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Dependence of clutch predation rate of Eurasian reed warbler *Acrocephalus scirpaceus* on nesting site selection: a model study

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Abstract: The article is focused on describing a possible way of how biological data can be processed, introduces the procedures used and compares the results gained from a field ornithological study. This was carried out using statistical methods of nonparametric regression with binomial classification and probit function together with the method with forward selection, and presents the most significant outcomes. Some of the interesting findings of this study are as follows: first, a lower level of reed warbler (*Acrocephalus scirpaceus* Hermann 1804) nest predation by bird predators was proven in the common reed [*Phragmites australis* (Cavanilles) Trinius 1841] stands growing in shallow waters, compared to nests located in stands growing in deeper waters. For this field research artificial nests containing one egg made of plasticine and one egg of Japanese quail were used. Second, a negative correlation was proven between predation of nests and their distance from the nearest tree, whereas no interdependence was proven either for various nesting-site types (oligotrophic sandpits, ponds with intensive fish-pond management and ponds with extensive use) or monitoring time (during the first, resp. second nesting). Based on the methods applied, 56% of egg predation variability was clarified and last but not least, the efficiency of these statistical methods was proven for practical use in similar field research zoological studies.

Key words: artificial nests; sandpit; pond; nonparametric regression; probit function

Introduction

Like many other animals, waterfowl belong to a group of endangered species and therefore many authors (e.g., Musil 1998, 2000) have been concerned with various aspects of the biology of birds living in aquatic and wetland ecosystems in the Protected Landscape Area Třeboňsko. One of the additional works in this field is a study dealing with nest predation of eggs. A suitable species for this kind of research are species of bird whose abundant occurence can provide enough data. One of such species is the Eurasian reed warbler (*Acrocephalus scirpaceus* Hermann 1804).

It is necessary to mention that during the nesting period of reed warbler not only the food variety at their nesting site, but also the safety of their nest and brood against bird predators and parasites are important. There are various ways of how the birds protect their clutches. As observed, the most common ways of protecting the nests are hanging them on or attaching them to safer sites, and very often in lower quantities. Among others, there are also significant changes in their behaviour depending on more frequent occurrence of predators, such as attacking the predators or (in case of parasitism) removing predators eggs from their nest. Yet the choice of a nesting site still prevails.

Due to behaviour, such as for example more aggressive behaviour against bird predators during the nesting period, the success rate of reed warbler brood leaving their nests has been increasing (Gill 1996; Neudorf 1992). While some bird species tend to prefer nesting sites situated close to residential areas in which potential bird predators appear only rarely (Golawski & Mitrus 2014), others, on the other hand, build their nests within other bird species communities (Polak 2014). Another strategy is building the nest as hidden as possible (Sieving 1998), or building it at sites with less frequent occurrence of nest predators, as described for example in the Sloan et al. (1998) study.

As for nesting, the optimum nesting conditions for reed warbler are both water reeds and terrestrial reeds; the area and spread of reeds are of minor importance. Based on numerous evidence, it was proven that this species tends to search for common reed [*Phragmites australis* (Cavanilles) Trinius 1841] stands with a density of at 40 stalks/m^2 and of minimum height of 120 cm. Its nests can be found in cattail (*Typha* sp.) stands as well and more rarely also in stands of *Urtica dioica*, *Carex* sp., or *Salix* sp. Common is both individual nesting and mass nesting in colonies (Šťastný 2006). The nesting period most often falls within May to July, occurs once or twice a year, and a clutch usu-

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ally amounts to 3–5 eggs. Typically, the nest looks like a deep-dish bowl made of grass with reed panicles spirally wreathed around a few upright reed stalks (Hume 2002) and is hung about one meter above the ground or the water surface (Šťastný 2006).

In order to determine the way warbler will, during their nesting period, react to nest predators, artificial models of potential nest predators and nesting parasites, such as sparrow hawk *Accipiter nisus* (L., 1758), jay *Garrulus glandarius* (L., 1758) or cuckoo *Cuculus canorus* (L., 1758), were placed in the surroundings (Duckworth 1991). As expected, higher frequency and intensity of reactions were observed at artificial models placed in close proximity to the nests, compared to those ones placed in a three-meter distance. Surprisingly, more intensive reactions and aggressive behaviour aroused to a cuckoo model, which was often attacked, whereas in most cases a sparrow hawk model only aroused wariness. Also the intensity of reactions to jay models was comparable with reactions to previous models. An increased intensity of reactions to a cuckoo model occurred after a clutch had been laid, however, it decreased again soon after brood hatching. The intensity of reactions to jay and sparrow hawk models did not vary. A noticeable decrease of great reed warbler reaction intensity to a cuckoo model after brood hatching was also described in the study carried out by Moskát (2005). The study of Čapek et al. (2010) proved that the reaction intensity to a cuckoo model tends to decrease not only during the season but also within the day. And the study of Stokke et al. (2007), which was concerned with possible cuckoo (*C. canorus*) parasitism predictors in 16 reed warbler populations all over Europe, revealed that the density of host nests seemed as a significant predictor for parasitism, for in cases with insufficient density of the host population, cuckoo parasitism did not occur.

Other two ways of defensive behaviour of reed warbler against nest predators are flocking together, which means that nesting pairs gather in flocks, and earlier egg-laying, for both of which the distance from a tree is a significant factor. And there are two more facts worth mentioning, the first one is the finding that individuals nestling further from a tree lay considerably heavier eggs (Øien et al. 1996), and the other one is that birds whose nests were predated usually reflect this negative experience in their nest building. This means that on the one hand the same rate of predation threat persists for those who have changed their nestling habits, but on the other hand increases for those with unchanged nestling habits (Halupka 2014).

Another necessary precondition for protecting reed warbler species from nest predation is a change in behaviour of nestling birds, especially in their movement, which was described in the study of Trnka et al. (2006).

As known from previous studies, nest predation rate or parasitism depend not only on the density of host nests, but also on the nesting site and structural features of stands. Generally, nest predation is more frequent at the margins rather than in the interior of the stands (Báldi et al. 1999, 2005; Batáry et al. 2004). Honza et al. (1998) mentioned higher nest safety of nests located further from a tree or of those ones hidden inside the vegetation. On the contrary, Kameníková (2009) came to a conclusion in which the correlation of brood survival rate depending on distance from a tree, as a place with potential predator threat, turned out not to be significant. Batáry et al. (2005) came up with another important finding which is related to stand density. The higher the stand density was, the more successful was brood survival and leaving the nest.

According to the study of Darolová et al. (2014), which compared nest predation rate in cattail (*Typha* sp.) stands and in common reed stands, lower nest predation rate was observed in those cases in which reed warbler nested in cattail (*Typha* sp.) stands. But no preference of cattail stands to common reed stands was proven. Nevertheless, females nesting in cattail laid bigger and heavier eggs. A similar study with a different species, the great reed warbler *Acrocephalus arundinaceus* (L., 1758), was carried out by Trnka et al. (2009), yet no considerable preference of one of the two compared vegetation types was observed. Therefore no direct dependence between the vegetation type and successful nest leaving was proven to exist. The only clear difference noted was that artificial nests were more frequently predated in common reed stands than in cattail.

Trnka et al. (2014) also conducted a study dealing with the impact of mowing reed stands on successful nest leaving of passerines nestling in reed stands. They came to a conclusion that, unlike large-scale mowing and areas with no management, mosaic-type and small-scale mowing of reed stands affect both clutch survival and higher density of arthropods, serving as a food resource, in a positive way. However, the study of Graveland (1999) showed reed warbler and sedge warbler, *Acrocephalus schoenobaenus* (L., 1758), preference for unmown stands. The explanation to such behaviour is that unmown stands enable earlier nest building, and, unlike the mown reed stands, there is no neccessity of searching for an appropriate nesting place.

Among others, Lopez-Iborra et al. (2004) focused on comparing the nest predation rate of reed warbler and great reed warbler; great reed warbler is characterized by building bigger nests than reed warbler. They used the method of experimental nests and proved that predation of experimental nests of reed warbler was less frequent than for those of the great reed warbler. Nevertheless, the number of eggs surviving was the same for both species, which means that both of the Warbler species are threatened by the same predators. And last but not least, the study showed that the predators are not attracted by the smell of eggs.

This study seeks to assess the impact of selected factors affecting nest placing and the nest predation rate, and is based on the above mentioned studies and their findings regarding nesting habit and bird predators of the reed warbler species.

Table 1. Influence of water depth and distance from a tree on *Acrocephalus scirpaceus* clutch predation.

Effect	Estimate	Standard error	Wald Statistics	P
Intercept	1.212	0.375	10.412	0.001252
Water depth	–0.034	0.007	22.094	0.000003
Distance from a tree	0.125	0.060	4.308	0.037932

Methods

Data collection

In 2008 (from the beginning of June to the end of August) observations of reed warbler nest predation were carried out using artificial nests and reflecting the following indicators/dependencies: distance from water bodies (assessed by water-depth measurement), distance from the nearest tree and height above the water surface. The distance between individual artificial nests was ten metres.

The nestbase was made of plastic badminton balls, which were wreathed by dry blades of grass, so that the nest in its shape and size resembled to a reed warbler one. Originally white badminton balls were painted dark brown and were fixed to form a solid frame of an artificial nest which would not subject to weather conditions. The nests were attached with a dark green string to reed stalks at a height of 50 cm above the water surface, which corresponded to a common height at which natural reed warbler nests were found at that site. Then a noticeably bigger Japanese quail (*Coturnix japonica* Temminck & Schlegel, 1849) egg and a plasticine (brindle coloured) egg – of size and shape equivalent to reed warbler eggs – were put into the nests. Subsequently, according to the way the eggs were damaged and by beak and teeth imprints on plasticine eggs, the predator species (bird, mammal) were identified.

Artificial nests were placed at three sites with reed warbler occurrence, all of them vegetated with common reed stands. Intentionally, three different sites – a sandpit (locality Halámky, 48°49′20.0522245″ N, 14°57′1.1975098″ E, a pond with an intensive fish-pond management (fishpond Naděje, 49°6′46.7427268″ N,14°44′56.9238281″ E) and a pond extensively used for sport fishing (pond Staňkovský, 48°59′6.6263518″ N, 14°59′2.3217773″ E), and two monitoring periods – the period of first nesting (June 1 to June 30) and second nesting (July 15 to August 15) of reed warbler (first period in June, second period in July to August), were selected. The aim was to minimize the impact of different nesting conditions and nesting times. Each monitored site amounted to 30 nests, which made 90 nests in total. All of the three sites are situated in The Czech Republic at the region of South Bohemia (Protected Landscape Area Třeboňsko) and were checked every week during the whole monitoring period, except for a two-week pause after the first month.

Data analysis

As for the data analysis, data collected in the following cases were disregarded: first, cases in which the nest predators turned out to be mammals (4 cases) and secondly, cases in which it was not possible to identify clearly the predator (10 cases). All of the other cases were divided into 2 groups – unpredated (63 nests) and predated by birds (13 nests).

The indicator of predation/non-predation was defined as a dependent variable. Independent variables were represented mainly by manipulated variables, the impact of which subjected to testing – distance from water bodies, distance from the nearest tree and height above the water surface (all of them as ratio variables). Independent variables further included key factors affecting the relation between predation rate and tested site, i. e. site and monitoring time (both of them as nominal variables).

For establishing the influence of independent variables on bird predation, the method of nonparametric regression for binomial distribution with Probit link function and forward stepwise model building were applied. Data were not transformed. Appropriateness of the model was assessed by using common indicators, e.g., the Hosmer-Lemeshow test to determine how well the model fits our data, and Nagelkerke pseudo-R^2, as a measure of variability explained by the proposed model.

Results

According to the results of the analysis of data collected in the field we managed to achieve a model that fits our data very well (Hosmer Lemeshow = 10.134; $P = 0.256$), and that clarifies 56% of the prediction variability for predation of reed warbler eggs.

Table 1 summarizes the results for two variables which were selected because they, from the point of statistics, significantly contribute to the explanation of variability whether the nests were predated by birds or not. Considering the fact that these two variables clarify 56% of variability, they can be regarded as significant. The shallower the water was and the further the distance from the nearest tree was, the less frequently the nests were predated. And more interestingly, the depth of water, in the place where the nest was located, proved to be more significant rather than the height at which the nest was hung above the water surface, which seemingly does not correspond with the other selected variable – distance from the nearest tree.

Discussion

First, our study showed that higher nest predation rate of reed warbler was more frequently observed at stand margins or narrow marginal reed belt areas rather than at larger stand areas. Similar results were published by Báldi et al. (2005) when the nest predation ratio for all of the stands was similar at all monitored sites, whereas marginal areas were more subjected to the impact of other factors.

Also Batáry et al. (2004) came to similar results which showed the nest predation rate of nearly 50% in marginal areas, whereas the nest predation in the interior of the stands kept at its minimum. By contrast, Ferguson (1994) failed in establishing a significant correlation between nest survival and features of the reed

stand. Only the distance from a margin positively correlated with successful nesting and nest leaving.

A possible explanation to these findings might be that reed stands growing in shallow waters are usually more dense and therefore protect the nests against bird predators in a better way, while those ones growing in deeper waters get less dense and so the nests become more visible and easily accessible for nest predators.

Next, this study supported previous findings that nest predation in shallow waters is typical for mammal predators that can easily approach and access the nest. Unlike the mammals, bird predators that rely mainly on their sight, predate nests in deep waters in reed stands closer to the margin because they can easily spot them from the air.

The same logical parallel can be seen between the predation rate and distance from the nearest tree; potential nest predators, especially jay (*Garrulus glandarius*), observe the prey from nearby trees.

Comparing the predation rate in individual months, the study of Hoi et al. (2001) shows higher predation rate in June. And similar results were also published by Ferguson (1994) who found a similar behaviour pattern at red bishop, *Euplectes orix* (L., 1758) nesting in reed stands in North Africa. In their work Hoi et al. (1988, 1994) mention that the nest predation ratio of reed warbler nests is seasonal and depends on the density of nests located at the observed site. The highest predation rate was measured at the beginning of June, but no significant dependence related to proportions of unsuccessful nesting during the nesting period was proven by Honza et al. (1998). Similarly, neither any obvious impact of a specific site (oligotrophic sandpit, pond with intensive fish-pond management and pond with extensive use), nor of the monitoring time was proven at observed water bodies in Protected Landscape Area Třeboňsko.

Last, this short study proved the efficiency of used statistical methods for practical use in similar field research zoological studies.

Conclusions

To conclude, using statistical methods of nonparamatrical regression with binomial classification and probit function together with the method with forward selection the following conclusions were drawn: first, a lower level of reed warbler nest predation by using of artificial nests was proven in the common reed stands growing in shallow waters compared to nests found in stands in deeper waters. Second, a negative correlation was proven between nest predation and their distance from the nearest tree, whereas no interdependence was proven either for various nesting-site types or nesting period.

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