ORNIS SVECICA 12:203–210, 2002 https://doi.org/10.34080/os.v12.22821

# Breeding success of Great Crested Grebe *Podiceps cristatus* on fishponds

MILAN VOGRIN

**Abstract**

Between 1993 and 2000, breeding success of Great Crested Grebe *Podiceps cristatus* was monitored at two fishpond localities, Vrbje in central and Rače in north-eastern Slovenia. During the study 50 and 23 nests with eggs were found, respectively. On average, 1.3 chicks per territorial pair survived until fledged in September. Between the two localities, there was no difference in number of fledged chicks per pair in September but a difference existed in number of hatched chicks per territorial pair (Mann-Whitney U test = 13.5; P<0.05). At both localities, the number of fledglings per nest was positively density-dependent. Young mortality was low, only 12%, in no year above 33%, and did not differ between the localities. Correlation between number of pairs and number of pairs known to have hatched chicks, and correlation between number of pairs and number of fledglings per pair in September varied between localities. In comparison with other studies nest losses were very low (4.3%, all predation, at Vrbje, and 18% by all causes, 4,0% by predation, at Rače).

*Milan Vogrin, Zg. Hajdina 83c, SI-2288 Hajdina, Slovenia.*
*E-mail: milan.vogrin@guest.arnes.si*

Received 27 October 2002, Accepted 15 December 2002, Editor: S. Svensson

## Introduction

To obtain data about quality of breeding habitats, monitoring numbers of animals alone is not enough. The greatest densities do not always indicate the best habitat qualities (e.g. Wiens 1989, Newton 1998). It is better to measure habitat quality in an independent manner, for example by breeding success (Vickery et al. 1992).

Reproductive success commonly varies greatly between individuals in a population, and a large part of this variation can often be attributed to complete breeding failure (e.g. Newton 1989). In the case of birds, the common causes of failure are predation of eggs, nestlings or incubating birds, and environmental factors, e.g. poor weather conditions (Newton 1989). In grebes, the major threats to the nests are avian predators (Salonen & Penttinen 1988) and unpredictable environmental factors, e.g. flooding and low waters, especially on man made water bodies.

I studied the breeding success of Great Crested Grebe *Podiceps cristatus* in fishponds. Little is known about breeding success of Great Crested Grebe in this kind of habitat, especially from the more southern part of its breeding range (see for example Fiala 1974, Hudec 1975, Ławniczak 1982).

## Material and methods

Research was conducted in the Rače fishponds in NE Slovenia (Dravsko polje) and in the Vrbje pond in Lower Savinja valley (Central Slovenia). The Rače fishponds consist of three large ponds with a total area of 33 ha. The vegetation consists mostly of *Typha* spp., *Nymphoides peltata*, *Polygonum amphibium* and *Trapa natans*. The vegetation covers 30–75% of the surface of the ponds, variable between years and ponds. The Vrbje pond is full of immersed (*Typha latifolia*, *T. angustifolia*) and floating (*Potamogeton crispus*, *P. natans*, *P. spicatum*, *Myriophyllum spicatum*, *Elodea canadensis*) vegetation, and the area is 13.5 ha. The vegetation covers 40–60% of the surface of the pond. At both localities, the ponds were intended for fish rearing and they were discharged once a year (autumn/spring) for about one to five months. Around Vrbje pond there are extensive areas of fields and hedges, whereas around Rače ponds there are mixed forests and hedges. For a detailed description of the study areas see Vogrin (1996), Vogrin & Vogrin (1997, 1999).

In order to detect pairs and breeding attempts both places were monitored from May through September over the eight year period 1993–2000. During this period the fishponds were visited at 5–15 day intervals. Breeding was considered to have taken place if nests, incubating birds, eggs or young were detected. At each visit, information was collected on the numbers of adults and their young.

Long term observations of incubating birds and nests with eggs were carried out from a distance using a telescope to monitor any disturbance to incubation and/or predation. Any shell fragments were collected in order to identify predators following Brown et al. (1987) and Green et al. (1987). Failed clutches were assumed to have been taken by predators if unhatched egg remains were found in or near the nest, provided that desertion was not known to have occurred first. If no trace of shell or membrane could be found, the cause of failure was classed as "unknown". Possible nest predators included *Vulpes vulpes*, domestic cats and dogs, *Rattus* spp., *Natrix natrix*, *Corvus cornix* and *Pica pica*.

The following information was collected: number of territorial pairs, number of pairs known to have laid eggs, number of pairs known to have hatched chicks, number of chicks hatched per territorial pair, number of fledged chicks per pair still alive in September, and chick mortality (%).

Statistical analyses were carried out using the SPSS 8.0/Windows statistical package and according to Sokal & Rohlf (1995).

## Results

The results are summarized in Table 1. A total of 95 territorial pairs (70 at Rače and 25 at Vrbje) were found in all eight years. At Rače ponds 50 pairs (72%) were found to breed (lay eggs). The proportion of non-breeders varied between 0 and 66.7% in different years. At Vrbje pond 23 nests (94% of all territorial pairs) were found, and non-breeding territorial pairs were found in only one year. On average, 62 pairs known to have hatched chicks produced 2.2 ±1.1 SD young per year (n = 14 "pond-years"). On average 1.3 ±0.93 SD chicks survived till September, if we merge both localities. Chick mortality was between 0 and 33.3%, and the difference between average mortality for the localities was small and not significant (Mann-Whitney U test, U = 21.0, P > 0.5). The mortality based on the pooled data was 12.1 %.

At Rače fishponds only two significant correlations were found, i.e. between number of chicks hatched per territorial pair and number of fledged chicks in September ($r_S$ = 0.98, n = 8, P < 0.001), and between number of territorial pairs and number of young ($r_S$ = 0.87, n = 8, P < 0.01). The last correlation, but not the first, holds true also for both localities together

Table 1. Some breeding parameters (±SD) of Great Crested Grebe *Podiceps cristatus* in two Slovenian study areas between 1993–2 000. In parenthesis, minimum and maximum values are given. Number of study years was eight in all cases but for the two marked with an asterisk (*), where the number was six years.
*Några häckningsdata (±SD) för skäggdopping i två slovenska studieområden 1993–2000. Inom parentes anges lägsta och högsta värde. Antalet år var åtta i samtliga fall utom för de två som markerats med asterisk (*), där antalet år var sex.*

| | Rače ponds | Vrbje pond | Average both localities *Medeltal båda lokalerna* |
|---|---|---|---|
| No. of territorial pairs *Antal revirhållande par* | 8.8 ± 4.9 (3–16) | 3.1 ± 2.1 (0–7) | 5.9 ± 4.6 (0–16) |
| No. of pairs that laid eggs *Antal par som lade ägg* | 6.3 ± 2.1 (3–10) | 2.9 ± 2.3 (0–7) | 4.6 ± 2.8 (0–10) |
| No. of pairs that hatched chicks *Antal par som kläckte ungar* | 5.1 ± 2.1 (2–9) | 2.6 ± 2.1 (0–6) | 3.9 ± 2.4 (0–9) |
| No. of chicks hatched per territorial pair *Antal kläckta ungar per revirhållande par* | 1.3 ± 0.6 (0.4–2.3) | 1.6 ± 1.5 (0–3.7) | 1.4 ± 1.1 (0–3,7) |
| No. of chicks per pair with hatched chicks *Antal ungar per par med kläckta ungar* | 2.1 ± 1.1 (1–4.6) | 2.3 ± 1.2 (1–3.7) * | 2.2 ± 1.1 (1–4.6) |
| No. of chicks in September per territorial pair *Antal ungar i september per revirhållande par* | 1.2 ± 0.5 (0.4–2) | 1.3 ± 1.2 (0–3.3) | 1.3 ± 0.9 (0–3.3) |
| % chick mortality% *ungdödlighet* | 11.8 ± 13.0 (0–33.3) | 12.7 ± 12.6 (0–33.3) * | 12.1 ± 12.4 (0–33.3) |

Table 2. Correlation between various parameters on Vrbje pond. In all cases n = 8, except for density, where n = 7. NS = not significant, * = P <0.05, ** = P <0.01
*Korrelation mellan olika variabler för Vrbje-dammen. I samtliga fall var n=8, utom för täthet, där n=7. NS = ej signifikant. * = P<0,5, ** = P<0,01.*

| | B | C | D | E | F | No. of chicks *Antal ungar* |
|---|---|---|---|---|---|---|
| A. No. of territorial pairs *Antal revirhållande par* | 0.98** | 0.94** | 0.83* | 0.83* | NS | 0.94** |
| B. No. of pairs that laid eggs *Antal par som lagt ägg* | – | 0.96** | 0.85** | 0.85** | NS | |
| C. No. of pairs that hatched chicks *Antal par som kläckt ungar* | – | – | 0.89** | 0.89** | NS | |
| D. No. of chicks hatched per territorial pair *Antal kläckta ungar per revirhållande par* | – | – | – | 1.0** | NS | |
| E. No. of chicks in September per pair *Antal ungar i september per par* | – | – | – | – | NS | |
| F. % chick mortality *% ungdödlighet* | – | – | – | – | – | |
| G. Density (pairs/10 ha) *Täthet (par/10 ha)* | 0.99** | 0.92** | 0.77* | 0.77* | NS | |

($r_S = 0.78$, n = 14, $P < 0.01$). On the other hand, many more correlations exist on Vrbje pond (Table 2). The most pronounced ones were between number of territorial pairs and number of pairs known to have laid eggs, and between number of chicks hatched per territorial pair and number of fledged chicks in September.

Very interesting was also the difference found between the two localities in number of correlations between density and other parameters. On Rače ponds no significant correlations was found, whereas on Vrbje pond most correlations were significant (Table 2).

Between localities, number of pairs with eggs (Mann-Whitney U test, U = 9.0, $P < 0.05$) and number of pairs with hatched chicks (Mann-Whitney U test, U = 13.5, $P < 0.05$) differed significantly. However, there was no significant difference between number of chicks hatched per pair and number of chicks per pair still alive in September (Mann-Whitney U test, U = 31.0 and 31.0, respectively).

Most chick deaths (71%) occurred in the earliest stages, i.e. when chicks were smaller than one fourth of adult size. Three dead young were found. Two of them were very small, less than one week old, and intact (Rače ponds). The third corpse was fresh and larger (about half of adult size) and partly eaten (Vrbje pond). It had been taken by a predator, probably a female *Accipiter gentilis*, which was observed hunting *Fulica atra* at this pond.

In the eight years period only ten failed clutches were recorded (nine at Rače and one at Vrbje ponds). The cause of failure was predation (3 nests), »unknown« (2) and human disturbance (5). One clutch that disappeared was assumed to have been taken by man or by mammalian predators because avian predators would always leave some shell fragments on or near the nest. Among the clutches taken by predators one disappeared during the night, an indication that a mammalian predators would be the most likely cause. At two other clutches where shell remains were found the predators were almost certainly *Corvus cornix*, which were observed at two occasions near the grebe nests.

## Discussion

The percentage of non breeders, present mainly on Rače ponds, was similar to data obtained in ponds near Nameš (28%; Fiala 1974) and gravel pits in Bavaria (25–61.5%; Leibl 1999). Possibly, the number of non-breeders is density dependent, but on Rače ponds this was not the case ($r_S = 0.70$, n = 8, $P > 0.05$). However, this result could be due to small sample size.

At both localities, the number of fledglings per nest seemed to be density-dependent. However, it was surprising to find that the dependence was positive, in contrast to other similar studies (e.g. Barbraud et al. 1999, see also Newton 1998).

It is not straightforward to compare my result of 1.3 fledged chicks per territorial pair in September with results obtained in other studies because of differences in method, particularly of recording units, e.g. different definitions of breeding pairs and successful nests. My result is similar to data obtained by Ławniczak (1982) at fishponds in Poland (1 chick/pair), at the fishponds at Nameš in Czech Republic (1.2; Fiala 1974), and at gravel pits in Bavaria (1.24; Leibl 1999). My result is also similar to data from western Finland (1.55–1.6 chick/pair) where *Podiceps cristatus* bred in offshore areas (Ulfvens 1989). Values from Belgium of 1.72 chicks per pair (Fourage & Jacob 1993), of 3.6 and 2.2 for Lake Żarnowieckie in Poland (Moskal & Marszałek 1986), and of 2.69 in Czech Republic (Hudec 1975) are probably overestimates due to the fact that the surveys were made too early in the season (mainly June–July). Data from Lake Neuenburger (Glutz Von Blotzheim 1989) and Lake Sempach (Fuchs 1982) in Switzerland are much lower (0.31–0.47 and 0.35–0.8 chick/pair, respectively) than elsewhere (but see Goc 1986). We must take into account also that locating nests and chicks may have been more difficult on larger water bodies (i.e. on research areas in Poland, Finland, Switzerland) and thus more time consuming to survey comprehensively (see also Hudec 1975). According to my experience it is likely that some chicks may not have been found rather than that they were not present. If I take into account only pairs that hatched young, the average value in my study becomes much higher and is then similar to the ones mentioned above, even the highest values.

The result of 1.3 fledglings per pair needs further explanation. In long-lived species such as Great Crested Grebes (see e.g. Cramp & Simmons 1977, Fuchs 1982; up to 14 years), production of 1.3 young per pair is actually rather high (see for example Burger 1984 for *Sterna antillarum*). Assuming that each pair must only replace themselves with two reproducing offspring, that mortality during the first year is about 40%, and that average mortality in later years is about 25–35% (Fuchs 1982), a pair may only need to fledge seven young during its lifetime. In my study areas the success was almost 100% greater (in ten years a pair of Great Crested Grebe fledge on average 13 young). The consequence of such great success was an increasing breeding population on the Dravsko polje in north-eastern Slovenia (Vogrin 1999a).

The percentage of nest losses in my study was very low in comparison with some other studies (Table 3). When all nests were combined, the proportion of unsuccessful nests was only 13.7% (n = 73). The main factors limiting nest success elsewhere appears to be predation (e.g. Ławniczak 1982, Goc 1986, Moskal & Marszałek 1986, Salonen & Penttinen 1988), but this was not the case at my localities, where the predation on grebe nests was detected only at three occasions (about 4%). This low predation rate was found in spite of the fact that the density of the main nest predators (Salonen & Penttinen 1988) was not low. Around the Rače ponds the densities of, for example, *Corvus corone cornix* and *Pica pica* were about 2 and 5 pairs/km$^2$, respectively (Vogrin 1998a, pers. obs.), and around the Vrbje pond between 1.1 and 1.9 pairs/km$^2$ and 5 pairs/km$^2$, respectively (Vogrin 1996, 1998b). These densities are similar to the ones found elsewhere in Europe.

For corvids, other authors have noted the importance of vision to find nests (e.g. Yahner & Wright 1985). The vegetation was quite dense in my study ponds, and the grebe nests had higher cover than nests of species in open farmland. Thus, the nests may have been well hidden from visual predators such as corvids. We must also take into account that Great Crested Grebes cover their eggs with vegetation when leaving the nest which is thus less visible.

Many studies have shown that predation is more frequent when nest density is high (e.g. Hill 1984a, Martin 1988, Sudgen & Beyersbergen 1986, see also Major & Kendal 1996, Newton 1993, 1998 for reviews). Densities of *Podiceps cristatus* in other study areas are in general similar to densities in my study areas (see also Vogrin 1989, 1996, 1999a, b; Table 3). Moreover, the correlation between densities and nest losses (data from Table 2, average values) is far from significant ($r_S = 0.21$, n = 9, P > 0.5) and the same holds true also for the relationship between densities and nest losses by predation ($r_S = -0.31$, n = 6, P > 0.5). These results makes me assume that nest predation in *Podiceps cristatus* is not density dependent (see also Salonen & Penttinen 1988). I believe that more important factors are good habitats (e.g. vegetation cover; Moskal & Marszałek 1986, Salonen & Penttinen 1988), and food supply, especially during chick rearing.

A relationship between density and predation rate, if it exists, may be confounded by other factors. For example, the presence of aggressive non-conspecifics in the area (Göransson et al. 1975), plot overlap with a predator territory (Erikstad et al. 1982), the abundance of other nests on the research area (Fretwell 1972), and the abundance of other prey items on each plot may have influenced predation rate.

Table 3. Percentage of nest losses among nests with eggs in Great Crested Grebe *Podiceps cristatus* in different part of Europe. Density = max. density (pairs/10 ha) available for study area.
*Procent boförluster för bon med ägg hos skäggdopping i olika delar av Europa. Tätheten är högsta tätheten (par/10 ha) för området.*

| Area *Område* | Years *År* | Area (ha) *Ytareal* | Density *Täthet* | Nests *Bon* | % nests lost *% förlorade* | % depredated *% rövade* | Source *Källa* |
|---|---|---|---|---|---|---|---|
| Fish ponds near Lednice, Czech Republic | 1959–1968 | | – | 36 | – | 27.8 | Hudec 1975 |
| Fish pond Milicz 1, Poland | 1972 | 101 | 7.4 | 144 | 59.7 | 33.3 | Ławniczak 1982 |
| Fish pond Milicz 2, Poland | | 160 | 0.9 | 16 | 17.4 | 11.8 | Ławniczak 1982 |
| Fish pond Milicz 3a–e, Poland | | 112 | 2.7 | 40 | 30.0 | 20.0 | Ławniczak 1982 |
| Lake Druzno, Poland | 1975–1980 | 1080 | 4.4 | 2502 | 42–82 | – | Goc 1986 |
| Lake Žarnowieckie, Poland | 1980–1981 | 1428 | 2.2 | 486 | 7.0–79.0 | – | Moskal & Marszałek 1986 |
| Lake Päijänne, Finland | 1983–1985 | 750 | 0.7 | 119 | – | 33–42.0 | Salonen & Penttinen 1988 |
| Lake Gerzensee | 1983–1986 | 27 | 5.5 | 58 | 33.3 | – | Keller 1989 |
| Lake Moossee | 1983–1986 | 31 | 4.8 | 55 | 53.3 | – | Keller 1989 |
| Lake Burgaschisee | 1984–1986 | 23 | 6.5 | 41 | 75.3 | – | Keller 1989 |
| Rače ponds, Slovenia | 1993–2000 | 33 | 4.8 | 50 | 18 | 4.0 | this study |
| Vrbje pond, Slovenia | 1993–2000 | 13.5 | 5.2 | 23 | 4.3 | 4.3 | this study |

Moreover, most studies of nest predation in Europe have been conducted in Northern Europe and in forest and farmland habitats (Andrén 1995), whereas water habitats have been less frequently studied (see Andrén 1995, Major & Kendal 1996). This is especially true for waterbirds which build floating nests, like grebes and rails. For these species very little is known about predation rates. It seems that birds nesting on water, or at least the Great Crested Grebe, have among the lowest predation rates found in birds. In the Great Crested Grebe the average value is 19.8% ± 13.6 (Table 3). The predation rates are normally much higher among ground, shrub and canopy nesters (Martin 1993).

High chick survival from hatching through the first year is also connected with rich food supply, which has been found for other water birds (e.g. Gardarsson & Einarsson 1994, 1997). Fishes, the main food of *Podiceps cristatus* (Cramp & Simmons 1977), are abundant in both my localities (pers. obs.).

Most chicks that died in my fishponds died soon after hatching, which is in agreement with some other studies on *Podiceps cristatus* (Glutz von Blotzheim 1989), *Podiceps griseigena* (Kloskowski 2000) and other waterfowl (e.g. Fox 1986, Hill et al. 1987). Older chicks (as well as adults) are large and presumably very rarely taken by avian predators, whereas mammalian predators are limited due to open waters. Small chicks could commonly be taken also by large fishes (Cramp & Simmons 1977).

According to the results on breeding success presented in the paper, I conclude that both my study localities are good habitats for nesting Great Crested Grebes (see also introduction) and most probably also for other water birds (see Vogrin 1999b). Moreover, it seems that density-dependent nest predation, as has been shown in several other water birds, e.g. ducks (Hill 1984b), does not occur in Great Crested Grebe (Salonen & Penttinen 1988, this study).

## Acknowledgements

All work was conducted without financial support. All fieldwork on which this paper is based was carried out by the author with the assistance of my brother Marjan, to whom I am particularly grateful. Thanks also to anonymous referee and editor Dr. Svensson for improving the manuscript.

## References

Andrén, H. 1995. Effects of landscape composition on predation rates at habitat edges. In: Hansson, L. Fahrig, L., Merriam, G. (eds.): *Mosaic Landscapes and Ecological Processes*. Chapman & Hall. London.

Barbraud, C., Barbraud, J.-C. & Barbraud, M. 1999. Population dynamics of the White Stork *Ciconia ciconia* in western France. *Ibis* 141: 469–479.

Brown, R., Fergusun, J. Lawrence, M. & Lees, D. 1987. *Tracks and signs of the birds of Britain and Europe: an identification guide*. Christoper Helm, London.

Burger, J. 1984. Colony stability in least terns. *The Condor* 86: 61–67.

Cramp, S. & Simmons, K.E.L. (eds.) 1977. *The Birds of the Western Palearctic. Handbook of the Birds of Europe, the Middle East and North Africa*. Vol. 1. Oxford University Press, New York.

Erikstad, K.E., Blom, R. & Myrberget, S. 1982. Territorial hooded crows as predators on willow ptarmigan nests. *Journal of Wildlife Management* 46: 109–114.

Fiala, V. 1974. Populationsdynamik und Brutbiologie der Lappentaucher Podicipedidae im Teichgebiet von Namešt n. Osl./ČSSR. *Anz. Orn. Ges. Bayern* 13: 198–218.

Fox, A.D. 1986. The breeding Teal (*Anas crecca*) of a coastal raised mire in central West Wales. *Bird Study* 33: 18–33.

Fourage, J-P. & Jacob, J-P. 1993. Recensement des anatides, rallides et grebes nicheurs en Region Bruxelloise en 1992. *Aves* 30: 17–30.

Fretwell, S.D. 1972. *Populations in a seasonal environment*. Princeton University Press. Princeton.

Fuchs, E. 1982. Bestand, Zugverhalten, Bruterfolg und Mortalität des Haubentauchers *Podiceps cristatus* auf dem Sempachersee. *Der Ornithologishe Beobachter* 79: 255–264.

Gardarsson, A., & Einarsson, A. 1994. Responses of breeding duck populations to changes in food supply. *Hydrobiologia* 279/280: 15–27.

Gardarsson, A., & Einarsson, A. 1997. Numbers and production of Eurasian wigeon in relation to conditions in a breeding area, Lake Myvatn, Iceland. *Journal of Animal Ecology* 66: 439–451.

Glutz Von Blotzheim, U. 1989. Populationsökologie des Haubentauchers *Podiceps cristatus* am Neuenburger See. *Der Ornithologishe Beobachter* 86: 94–95.

Goc, M. 1986. Colonial versus territorial breeding of the Great Crested Grebe *Podiceps cristatus* on Lake Druzno. *Acta Ornitologica* 22: 95–145.

Göransson, G., Karlsson, J. Nilsson, S., Ulfstrand, S. 1975. Predation on birds nests in relation to antipredator aggression and nest density: an experimental study. *Oikos* 26: 117–120.

Green, R.E., Hawell, J. & Johnson, T.H. 1987. Identification of predators of wader eggs from egg remains. *Bird Study* 34: 87–91.

Hill, D.A. 1984a. Factors affecting nest success in the mallard and tufted duck. *Wildfowl* 35: 151–156.

Hill, D.A. 1984b. Population regulation in the Mallard. *Journal of Animal Ecology* 53: 191–202.

Hill, D., Wright, R. & Street, M. 1987. Survival of Mallard ducklings *Anas platyrhynchos* and competition with fish for invertebrates on a flood gravel valley quarry in England. *Ibis* 129: 159–167.

Hudec, K. 1975. Density and breeding of birds in the reed swamps of southern Moravian ponds. *Acta Scientiarum Naturalum Academiae Scientiarum Bohemoslovace* 9: 3–40.

Keller, V. 1989. Variations in the response of Great Crested Grebes *Podiceps cristatus* to human disturbance – a sign of adaptation? *Biological Conservation* 49: 31–45.

Kloskowski, J. 2000. Reproduction and feeding success of the Red-necked Grebe *Podiceps griseigena* at fish ponds, SE Poland. *Acta Ornithologica* 35: 85–89.

Ławniczak, D. 1982. On the ecology and biology of Great Crested Grebe (*Podiceps cristatus*), Red-necked Grebe (*Podiceps griseigena*) and Black-necked Grebe (*Podiceps nigricollis*) breeding on the fish-ponds near Milicz. *Acta Universitatis Wratislaviensis* 487: 63–81. Wrocław. (In Polish with English summary).

Leibl, F. 1999. Bestandwicklung und Brutbiologie des Haubentauchers (*Podiceps cristatus*) in einem ostbayerischen Kiesabbaugebiet. *Orn. Anz.* 38: 177–188.

Martin, T.E. 1988. On the advantage of being different: Nest predation and the coexistence of bird species. *Proc. Natl. Acad. Sci. U.S.A.* 85: 2196–2199.

Martin, T. E. 1993. Nest predation among vegetation layers and habitat types: revising the dogmas. *The American Naturalist* 141: 897–913.

Major, R.E. & Kendal, C. 1996. The contribution of artificial nest experiments to understanding avian reproductive success: a rewiew of methods and conclusions. *Ibis* 138: 298–307.

Moskal, J. & Marsalek, J. 1986. Effect of habitat and nest distribution on the breeding success of the great crested grebe *Podiceps cristatus* on Lake Žarnowieckie. *Acta Ornithologica* 22: 147–158.

Newton, I. (eds.) 1989. *Lifetime reproduction in birds*. Academic Press. London.

Newton, I. 1993. Predation and limitation of bird numbers. In: Power, M.D. (ed.). *Current Ornithology*. Volume 11. Plenum Press. New York.

Newton, I. 1998. *Population limitation in birds*. Academic Press. Sand Diego.

Salonen, V. & Penttinen, A. 1988. Factors affecting nest predation in the Great Crested Grebe: field observations, experiments and their statistical analysis. *Ornis Fennica* 65: 13–20.

Sokal, R.R., & Rohlf, F.J. 1995. *Biometry. The principles and practice of statistics in biological research*. H. Freeman and Company. New York.

Sudgen, L. & Bryersbergen, G. 1986. Effect of density and concealment on American Crow predation of simulated duck nests. *J. Wildl. Mgmt.* 50: 9–14.

Ulfvens, J. 1989. Offshore breeding in the Great Crested Grebe *Podiceps cristatus*: two offshore areas examined in relation to an inshore area in western Finland. *Ornis Fennica* 66: 112–116.

Vickery, P.D., Hunter, M.L. & Wells, J.V. 1992. Is density an indicator of breeding success? *Auk* 109:706–710.

Vogrin, M. 1989. Colony breeding of the Great Crested Grebe *Podiceps cristatus* on ponds at Rače. *Acrocephalus* 10: 51–56. In Slovene with English summary.

Vogrin, M. 1996. Birds of Vrbje pond in the Lower Savinja valley, and a look at its conservationist complexity. *Acrocephalus* 17: 7–24. In Slovene with English summary.

Vogrin, M. 1998a. Density, nest site and breeding success of a rural population of the Magpie *Pica pica* in NE Slovenia. *Die Vogelwarte* 39: 293–297.

Vogrin, M. 1998b. Abundance and habitat selection of breeding *Corvus corone cornix* on agricultural land in Central Slovenia. *Acta Zoologica Lituanica* 8: 127–130.

Vogrin, M. 1999a. Breeding ecology of Great Crested Grebe *Podiceps cristatus* in northeastern Slovenia. *Ornis Hungarica* 8–9: 27–32.

Vogrin, M. 1999b. Breeding birds of Rače ponds in NE Slovenia and their trends during 13 years. *Ornis Svecica* 9: 127–132.

Vogrin, M. & Vogrin, N. 1997. Vrbje pond and its vicinity. Pp. 17–48. In: VOVK–PETROVSKI, G. (ed.): *Vrbje pond and* *its vicinity*. Guide. In Slovene with English and German summary.

Vogrin, M. & Vogrin, N. (eds.) 1999. *Landscape park Racki ribniki – Pozeg*. DPPVN – Society for bird research and nature protection. Rače. 152 pp.

Wiens, J.A. 1989. *The ecology of bird communities*. Vol. 1. Cambridge Universtity Press.

Yahner, R.H. & Wright, A.L. 1985. Depredation on artificial ground nests – effects of edge and plot age. *J. Wildl. Manage*. 49: 508–513.

## Sammanfattning

*Häckningsframgång hos skäggdopping* Podiceps cristatus *i fiskdammar*

För att bedöma värdet av en biotop som häckningslokal är det inte tillräckligt att enbart räkna antalet fåglar. Det är bättre att också ha ett oberoende mått, till exempel häckningsframgången. Framgången varierar ofta mellan individerna i en population och denna variation kan ofta tillskrivas fullständiga misslyckanden, ofta orsakade av predation på ägg, ungar eller ruvande fåglar eller av dåligt väder. För doppingar är de främsta hoten fågelpredatorer och oförutsägbara miljöfaktorer, till exempel för högt eller för lågt vattenstånd, särskilt på lokaler som skapats av människor. Jag har studerat häckningsframgången för skäggdopping i fiskdammar i Slovenien. Föga är känt om förhållandena i sådana biotoper, särskilt i södra delen av utbredningsområdet.

*Material och metoder*

Undersökningen utfördes i tre dammar om tillsammans 33 ha vid Rače (Dravsko polje) i nordöstra Slovenien och i en damm om 13,5 ha vid Vrbje i nedre Savinjadalen i centrala Slovenien. Rače-dammarna hade en vegetation med *Typha* spp, *Nymphoides peltata, Polygonium amphibium* och *Trapa natans*. Vegetationen täckte 30–75% av dammarna, olika i olika dammar och under olika år. Vrbjedammen täcktes till 40–60% av uppstickande *Typha latifolia* och *T. angustifolia* och flytande *Potamogeton crispus, P. natans, P. spicatum, Myriophyllum spicatum* och *Elodea canadensis*. Alla dammar hade skapats för fiskodling och de tömdes varje år under en till fem månader.

Skäggdoppingarnas häckning följdes varje år 1993–2000 från maj till september genom besök med 5 till 15 dagars mellanrum. Häckning registrerades om bo, ruvande fågel, ägg eller ungar upptäcktes. Vid varje besök noterades också antalet gamla fåglar och ungar. Jag gjorde också avståndsstudier med tub under långa perioder för att registrera störningar av ruvningen och predation. Skalfragment samlades in för att identifiera predatorerna. En häckning ansågs ha misslyckats på grund av predation om jag fann rester av okläckta ägg i eller i närheten av boet, förutsatt att jag visste att boet dessförinnan hade övergivits. Om inga skalfragment påträffades klassificerades orsaken som ”okänd”. Tänkbara bopredatorer var räv, katt, hund, råtta, snok, kråka och skata.

Följande data insamlades: antal revirhållande par, antal par som bevisligen hade lagt ägg, antal par som bevisligen hade kläckt ungar, antal kläckta ungar per revirhållande par, antal flygga ungar per par i september samt ungdödligheten.

*Resultat*

Resultaten finns summerade i Tabell 1. Totalt registrerades 95 par (70 i Rače och 25 i Vrbje) under alla åtta åren. Vid Rače häckade 50 par (72%) och vid Vrbje 23 par (94%). För 62 par, som bevisligen kläckte ungar, var medelantalet ugnar 2,2, och 1,3 ungar per par var vid liv i september. Ungdödligheten var 12,1%.

Vid Rače erhölls endast två korrelationer, nämligen mellan antal kläckta ungar och antalet ungar i september per revirhållande par och mellan antalet revirhållande par och antalet ungar. Vid Vrbje erhölls fler korrelationer (Tabell 2). De tydligaste var mellan antal revirhållande par och antal par som lagt ägg samt mellan antal kläckta ungar per revirhållande par och antal flygga ungar i september. Intressant var skillnaden mellan lokalerna när det gällde korrelation mellan tätheten och olika variabler. Vid Vrbje, men inte vid Rače, var de flesta korrelationer signifikanta (Tabell 2). Mellan lokalerna fanns signifikant korrelation mellan antal par med ägg eller antal par med kläckta ungar. Däremot fanns ingen korrelation för antal kläckta ungar per par eller antal ungar per par vid liv i september.

De flesta ungar som dog, dog när de var mindre än en fjärdedel av vuxen storlek. Tre döda ungar påträffades. Två av dem var mindre än en vecka gamla och oskadade. En unge var nydöd som ungefär halvvuxen och delvis uppäten. Den hade troligen tagits av en duvhök som hade observerats jaga sothöns i dammen.

Under alla åtta åren noterades endast tio misslyckade bon. Orsaken var predation (3 bon), ”okänd” (1 bo) och mänsklig störning (5 bon). I ett fall var predatorn sannolikt ett däggdjur och i två fall nästan säkert kråka.

*Diskussion*

Andelen icke häckande fåglar, vilka fanns främst vid Rače, var ungefär densamma som man funnit på ett par andra lokaler. Vid båda lokalerna var antalet flygga ungar per bo täthetsberoende, men det var överraskande att finna att sambandet var positivt, vilket kontrasterar mot andra studier.

Tyvärr går det inte att direkt jämföra mitt resultat om 1,3 flygga ungar per par i september med andra studier eftersom man dels haft olika definitioner av vad som skall anses vara ett häckande par och i vissa studier räknat ungarna tidigare på sommaren (juni eller juli). Mitt värde liknar dock de som noterats i smärre dammar i Polen (1,0), Tjeckien (1,2) och Bayern (1,24) samt bland kusthäckare i västra Finland (1,6). Andra studier visar högre värden (1,7–2,7), men dessa värden är troligen överskattningar på grund av att ungräkningarna gjorts för tidigt på säsongen. Det finns också studier med mycket lägre värden. Man måste dock hålla i minnet att det är svårt att fastställa antal bon och ungar, särskilt i större vatten. Jag tror genom min erfarenhet att de låga värdena kan bero på att man missat ungar. Om jag räknar antalet ungar endast för de par fått ungar får jag betydligt högre värden, väl i paritet med de högsta som noterats.

För en långlivad art som skäggdoppingen är 1,3 ungar per revirhållande par faktiskt ganska högt och fullt tillräckligt för att kompensera för dödligheten i populationen. Om man antar att varje par i genomsnitt bara behöver ersätta sig själva, att dödligheten under första året är ca 40% och därefter 25–35%, behöver endast sju ungar produceras under ett pars livstid. I min studie var produktionen nästan dubbelt så stor. Detta är sannolikt orsaken till att beståndet av skäggdopping har ökat i Dravsko polje i nordöstra Slovenien.

Bofölusterna var låga i min studie, endast 13,7% (Tabell 3). Enligt andra studier tycks predation vara den viktigaste faktor som begränsar häckningsframgången, men detta var inte fallet på mina lokaler. Jag noterade låg predation trots att bestånden av de främsta predatorerna inte var låg. Tätheterna av kråka och skata var normala för Europa, ungefär 2 respektive 5 par per kvadratkilometer. Eftersom dessa predatorer litar till synen, kan orsaken ha varit den täta vegetationen, som förhindrar upptäckt av doppingbona, som dessutom täcks över när föräldrarna lämnar dem. I motsats till andra studier fann jag inte någon högre predation vid högre täthet av doppingar; predationen var alltså inte täthetsberoende. Jag tror att andra faktorer, såsom biotopens skyddsförmåga och födotillgången är viktigare.

Allmänt kan sägas att bopredation bland fåglar som häckar både på öppen mark och i skog oftast är betydligt högre än vad jag funnit för skäggdoppingen. Tyvärr finns få studier av arter som häckar ”på” vatten, t.ex. rallar och doppingar, men det är möjligt att predationen generellt är lägre bland dessa. De få fall jag noterade gällde små ungar. Äldre ungar (och gamla fåglar) torde vara utsatt för relativt liten risk från fågelpredatorer, och rovdäggdjur hindras ofta av öppet vatten. Små ungar men inte större kan också tas av stora fiskar. Jag drar slutsatsen att båda mina lokaler är av hög kvalitet för doppingar och sannolikt också för andra vattenfåglar. Det verkar heller inte att finnas någon täthetsberoende bopredation hos skäggdoppingen, vilket man funnit hos exempelvis änder.