

Habitat preferences and prey composition of Saker Falcon (*Falco cherrug*) wintering in Sicily

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INTRODUCTION

The Saker Falcon breed in Central and East Europe, especially in the Pannonian Plain (Hungary) and the southern part of Ukraine. However, a small contingent of individuals uses the Mediterranean area, in particular Sicily, to overwinter. Satellite tracking and continuous monitoring of an individual in particular, during the winter 2012-2013, allowed the identification of the roost and the collection of pellets that provided first-hand data on diet during the wintering period. Moreover, to investigate habitat use during winter and the future prospection of individuals in Sicily, was drawn a Species Distribution Model (SDM), a statistical approach that combined Saker Falcons observations (satellite GPS fixes) with estimates of environmental variables. SDMs are now widely used to gain ecological and evolutionary insights and to predict distributions across terrestrial landscapes, freshwater habitats and marine realms.

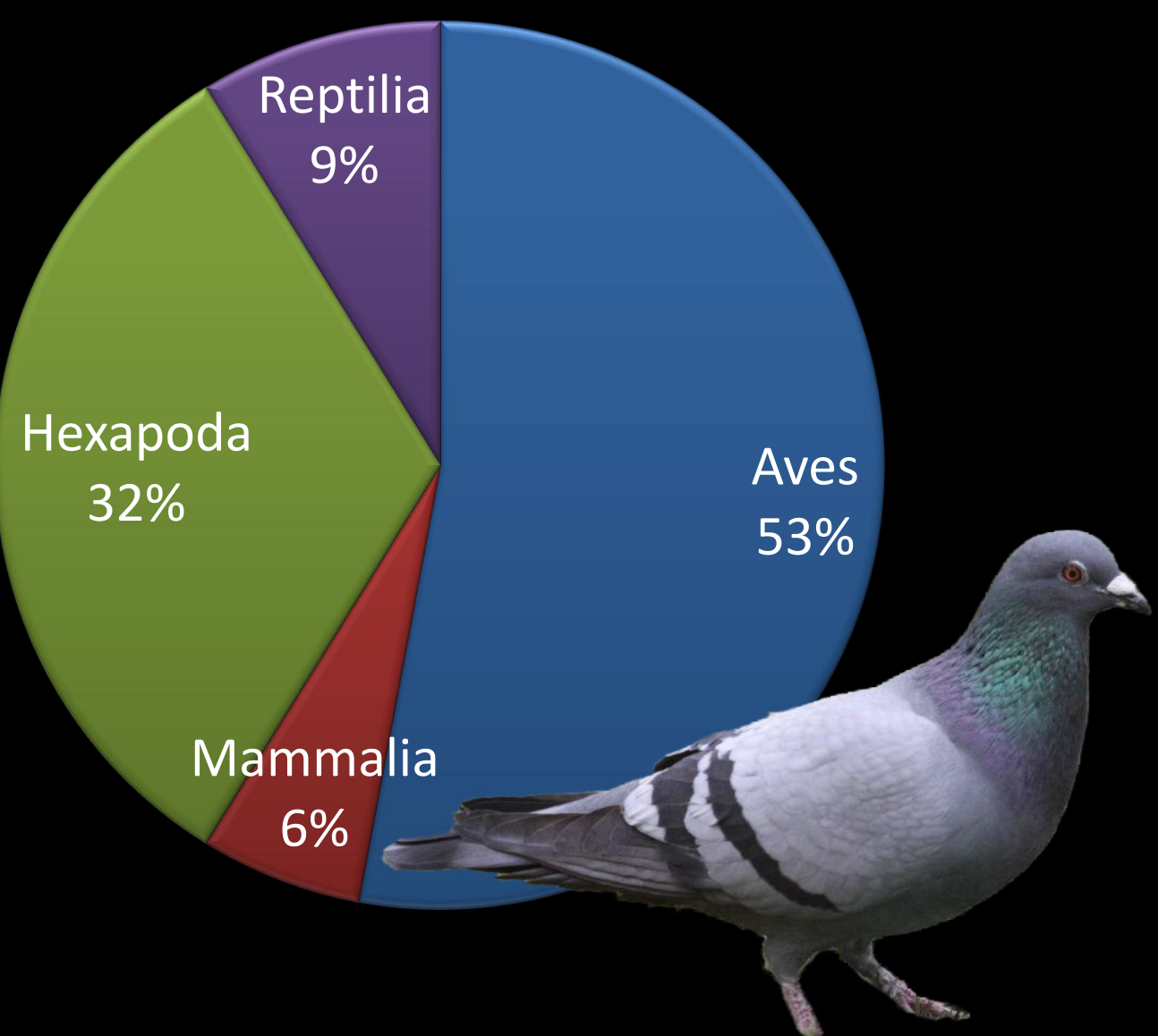


Fig. 1 – Prey remains found in the Saker Falcon pellets

MATERIALS AND METHODS

Maximum entropy modelling (Maxent; Dudík *et al.*, 2004; Phillips *et al.*, 2006) is a technique adopted from statistical mechanics that adopts presence-only data to render probabilistic distribution models and suitability maps for a given species. Maxent performs well in comparison with traditional presence-absence methods such as generalized additive models and is also fairly robust in dealing with correlations among environmental variables therefore reducing some of the uncertainty arising from the model selection. Modelling of satellite fixes was conducted by using Maxent 3.3.3 software with its default model parameters.

RESULTS

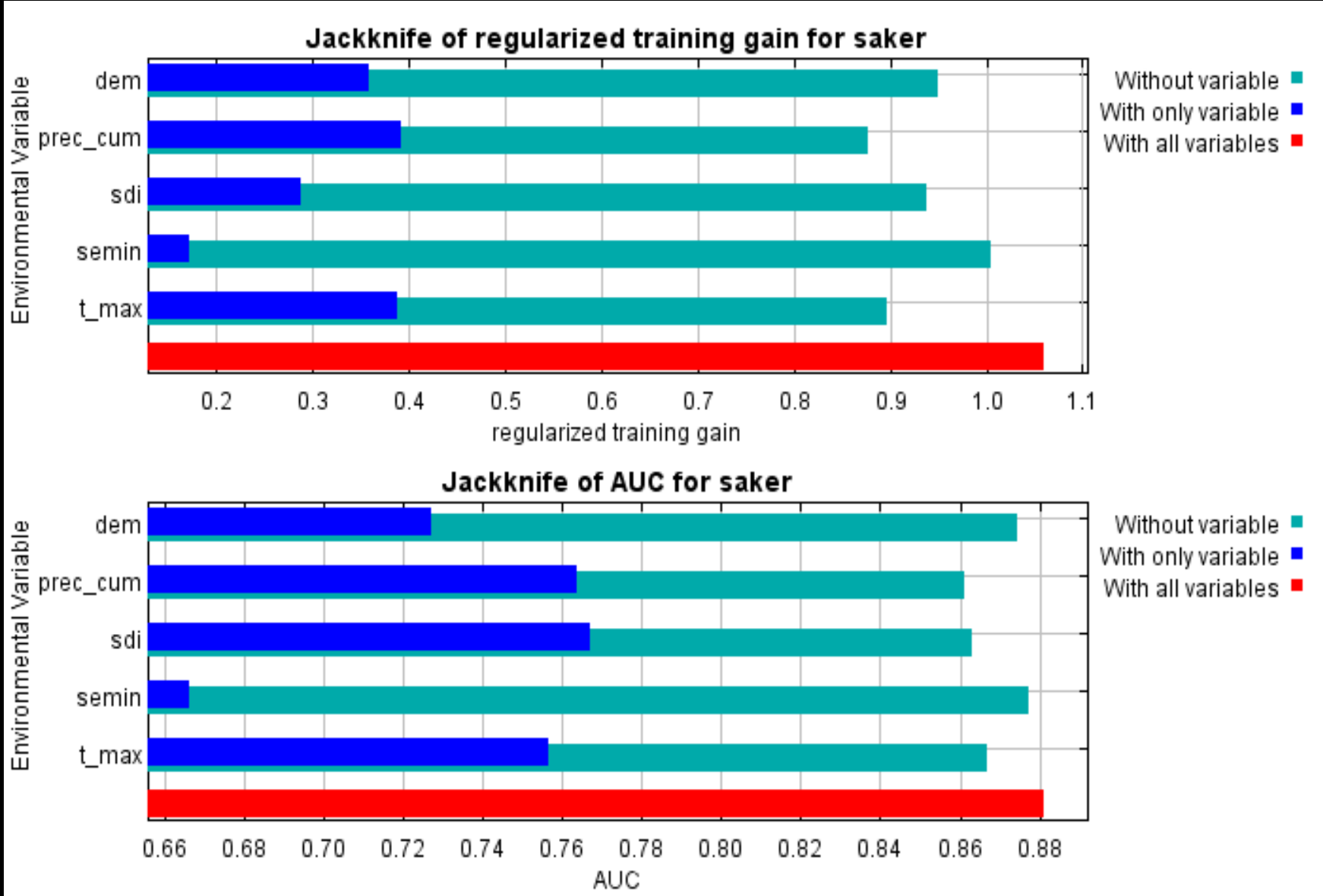
The results of pellets analyses are in Fig. 1. The 53% of recovered pellets contained remains of birds, whose 47% were represented by Feral Pigeons (*Columba livia*), the most hunted prey. Other preyed species in order of abundance were: *Sturnus vulgaris*, *Passer hispaniolensis*, *Galerida cristata* and *Tringa sp.* A remarkable 32% of pellets contained insects. Insects were mainly Orthoptera (*Anacridium aegyptium*, *Calliptamus barbarus*, *Eyprepocnemis plorans* and *Aiolopus strepens*), Coleoptera (*Carabus morbillosus*, *Pentodon bidens*, *Chrysomela sp.*), plus some Mantodea (*Mantis religiosa*) and indetermined Odonata. Insect use during winter was much higher than predation upon other vertebrates, like Reptiles and Mammals. Those latter being represented by only three species: *Oryctolagus cuniculus*, *Natrix natrix* and *Chalcides ocellatus*. These data show a shift of the diet during winter in the Mediterranean with respect to the nesting period in Central and Eastern Europe, where the Saker Falcon most preys upon small mammals such as *Spermophilus* ground squirrels.

The Maxent model estimated the relative contributions of the environmental variables contributing to the Saker SDM in Sicily (Table 1). By permutation, seasonal (Oct-Feb) overall precipitation (prec_cum) was the most important variable, together with the average of seasonal maximum ambient Temperature (t_max) and altitude a.s.l (dem). Fig. 2 shows the results of the jackknife tests of variable importance. The environmental variable with the highest modelling gain when used in isolation is prec_cum, which therefore appears to have the most useful information by itself. Again the environmental variable that decrease the gain the most when it is omitted is prec_cum, which therefore appears to

Variable	Relative contribution (%)	Permutation importance (%)
Mean max T (°C)	29.9	25.3
Overall rainfall (mm)	23.8	28.4
Altitude a.s.l.	17.8	26.7
Landscape diversity	17.4	16.0
Arable land (ha)	11.1	3.6

Table 1 – The most important variables resulting from the final Maxent model

Fig. 2 – Variables most contributing to Saker Falcon habitat use during winter



have the most information that is not present in the other variables. Values shown are averages over 10 replicate runs. In addition, the jackknife test, using AUC on test data, records the high contribution of landscape diversity (Shannon diversity index, sdi) (AUC = 0.765) followed by prec_cum (AUC = 0.762) and t_max (AUC = 0.758). The response curve modelling the probability of Saker Falcon presence respect to overall precipitation has been reported in Fig. 3 and shows how the falcons use dry habitats in winter (overall precipitation 70-90 mm). Eventually, the mapping of the final logistic model, averaged among the 10 grids from the replicate runs has been reported in Fig. 4. The Saker Falcon used the southern habitats of Sicily from west to east, with three core areas (red and yellow in Fig. 4) located in the Trapani Province, the Gela Plain and the Catania Plain. Conservation action need to be directed in those areas to prevent illegal hunting, collisions with power lines and other risks to the wintering individuals.

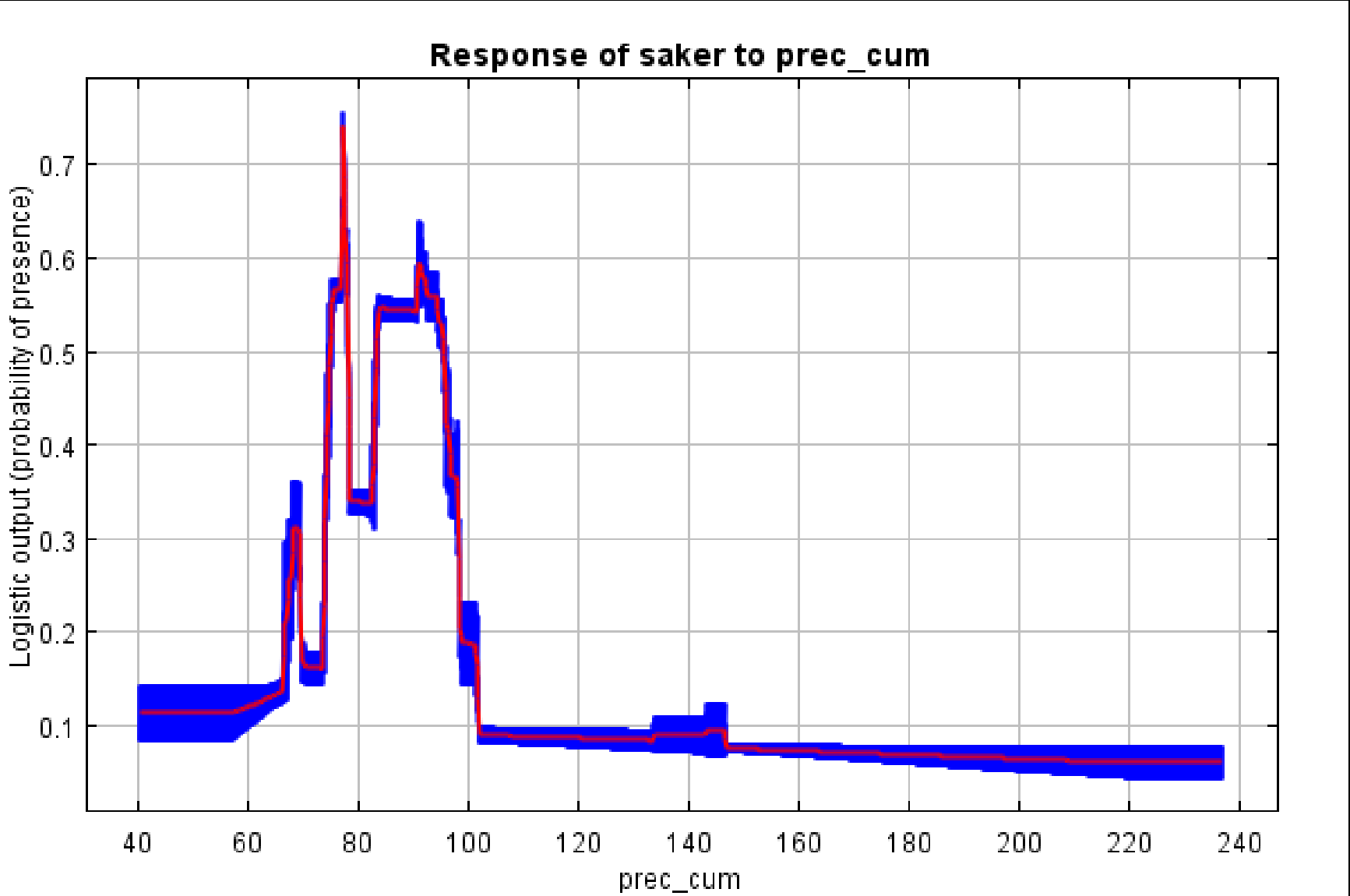


Fig. 3 – Probability of Saker Falcon presence in relation to overall winter precipitation

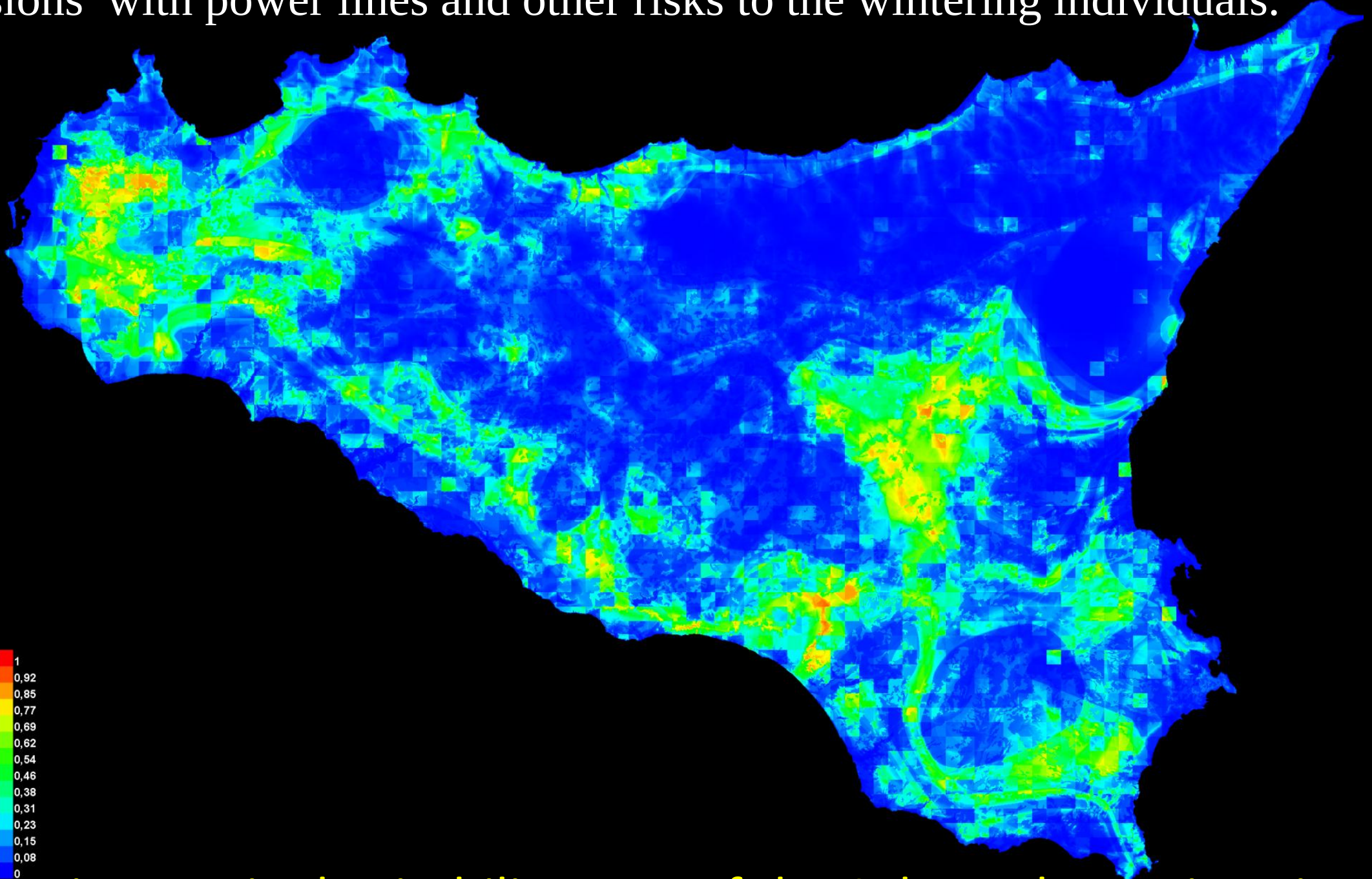


Fig. 4 – Final suitability map of the Saker Falcon wintering areas (red most suitable, blue less suitable).