1 Regional habitat models – an alternative to wildlife mapping in Norway

Leif Kastdalen
Hedmark University College/Norwegian Space Agency
Evenstad/Oslo, Norway

Jan Paul Bolstad and Terje Krogh
Directorate for Nature Management
Trondheim, Norway

1.1 Introduction

Maps indicating the occurrence of animal species or suitable habitats are produced in several ways (Scott et. al. 2002). The Norwegian Directorate for Nature Management began early to produce maps that showed important habitat for different wildlife species (DN-handbook 1996). Those maps were made mostly from knowledge of local people. These informant-based maps were difficult and costly to keep updated and suffered from a lack of objectivity. Maps were imprecise due to rapid landscape changes or the lack of informants in some places.

Alternative methods are used to produce wildlife maps through the use of habitat models that are based either upon empirical observational data or expert knowledge of species habitat associations, or a combination of the two. Observational models are linked to the data that derived them, and it is often difficult to sample observational data representative for large areas. Good empirical data can be used to produce precise maps. Expert-based models are more general, are easier to adapt to new areas and have been shown to work well for large areas like counties.

1.2 The expert model

As a part of a joint program (SatNat) between the Norwegian Directorate for Nature Management (DN) and the Norwegian Space Centre (NRS), a production line for creating county-level maps of potential habitats has been developed (Bolstad et. al. 2005). The production line generally follows the procedure used in the Gap Analysis Program of the United States (Csuti & Crist 2000), with adaptations to available data sources in Norway. The process of making maps has been automated through the development of an extension to ArcView 3.x. This article describes the analysing process in this extension. The production of a database with habitat association for a selection of wildlife species is described by Bevanger (2007) and more detailed information of the satellite based land cover data is described in Vikhamar et al. 2004 and Lieng et al. 2006.

Before making the habitat models it was necessary to pre-process the data. Distribution data from the Norwegian Ornithological Association and the Norwegian Zoological Association (ATLAS–data) together with species distribution data from the DN Naturebase are combined and converted to raster layers. For 168 species a map are produced showing those quadrants of 10 x 10 km where the species have been observed.

In order to map the habitat parameters, we used a standard topographic map in scale 1 : 50 000 (N50), a map of vegetation geographical zones (continuous data) in the same scale (Lieng et al. 2006), a digital elevation model with 25 meter pixel resolution and a land cover map derived from Landsat satellite data with 30m meter pixel resolution.

The pre-processing include dividing the data into several thematic layers and convert the vector data to raster formats equivalent to 30m Landsat pixels, reclassifying the vegetation zones into standard categorical zones, making maps of slope and aspect and separating the land cover data into 5 broad groups with 3 -11 classes each (Table 1).

Table 1. *The different landscape parameters used in the model for Sør-Trøndelag county.*

Main groups	# of classes	Classes used in the model
Open areas at lower elevation	10	Sparsely vegetated, lichen-dominated, heath-/shrubland, meadows, other grass-dominated areas, coastal heathland, developed areas, shoreline, seashore meadows
Agriculture areas	3	Fertilized and surface treated, fertilized pasture, grazing land
Bogs	3	Bog with trees, wet bog, open bog
Forest	11	Clearcut, young coniferous forest, dense spruce, open spruce, dense pine, open pine, sparsely vegetated, unproductive land, broad-leaved forest, dense boreal forest, open boreal forest, mountain birch forest
Mountains	6	Barren areas, sparsely vegetated areas, lichen-dominated areas, heath/shrubland, meadows, other grass- dominated areas
DEM	3	Elevation, slope, aspect
N50	8	Sea, lake/pond, river/stream, glacier, wetland, road, railroad, developed areas

Habitat associations were a central part of the model. We created a database of habitat associations in spreadsheet format, with columns representing habitat variables and rows representing species (Bevanger 2007). These were derived from expert knowledge and literature studies. We classified each map category (table 1) as either “used” or “not used” by the species, or “unknown” when we did not have sufficient data or knowledge. We identified values for upper and lower limits for maps with continuous variables

A given wildlife species tends to prefer or avoid different features of the environment. We coded such data (roads, water, built-up areas, etc.) as “including” or “excluding” and identified an effective buffer distance. Buffer distance were only used when avoidance of, or attraction to, different environmental qualities were known for the species.

The Arcview 3.x extension conducts analysis for a species selected by the operator. A Microsoft access database is linked to the extension by ODBC, and the extension makes complicated calculations which link the information from the habitat association database with all the different raster grids.

In a post-processing analysis the map of potential habitats is spatially generalised by using a majority filter, and the distribution delimited by the 10 x 10 km quadrant map of observational data. As a result two maps are produced, with one map showing potential habitat and the other the probable species distribution. The species distribution is only a limitation of the potential habitat based upon the result from the 10 x 10 km quadrant map of observational data. It is possible to save temporal maps made during the calculations. These maps are useful for identifying where the models can be improved.

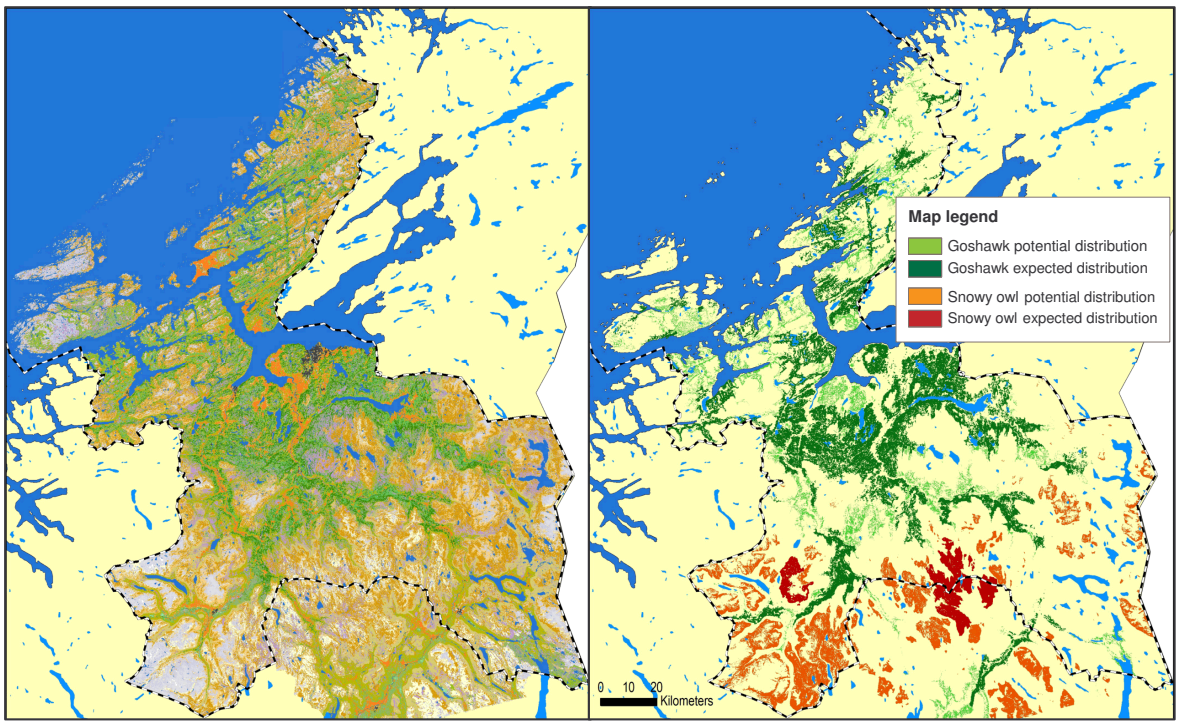


Figure 1. *Model predictions for Goshawk and Snowy Owl in Sør-Trøndelag and northern part of Østerdalen. Predicted is before using observations within the 10 x10 km Atlas quadrants to adjust the distribution, expected is after adjustment.*

For Sør-Trøndelag county (19 000 km²), the analysis for one species takes approximately 3 minutes on an ordinary desktop computer. A manual analysis of the same data would take several days. Figure 1 shows an example from the model for two species in Sør-Trøndelag.

1.3 Validation

So far the results have not been comprehensively validated. Few good data exist for conducting an accuracy assessment. In Østfold county, Finne (2005) compared the distribution maps from an expert model with observational data for four avian species. Data from Nightjar (*Caprimulgus europaeus*) and Woodlark (*Lullula arborea*) were sampled by drawing circles with a radius of 100 meter around those areas were the species had been observed. Counts of Black Grouse (*Tetrao tetrix*) and Capercaillie (*Tetrao urogallus*) were conducted by hunters with free-ranging pointer dogs in early August. Both the bird observations and the track of the hunter were determined with GPS. A 60 m buffer around the tracks was defined as the study area. Within the defined study area the percent of estimated habitats and the number of observations in estimated habitats were calculated. Finne suggested that the habitat model worked well for predicting a distribution if there were a low percentage of estimated habitats inside the sampling areas and the observational points covered a high percent of suitable habitats estimated by the model.

There were good matched s between the habitat model and the observations for Nightjar and Woodlark (Table 2). The habitat associations used in the model are clearly capturing important habitat variables for these two species. Capercaillie had a high percent of observational points in estimated habitat (92%), but also a high percent of estimated habitat inside the buffer. Black Grouse had a low percent (43 %) of estimated habitats in controlled areas and a similar proportion of observational points in estimated habitat (45%). The result for the Capercaillie is not unexpected due to the high percent of estimated habitat inside the controlled area (the buffer area). A conclusion from the assessment of Capercaillie and Black Grouse was that the habitat variables in the land cover map were not detailed enough to give a good identification of important summer areas.

For capercaillie, 49 leks were located with GPS in the eastern part of Halden municipality. Nearly 80 % of the leks were located in habitats estimated from the model, while the study area cover less than 40% of these preferred habitats (Tabel 1). These results indicate that the estimated habitat map gives a good prediction of the distribution of potential lek areas.

Table 2. *Accuracy assessment based on observational data and suitable habitats estimated by the model for four wood living species.*

Species	A (%)	B (%)
Nightjar	39	85
Woodlark	37	76
Capercaillie	84	92
Black grouse	43	45
Capercaillie leks	39	77

A – percent cover of estimated habitats in controlled areas
B – percent of observational points in estimated habitats

Recommendations from the accuracy assessment on four species indicate that the present habitat model is useful as a supplement to wildlife mapping based on field surveys to delimit areas of interest. This is especially valid for species with a good match between the habitat model and the land cover variables.

1.4 References

Bevanger, K. 2007. Predicting vertebrate distribution: Database input needs for expert generated species–habitat associations. In: Habitat modelling. A tool for managing landscapes?, eds. Brainerd, S., Seiler, A. & Kastdalen, L. p.37-41. NINA Report xx-2007.

Bolstad, J.P., Krogh, T., Bevanger, K., Kastdalen, L. & Finne, M. 2005. Predicted animal species distribution: use of expert models and satellite data in a geographic information system (GIS). – Paper presented at the 31st International Symposium on Remote Sensing of Environment, St. Petersburg 20–24 June 2005.

Csuti, B & Crist, P. 2000. Methods for Developing Terrestrial Vertebrate Distribution Maps for GAP Analysis. Ver. 2.0.0. Idaho Co-operative Fish and Wildlife Research Unit. University of Idaho, Moscow, ID, USA.

Direktoratet for Naturforvaltning. 1996. Viltkartlegging .DN- håndbook 11. Trondheim, Norway.

Finne, M. 2005. Test av satellittbaserte viltkart for Østfold fylke. Utmarksavdelingen for Akershus og Østfold.

Lieng, E., Kastdalen, L. & Bolstad, J.P. 2006. Satellittdata til kartlegging av arealdekke. Utprøving av tilgjengelige kartdata for klassifisering av Sør-Trøndelag. Direktoratet for Naturforvaltning DN-Utredning 2006-5. Trondheim, Norway.

Scott, J.M., Heglund, P.J.& Morrison, M.L. (eds). 2002. Predicting species occurrences. Issues of Accuracy and Scale. Island Press, Washington.

Vikhamar, D., Fjone, G., Kastdalen, L. & Bolstad, J.P. 2004. Satellittdata til kartlegging av arealdekke. Utprøving av beslutningstremetodikk i Østfold fylke. Direktoratet for Naturforvaltning DN-Utredning 2004-3. Trondheim, Norway.