Marine Mammal Scientific Support Research Programme MMSS/001/11

CSD 4 Report

Harbour seal decline: population modelling

Executive summary

A baseline model was developed to estimate harbour seal (*Phoca vitulina*) demographic rates, such as fecundity and survival for different age classes. Count data and two independent estimates of population size based on capture-recapture photo-ID studies, were used to fit the model along with historical records of shooting of seals in the area. Modifications made to an earlier model (Matthiopoulos *et al.*, 2013) resulted in a more realistic and robust version. The estimated demographic trends are very similar to the original model but with a considerably better fit to the independent estimates. Using simulations based on the fitted model, the sensitivity of the population growth rate to different scenarios of fecundity, survival or seal management was investigated. The results of fitting the baseline model suggest that of the demographic trends, the fecundity rate appears to be the most variable in time and the parameter most sensitive to environmental changes. The most important age class in the population are the adult females (Harwood & Prime, 1978). If the adult female annual survival rate decreases by 5% per annum then the population will decline.

Next, the possible effects of other covariates that could potentially have an impact on these rates were investigated, including prey covariates: herring (*Clupea harengus*), Atlantic cod (*Gadus morhua*), sprat (*Sprattus sprattus*) and sandeels (*Ammodytes marinus)*; environmental covariates: sea surface temperature (SST), North Atlantic oscillation (NAO) winter index; interaction covariates: counts of grey seals in northern Moray Firth; and biotoxin data: mussel concentration of saxitoxin and domoic acid. Over all the models two covariates were significantly different to zero, indicating a correlation between (a) grey seal (*Halichoerus grypus*) abundance and harbour seal pup survival, and (b) sandeel abundance and fecundity. With the grey seal abundance covariate included in the model the trend in the pup survival rate is very different to the one in the baseline model, with a decreasing pup survival rate linked to an increase in the grey seal population size.

Finally, to explore the potential to fit such models at sites where fewer data are available, the baseline model was modified such that only one part of the data was used to fit the model. Results were then compared with those obtained using the full data set. For the model run with only moult data either the fecundity rate was fixed using the value estimated by Cordes (2011) or an informative prior to the fecundity rate was set. The model overestimated the abundance but abundance trends were similar to estimates based on the full dataset. With a minimum of one breeding survey per year the results were much better. This time the non-pups were slightly overestimated but the fecundity and the pup survival trends were very close to the credible interval of the baseline model.

In conclusion, if the objective is to understand what parameters drive harbour seal vital rates (fecundity and survival), and to predict the status of the population, it is very important, as a minimum to collect both regular harbour seal moult counts and pup counts and to collect covariate data on potential drivers at a local level.