Ann. Zool. Fennici 45: 102–108 ISSN 0003-455X (print), ISSN 1797-2450 (online)
Helsinki 29 April 2008

Micro-habitat nest preferences of the great bittern, *Botaurus stellaris*, on fishponds in central-eastern Poland

Marcin Polak[1,*], Zbigniew Kasprzykowski[2] & Marek Kucharczyk[1]

[1)] *Department of Nature Conservation, Institute of Biology, Maria Curie-Skłodowska University, Akademicka 19, PL-20-033 Lublin, Poland (*email: mpolak@hektor.umcs.lublin.pl)*
[2)] *Department of Ecology and Environmental Protection, University Podlasie, Prusa 12, PL-08-110 Siedlce, Poland*

Received 21 May 2007, revised version received 10 Jan. 2008, accepted 10 Jan. 2008

Polak, M., Kasprzykowski, Z. & Kucharczyk, M. 2008: Micro-habitat nest preferences of the great bittern, *Botaurus stellaris*, on fishponds in central-eastern Poland. — *Ann. Zool. Fennici* 45: 102–108.

The nest-site requirements of the great bittern *Botaurus stellaris* females in relation to habitat availability were studied in 2003–2006 at fish-pond complexes located in the Lublin and Podlasie regions (eastern Poland). The structure of emergent vegetation and water depth were measured and described in 230 control squares and 98 squares with occupied nests. Water depth, vegetation cover, the height and diameter of reed shoots, the number of flowering shoots, the density of old (dry) and new (green) reed shoots were measured. Great bittern females nested in all available types of emergent vegetation and most of the nests were located in reedbeds. Using the logistic regression model it was shown that when choosing the place for nesting the great bitterns preferred reedbeds with a high density of old-reed stems.

Introduction

Due to a significant loss and degradation of suitable habitats, the great bittern (*Botaurus stellaris*) is a species with high protection status (category 3 SPEC) in Europe (BirdLife International 2004). This is also an umbrella species in wetland protection in the European Union (White *et al*. 2006). Due to the secretive behaviour, cryptic plumage and characteristics of habitats, the great bittern — being the least known heron on our continent — is still a species whose ecology is little studied (Alessandria *et al*. 2003). The results of recent studies confirm that its breeding ecology is different than that of other European herons *Ardeidae* (Voisin 1991, Kushlan & Hafner 2000, White *et al*. 2006). In early spring the males occupy territories located in wet, elevated, marshy habitats where they mate with one to five females (Gauckler & Kraus 1965, Puglisi & Bretagnolle 2005, Polak 2006). However, females alone incubate the eggs and provide food for the chicks (Puglisi & Bretagnolle 2005, White *et al*. 2006). It is thought that the great bitterns inhabit a wide spectrum of habitats and feed on a great variety of food (Gilbert *et al*. 2003, Dmitrenok 2004, Puglisi & Bretagnolle 2005, Poulin *et al*. 2005, Polak 2007a, Polak 2007b), however, most of ecological studies on the great bittern were carried out in countries with insignificant breeding populations nesting in diversified habitats (Poulin *et al*. 2005, Puglisi & Bretagnolle 2005, Gilbert *et al*. 2007). This species breeds in stands of reed *Phragmites australis*, reedmace *Typha langustifolia*, saw-sedge

This article has been scientifically edited by Philip Starks

Cladium mariscus, bulrush *Scirpus lacustris*, but also on rice fields, in wet willow (*Salix* sp.) growth, and even in barley cultures (Cramp & Simmons 1977, Alessandria *et al*. 2003, Gilbert *et al*. 2005a, 2005b, Poulin *et al*. 2005, Puglisi & Bretagnolle 2005, Puglisi *et al*. 2005, White *et al*. 2006, Longoni *et al*. 2007, V. Bretagnolle unpubl. data). Wet reed represents the first phase of the succession in a reed marsh and the great bittern is a bird species dependent on the first stages of the hydroseral succession (White *et al*. 2006).

In Poland, the habitats where the great bitterns appear are primarily eutrophic lake shores and flooded river valleys. In regions devoid of natural wetlands fish ponds become important nesting habitats (Dobrowolski 1995, Dombrowski 2001, Polak & Krogulec 2006). The habitat preferences of the great bitterns on fish ponds have not been described, primarily due to the lack of such habitats in western Europe. However, in middle and eastern Europe these types of semi-natural ecosystems are important in supporting the populations of this vulnerable species.

The main aim of this study was to analyze the influence of micro-habitat parameters on the choice of nesting place by great bittern females on fish ponds in eastern Poland. The null hypothesis was also tested that nest-site preferences of the species are independent of water depth and the degree of vegetation cover. We expected, however, that great bitterns prefer to nest over deep water in tall and dense vegetation because other studies on marsh-nesting birds have documented a decrease in rates of nest predation with an increase in water depth and vegetation density (Martin 1992, Martin 1993, Sanchez-Lafuente *et al*. 1998, Caro 2005, Hoover 2006). Obtained results and conclusions have significant implications for the conservation of great bittern, because they can be valuable in undertaking procedures to maintain or restore appropriate habitats and in formulating postulates for the management of great bittern populations.

Material and methods

Study area

Field work was carried out in 2003–2006 in central-eastern Poland on 10 fish-pond complexes located in the Lublin region: Samoklęski, Garbów, Kraśnik, Uścimów, Czesławice, Niedrzwica, Piaski, Chodel, Opole Lubelskie and Antopol (50°55´–51°29´N, 21°58´–22°54´E) and on 4 fishpond complexes located in Podlasie: Siedlce, Mościbrody, Rudka and Szostek (52°05´–52°11´N, 21°58´–22°18´E). The surface of the studied fish ponds varied from 14 to 185.5 ha. Some ponds were partially covered (range from 0% to 90%) by vegetation stands dominated by reed, reedmace, sedges *Carex* sp. The water level was 0–120 cm in spring within the emergent vegetation and, generally, lower during the breeding season. The common carp (*Cyprinus carpio*) was the most abundant species stocked in all sampled fish ponds. Fish farming in eastern Poland is characterised by the extensive management, and carp production output ranges between 200–300 kg ha^{-1} (Dobrowolski 1995). For more detailed description of the study area and general methods, *see* Polak (2006), Polak and Krogulec (2006), and Polak (2007a, 2007b).

Field procedures

During each field visit, locations of booming males and nests were plotted on 1:5000 maps (*see* map in Polak 2006). The basic method of locating nests was the systematic searching of all potential breeding places in the emergent vegetation from April to the beginning of July (at least once a week). In total, 98 occupied nests were localized in the study areas, which were discovered at the phase of egg laying (29 nests), incubation of eggs (64) and early stage of nestling period (5). Analysis of nest-site preferences was based, with some modifications, on the methodology applied in the studies on great bitterns in the UK (*see* Tyler *et al*. 1998). Micro-habitat measurements were done on potential nesting habitats (control squares on 23 transects) and in nesting places (nesting squares), where the central point was the great bittern nest. At the studied pond complexes, 23 habitat patches of emergent vegetation known to have been used by female great bitterns were chosen for detailed habitat studies. In each vegetation patch one linear 60-m-long transect was established along which 10 control

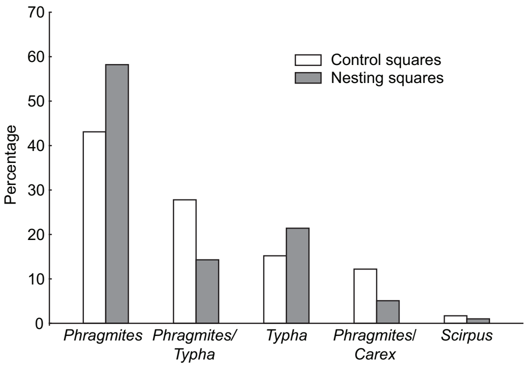

Fig. 1. Frequency of the type of vegetation available at study sites (control squares) and at nests (nesting squares) on fish ponds in the Lublin and Podlasie regions (G-test = 10.91, P = 0.03, df = 4).

squares were marked 5 m one from another. In each 2 m × 2 m square, the water depth and vegetation cover were measured. The degree of coverage of each square by the dominating plant species (*Phragmites, Typha, Carex, Scirpus*) was categorised as follows: I = 0%, II = 1%–20%, III = 21%–40%, IV = 41%–60%, V = 61%–80%, VI = 81%–100%. In addition, in squares with growing reed, selected floral parameters were measured (Table 1). All measurements were made from the end of April to the end of May. Totally, the vegetation and water depth were simultaneously described and measured in 230 control squares and 98 nesting squares.

Data analyses

With the goal of verifying the hypothesis stated in the introduction, the material incorporating all the nesting and control squares was analysed with the logistic regression model (STATISTICA 6.0 pack, Statsoft Inc. 2001). Occupation of a square by the great bittern was treated as a binary concept, where: 0 = lack of nest (control square), 1 = occupied nest (nesting square). The presence of a nest in the square was considered the dependent variable, and habitat measurements as the independent variables. The logistic regression model was also used to specify the preference of select traits and structure of reedbeds. To this end, 76 squares with great bittern nests and 196 control squares were selected for analysis, in which the presence of reed was recorded. All variables were tested on autocorrelation before including into the model. In the analyses, parametric tests were applied before the prior testing for statistical normality using a Kolmogorov-Smirnov test. All tests were two-tailed. Data are presented as mean ± SD.

Results

Female great bitterns nested in all types of emergent vegetation distinguished in the control squares (Fig. 1). The individuals preferred pure reedbeds and stands of reedmace. The presence of reed was noted in 77% of the nesting squares and most nests (58%) were found in the homogenous reedbeds. Most nests (51%) were found in category III of plant cover, considerably fewer in category IV = 31% nests, V = 11%, II = 4%, VI = 3%, I = 0%. The average height of the flowering reed stems in the nesting squares was 2.4 m (SD = 0.46, N = 278, range 1.6–4.0), and the average diameter of the shoots was 5.2 mm (SD = 1.37,

Table 1. The micro-habitat variables obtained at plots with active nests and control squares.

Code	Meaning
WATER	Estimated water depth (cm) at the centre of the plot with 1-cm precision
COVER	Vegetation cover (%) (*Phragmites*, *Typha*, *Carex*, *Scirpus*) in the 4 m^2 in six categories: I = 0%, II = 1%–20%, III = 21%–40%, IV = 41%–60%, V = 61%–80%, VI = 81%–100%
HEIGHT	Mean height of 5 flowered dry reed stems chosen randomly with 10-cm precision
DIAMETER	Mean diameter of 10 reed stems chosen randomly with a calliper precision of 0.1 mm
FLOWER	Number of flowering stems out of 50 stems selected at random within the square
OLD	Number of dry stems within a 50 × 50 cm square
NEW	Number of green stems within a 50 × 50 cm square

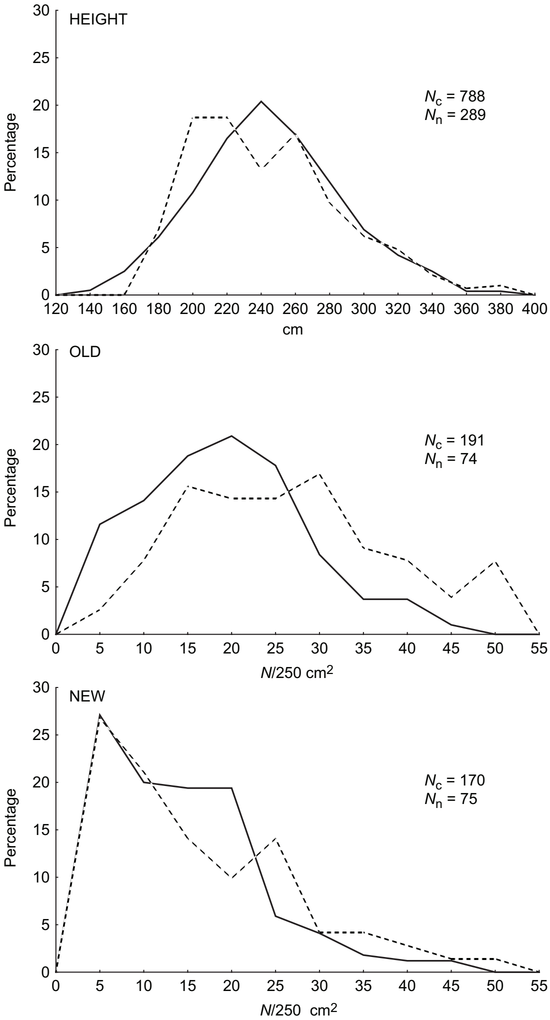

Fig. 2. Comparison of reed chosen for nesting (dashed line: N_n = number of measurements in the nesting squares) by female great bitterns and reed availability (line: N_c = number of measurement in the control squares) on fishponds in eastern Poland (Mann-Whitney test: HEIGHT $Z = -2.03$, $P < 0.05$, DIAMETER $Z = -1.78$, $P = 0.08$, FLOWER $Z = 1.30$, $P = 0.19$, NEW $Z = -0.190$, $P = 0.85$; *t*-test: OLD $t = -4.930$, $P < 0.0001$).

N = 727, range 2.0–10.0). The density of old stems varied between 5 and 85 (mean = 42.2, SD = 13.1, N = 74) and was higher than that of new shoots: range 1–48 (mean = 14.3, SD = 10.9, N = 71) and the difference was statistically significant (*t*-test: $t = 4.97$, $P < 0.0001$). The average number of flowering shoots in the nesting squares was 8.5 (SD = 7.6, N = 66, range 1-44). Reed with properties and structure appropriate for great bitterns was widely available in the study area (Fig. 2). The common feature of all the breeding places was the presence of water around the nest. The level of water at the nest at the beginning of the nesting season varied between 10 and 97 cm (mean = 45.1 ± 17.6 cm, N = 98). There were significant differences in the water depth near nests located in three main types of vegetation: *Phragmites, Phragmites*/*Typha, Typha* (Fig. 3). The nests in pure *Typha* vegetation were built at the deeper sites. The logistic regression model incorporating water depth and the degree of covering of the square by vegetation showed a lack of statistically significant influence on the choice of nest site, even thought the latter parameter was close to reaching the significance level (WATER: estimate = 0.003, SE = 0.006, Wald $\chi^2 = 0.23$, $P = 0.63$; COVER: estimate = 0.013, SE = 0.007, Wald $\chi^2 = 3.54$, $P = 0.06$). Analysis of the reed characteristics showed that the only significant variable in the model was old-stem density (Table 2). The remaining parameters: the average height of stems, the average diameter of shoots, the number of flowering stems, the density of new shoots did not influence the nesting preferences of the female great bitterns in the studied reedbeds.

Discussion

Our study indicated that despite the utilization of a variety of types of emergent vegetation, great bittern females, in choosing their nesting habitat at fishponds in eastern Poland, preferred places with dense and old reed stems. Similar average values of this parameter were noted at the nest sites of great bitterns breeding in the reedbed complexes in the United Kingdom (Gilbert *et al*. 2005a). In the French population, the comparison of nesting places with random locations showed that the great bittern nests were located in places with higher and denser growing reed shoots (Provost *et al*. 2004). The adaptational value of preferring denser vegetation most likely results from the possibility for better hiding of nests from predators (Kristiansen 1998, Graveland 1999, Caro 2005, Gilbert *et al*. 2005a). That is particularly important in the early stage of breeding season, when developed (green) reed shoots are lacking.

In the studied fishponds, there was a higher (three-fold) proportion of old than new stems in the nesting squares. The average new stem density was significantly lower than dried stem density in the same squares and significantly lower than values given in breeding places in the UK (Gilbert *et al*. 2005a). The importance of this micro-habitat parameter for the great bittern population from the UK was found, because the higher density of new stems was noted at nest sites located in the places that had retained breeding great bitterns in comparison with those that lost them (Tyler *et al*. 1998). Apparently this situation was related to the commercial cutting of reedbeds in the majority of these locations (Gilbert *et al*. 2007). Fish farming in the studied fish ponds in eastern Poland was characterised by extensive management with only occasional emergent-vegetation cutting, which ensured more favourable nesting conditions for the great bitterns. No difference in stem diameter between the nesting and control places at the studied fishponds can result from wide morphometric diversity of stems. Also, in the French population, the lack of such difference was noted between nest sites and random locations (Provost *et al*. 2004). The shoot height and diameter at nest sites in eastern Poland were similar to those recorded in the UK (Gilbert *et al*. 2005a).

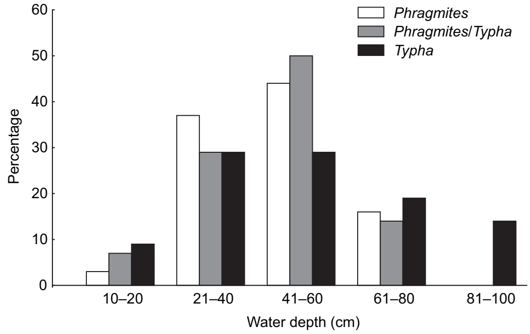

Fig. 3. Comparison of water depth at nests located in the main types of beds. The difference was statistically significant between *Typha* and *Phragmites* (G = 26.23, P < 0.001, df = 4) and *Typha* and *Phragmites*/*Typha* (G = 25.69, P < 0.001, df = 4), but there was no difference between *Phragmites* and *Phragmites*/*Typha* (G = 2.79, P = 0.59, df = 4).

At fish ponds in eastern Poland the majority of nests were found in reedbeds (58%) and the second important type of vegetation was reedmace (21%). In Italy and France, nests were located in vegetation with the dominating species of plants: 52% of nests were found in reed, 30% in bulrush, 15% in reedmace and 4% in sawsedge (Puglisi & Bretagnolle 2005). The majority of nests (96 %, N = 74) in the UK were located in reedbeds (Gilbert *et al*. 2005). By contrast, other nesting habitats were described from Colfiorito, northern Italy, where great bittern females settled exclusively in stands of bulrush, and avoided nesting in reedbeds (Adamo *et al*. 2004). The type and structure of vegetation can also determine the start of reproduction. In the rice fields of Italy, the

Table 2. Best model according to forward stepwise logistic regression to explain nest preferences in bittern population breeding in the Lublin and Podlasie regions.

Variable	Estimate	SE	Wald χ^2	P
Constant	–2.11	0.317	44.520	0.000001
OLD	0.059	0.014	18.426	0.0001

great bittern females showed a significant delay of egg laying, since these territories were flooded with water in late April and appropriate vegetation for hiding the nests appeared at the end of May (Longoni *et al*. 2007).

Apart from tall and dense vegetation that allows for hiding nest, a basic habitat requirement for this species is the presence of water (Gilbert *et al*. 2007). Earlier studies indicated that the most important barrier to nest predation in this population was the presence of deep water around nests (Polak 2007b). All nests of the great bitterns in the studied region were found in wet vegetation, however in this study, females did not clearly prefer places with deeper water. This is most likely associated with the fact that in artificially-maintained fish ponds water level is controlled. At the beginning of the great bittern breeding period, the majority of the ponds have similar and relatively deep water adapted to the fish farming. In comparison with the presented results, an average water depth noted in nesting places in the UK was twice lower (Gilbert *et al*. 2005a), whereas it was twice higher in the Italian population (Adamo *et al*. 2004). Such a significant difference can be related to the local conditions made evident by the lowering of the water level during the breeding season. The presence of deep water at nest sites has an anti-predator function, reducing nest accessibility by terrestrial predators (Honza *et al*. 1998, Sanchez-Lafuente *et al*. 1998, Barbraud *et al*. 2002, Hoover 2006). In addition, the high water level also ensures adequate feeding resources, because females search for food in the close vicinity of the nest (Adamo *et al*. 2004, White *et al*. 2006). Unfavourable feeding conditions in nesting places force the females to undertake long flights for prey in the chick phase. This results in often leaving the nestlings without care and greater exposure to destruction by predators (*see* Martin 1992, Polak 2007b).

Our study showed that the character of the fish farms in eastern Poland correspond to the nest-site preferences of the great bitterns. Due to the appearance of various types of emergent vegetation and the wide morphometric diversity of reed stems, the great bittern females have the possibility of choosing the most appropriate nesting places. Water level as an element determining nesting place was less significant due to its artificial management and commercial demands of fish farms. Extensive management of fish ponds without the elimination of emergent vegetation in the study area provides suitable nesting habitat for this species. However, due to the privatisation of fish ponds, the situation is rapidly changing to more intensive production. In this case, we propose promotion of appropriate habitat management such as high water-levels and avoiding pond emptying during the breeding season and the retention of at least 30% of old vegetation on some ponds within the fishpond complex (for more details *see* Polak & Krogulec 2006).

Acknowledgements

We thank all the people who helped during the period of sampling, particularly: M. Gąska, A. Lesiuk, J. Kloskowski, M. Kołodziejczyk, J. Krogulec, M. Nieoczym, J. Polak, E. Zębek. We are grateful Lech Kufel for correction to the English.

References

Adamo, M. C., Puglisi, L. & Baldaccini, N. E. 2004: Factors affecting bittern *Botaurus stellaris* distribution in a Mediterranean wetland.— *Bird Conservation International* 14: 153–164.

Alessandria, G., Carpegna, R. & Toffola, M. D. 2003: Vocalizations and courtship displays of the bittern *Botaurus stellaris*. — *Bird Study* 50: 182–184.

Barbraud, C., Lepley, M., Mathevet, R. & Mauchamp, A. 2002: Reedbed selection and colony size of breeding purple herons *Ardea purpurea* in southern France. — *Ibis* 144: 227–235.

BirdLife International 2004: *Birds in Europe: population estimates, trends and conservation status*. — BirdLife International, Cambridge.

Caro, T. 2005: *Antipredator defenses in birds and mammals*. — University of Chicago Press, Chicago.

Cramp, S. & Simmons, K. E. L. (eds.) 1977: *The birds of the Western Palearctic*, vol. 1. — Oxford University Press, Oxford.

Dobrowolski, K. A. (ed.) 1995: *Environmental-economic evaluation of fishponds in Poland*. — IUCN Poland, Warszawa.

Dombrowski, A. 2004: *Botaurus stellaris* (L., 1758) — Bittern. — In: Gromadzki, M. (ed.), *Birds. Manual of habitats and species conservation — Natura 2000*: 58–63. Ministry of the Environment, Warsaw.

Dmitrenok, M. 2004: Breeding and feeding of bitterns on the

Belarus fish-ponds. — In: *Proceedings of the European seminar on Bitterns, Angerville L'Orcher, France, 10–12 December 2004*: 19–20. LPO (Ligue pour la Protection des Oiseaux), Angerville L'Orcher, Seine-Maritime.

Gauckler, V. A. & Kraus, M. 1965. Zur Brutbiologie der Grossen Rohrdommel (*Botaurus stellaris*). — *Die Vogelwelt* 86: 129–145.

Gilbert, G., Tyler, G. A. & Smith, K. W. 2003: Nestling diet and fish preference of bitterns *Botaurus stellaris* in Britain. — *Ardea* 91: 35–44.

Gilbert, G., Tyler, G. A., Dunn, C. J. & Smith, K. W. 2005a: Nesting habitat selection by bitterns in Britain and the implications for wetland management. — *Biological Conservation* 124: 547–553.

Gilbert, G., Tyler, G. & Smith, K. W. 2005b: Behaviour, home-range size and habitat use by male great bittern *Botaurus stellaris* in Britain. — *Ibis* 147: 533–543.

Gilbert, G., Tyler, G. A., Dunn, C. J., Ratcliffe, N. & Smith, K. W. 2007: The influence of habitat management on the breeding success of the great bittern *Botaurus stellaris* in Britain. — *Ibis* 149: 53–66.

Głowaciński, Z. (ed.) 2001: *Polish Red Data Book of Animals*. — PWRiL, Warsaw.

Graveland, J. 1999: Effects of reed cutting on density and breeding success of reed warbler *Acrocephalus scirpaceus* and sedge warbler *A. schoenobaenus*. — *Journal of Avian Biology* 30: 469–482.

Honza, M., Oien, I. J., Moksnes, A. & Roskaft, E. 1998: Survival of reed warbler *Acrocephalus scirpaceus* clutches in relation to nest position. — *Bird Study* 45: 104–108.

Hoover, J. P. 2006: Water depth influences nest predation for a wetland-dependent bird in fragmented bottomland forests. — *Biological Conservation* 127: 37–45.

Kristiansen, J. N. 1998: Egg predation in reedbed nesting greylag geese *Anser anser* in Vejlerne, Denmark. — *Ardea* 86: 137–145.

Kushlan, J. A. & Hafner, H. 2000: *Heron conservation*. — Academic Press, London.

Longoni, V., Rubolini, D. & Bogliani G. 2007: Delayed reproduction among great bitterns *Botaurus stellaris* breeding in ricefields. — *Bird Study* 54: 275–279.

Martin, T. E. 1992: Interaction of nest predation and food limitation in reproductive strategies. — *Current Ornithology* 9: 163–197.

Martin, T. E. 1993: Nest predation and nest sites: new perspectives on old pattern. — *BioScience* 43: 523–532.

Polak, M. 2006: Booming activity of male bitterns *Botaurus stellaris* in relation to reproductive cycle and harem size. — *Ornis Fennica* 83: 27–33.

Polak, M. & Krogulec, J. 2006: Threats and opportunities for the bittern within fishpond management in Poland. — In: White, G., Purps, J. & Alsbury, S. (eds.), *The bittern in Europe: a guide to species and habitat management*: 159–161. The RSPB, Sandy.

Polak, M. 2007a: Food of nestling great bitterns *Botaurus stellaris* at fishpond complexes in eastern Poland. — *Bird Study* 54: 280–283.

Polak, M. 2007b: Nest-site selection and nest predation in the great bittern *Botaurus stellaris* population in eastern Poland. — *Ardea* 95: 31–38.

Poulin, B., Lefebvre, G. & Mathevet, R. 2005: Habitat selection by booming bitterns *Botaurus stellaris* in French Mediterranean reed-beds. — *Oryx* 39: 265–274.

Provost, P., Bretagnolle, V. & Demongin, L. 2004: Selection of nesting sites in bitterns and preliminary implications for reedbed management: analysis in the baie de Seine and in France. — In: *Proceedings of the European seminar on Bitterns, Angerville L' Orcher, France, 10–12 December 2004*: 14–16. LPO (Ligue pour la Protection des Oiseaux), Angerville L'Orcher, Seine-Maritime.

Puglisi, L., Adamo, C. M. & Baldaccini, N. E. 2005: Man-induced habitat changes and sensitive species: a GIS approach to the Eurasian bittern *(Botaurus stellaris)* distribution in a Mediterranean wetland. — *Biodiversity and Conservation* 14: 1909–1922.

Puglisi, L. & Bretagnolle, V. 2005: Breeding biology of the bittern. — *Waterbirds* 28: 392–398.

Sanchez-Lafuente, A. M., Alcántra, J. M. & Romero, M. 1998: Nest-site selection and nest predation in the purple swamphen. — *J. Field Ornitol*. 69: 563–576.

Statsoft Inc. 2001: *Statistica for Windows (data analysis system)*, ver. 6. — Available at www.statsoft.com.

Tyler, G. A., Smith, K. W. & Burges, N. 1998: Reedbed management and breeding bitterns *Botaurus stellaris* in the UK. — *Biological Conservation* 86: 257–266.

White, G., Purps, J. & Alsbury, S. (eds.) 2006: *The bittern in Europe: a guide to species and habitat management*. — The RSPB, Sandy.

Voisin, C. 1991: *The herons of Europe*. — T. & A.D. Poyser, London.