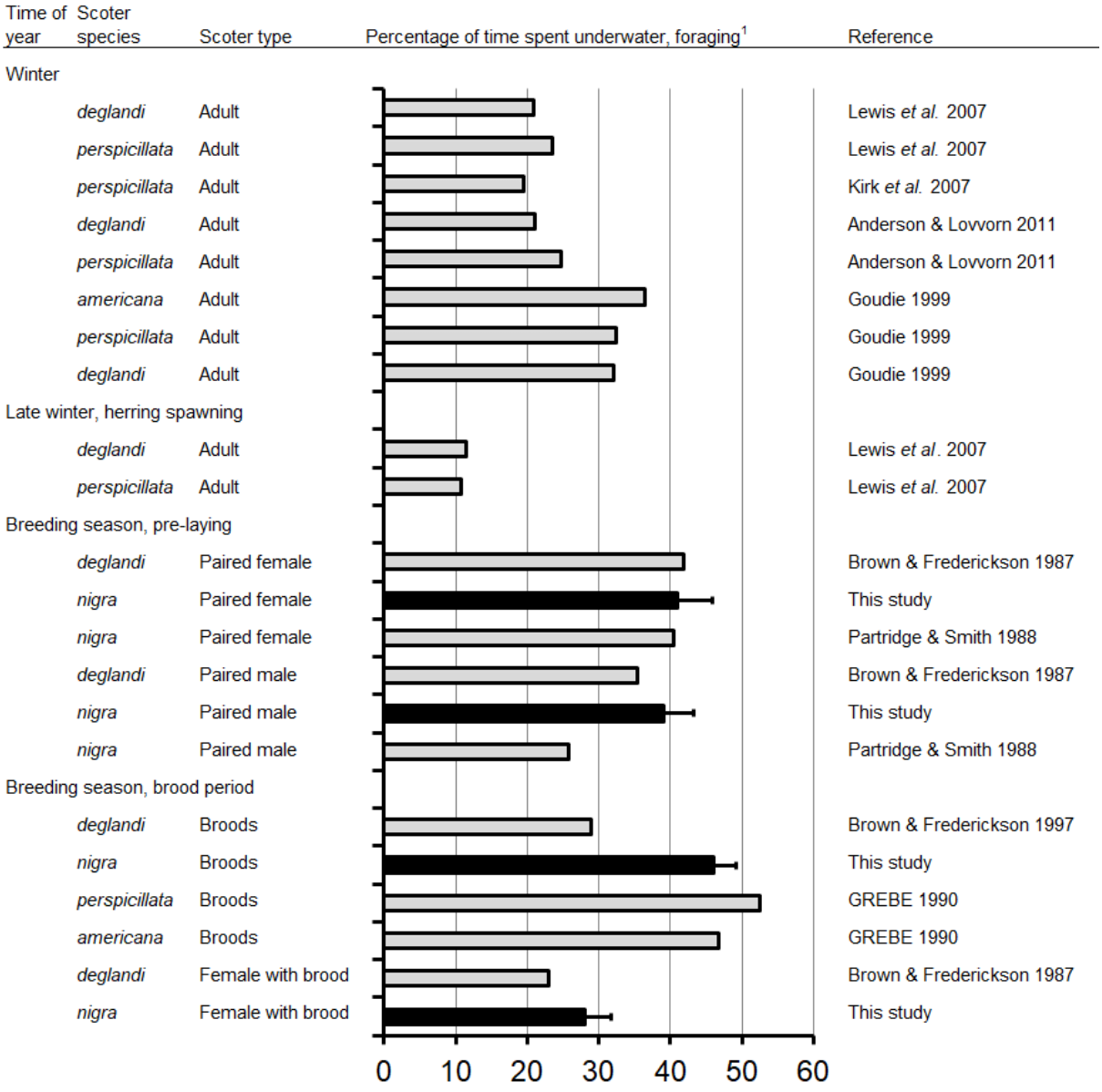


Fig. S3 Comparing the foraging time budgets of scoters (*Melanitta* spp.), between this study (black bars, with lake-level standard errors) and other studies (grey bars). Where a study included more than one species, site or period, a mean species-level value was calculated, weighted by the sample size of each site or period.



1. Two other relevant studies give foraging time, without clearly stating whether this was underwater time only, or included foraging related activity on the water's surface, such as 'dive pauses'. Mikola *et al.* 1994 found that *M. fusca* ducklings spent 41% of their time feeding. Savard *et al.* 1999 found that *M. perspicillata* ducklings and accompanying females spent 58% and 32% of their time feeding, respectively.

Supplementary references

Anderson, E.M. & Lovvorn, J.R. 2011: Contrasts in energy status and marine foraging strategies of white-winged scoters (*Melanitta fusca*) and surf scoters (*M. perspicillata*). — Auk 128: 248-257.

GREBE, 1990: Hydro-Quebec, Vice-Presidence Environment. Complex Grande-Baleine. Avant-project - Phase II. Etude de l'Avifaune et du Castor: Ecologie des macreuses a bec jaune (*Melanitta nigra*) et a front blanc (*Melanitta perspicillata*) en periode de reproduction sur le territoire du complexe Grande-Baleine. — Consortium Gauthier and Guillemette, Quebec.

Kirk, M.K., Esler, D. & Boyd, W.S. 2007: Foraging effort of surf scoters *Melanitta perspicillata* wintering in a spatially and temporally variable prey landscape. — Canadian Journal of Zoology 85: 1207-1215.

Mikola, J., Miettinen, M., Lehikoinen, E. & Lehtilä, K. 1994:. The effects of disturbance caused by boating on survival and behaviour of velvet scoter *Melanitta fusca* ducklings. — Biological Conservation 67: 119-124.

Savard, J.-P.L., Reed, A., Aubry, Y., Morrier, A., Lesage, L. & Reed, E. 1998: Time budgets of surf scoter broods. In Behaviour and Ecology of Sea Ducks, Canadian Wildlife Service Occasional Papers no. (eds. Goudie, R.I., Peterson, M.R. & Robertson, G.J.): 21-26. — Canadian Wildlife Service, Ottawa.